

SCIENCE TALENT SEARCH

A program of SOCIETY FOR SCIENCE Since 1942

# REGENERON SCIENCE TALENT SEARCH 2023 FINALISTS



The Regeneron Science Talent Search (Regeneron STS), a program of Society for Science, 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 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 2023**

### MARCH 9–14, 2023

The 40 finalists of the Regeneron Science Talent Search 2023, a program of Society for Science, were selected based on the scientific rigor and world-changing potential of their research projects. These students are invited to attend the Regeneron Science Talent Institute, where they will compete for \$1.8 million in awards.

The 40 finalists come from 34 schools, including one home school, in 14 states. Finalists were selected from 1,949 entrants, representing 627 high schools in 48 states, Washington, D.C., Puerto Rico, and four 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 2023 finalists, Regeneron and Society for Science acknowledge with gratitude the guidance, expertise and patience of the experienced researchers who made many of these projects possible.

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### REGENERON

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## HISTORY

The Science Talent Search (STS), a program of Society for Science 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 2023 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 24,511 finalists and scholars who have received more than \$34 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.

The top 40 finalists participate in a finals week competition, typically held in Washington, D.C. Finalists meet leading scientists and distinguished national leaders, and visit institutions of historic and political importance. Finalists will display their research at to the public in a virtual forum on March 12, where they describe their work to the public. 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 on March 14.

Each of the 300 students named a scholar in the Regeneron STS 2023 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 2023. The award is used to advance excellence in science, math and/or engineering education at the recipient school.



## Kamisi Adetunji She/Her/Hers

North Carolina School of Science and Mathematics NORTH CAROLINA

**Kamisi Adetunji**, 17, of **Holly Springs**, investigated a possible treatment for sickle cell disease (SCD) for her Regeneron Science Talent Search **biochemistry** project. SCD is a common genetic blood disorder found mostly in Africans and those of African descent, in which red blood cells change from a disc shape to a crescent (sickle) shape and block blood flow. The main cause of this change is the removal

of an oxygen atom from hemoglobin. Kamisi knew that aromatic aldehydes, which are chemical compounds that bind easily to oxygen, can prevent hemoglobin from losing oxygen. She further knew that flavonoids are natural antioxidants that neutralize oxygen-robbing free radicals. She therefore tried combining the two, extracting flavonoids from fruit and modifying their structures with aldehydes to increase their anti-sickling ability. She hopes her promising results might advance research on a treatment for SCD. The daughter of Moyin and Gbolabo Adetunji, Kamisi attends the **North Carolina School of Science and Mathematics** in Durham, is a dorm monitor, tutors math and co-leads Girl Up, a group that combats gender inequity. As dance captain of a West African Dance troupe, Kamisi instructs, choreographs and performs.



## Ariella Maia Blackman She/Her/Hers

Harrison High School NEW YORK

**Ariella Maia Blackman**, 18, of **Purchase**, investigated how simulated Martian soil could be modified to allow future astronauts to grow plants and thereby generate oxygen on Mars for her Regeneron Science Talent Search **plant sciences** project. Ariella used conventional potting soil from Earth as a control group and added different concentrations of another material, MGS-1, that mimics the regolith, or loose

rock and dust, found on Mars. She grew drought-tolerant tepary beans in various soil-regolith combinations over 20 days and entered the results into a mathematical model she developed to determine each plant's oxygen production. She found that the ideal ratio to optimize high oxygen production and lower the cost of transporting soil from Earth was between 50% and 75% MGS-1. Ariella is the drum major of the marching band at **Harrison High School**, where she is also active in musical theater and plays the flute in the chamber ensemble. She is the daughter of Rebecca and Keith Blackman and founded a Women in STEM program to benefit local Girl Scouts. An accomplished ballet dancer, she has performed since the age of three, and also enjoys volunteering with younger children during performances.



### **Angela Chen** She/Her/Hers North Carolina School of Science and Mathematics NORTH CAROLINA

**Angela Chen**, 17, of **Cary**, developed models for predicting California wildfire risk and burn areas based on nine environmental factors for her Regeneron Science Talent Search **environmental science** project. After a close family friend was nearly killed in a wildfire five years ago, Angela developed a machine learning model to quantify the effect of drought on overall burn area and published her findings in the International

Journal of Wildland Fire as sole author. Angela's project expands on that research to add eight more variables, such as wind speed and soil moisture, and quantifies their impact on fire risk and burn area. Drawing from 36 years of publicly available data, she developed models to calculate possible burn areas and regional wildfire risks based on those nine environmental variables. With a prediction rate of over 90% accuracy, Angela hopes her research can improve forecasting ahead of the state's future fire seasons. At **North Carolina School of Science and Mathematics** in Durham, Angela is co-president of the speech and debate club. She previously co-founded a nonprofit that arranges tutoring and tournaments for chess players from marginalized groups. Her parents are Chunling Tang and Dong Chen.



#### **Corona Chen** She/Her/Hers The University of Chicago Laboratory High School ILLINOIS

**Corona Chen**, 17, of **Chicago**, investigated the existence of microbial life deep within ordinary city concrete for her Regeneron Science Talent Search **environmental science** project. Corona demonstrated that these microbial communities are affected by the environmental conditions within the concrete as well as the environmental conditions that surround it, like the presence of water, air or soil. During her work,

she also demonstrated that viable fungal microbes exist within the concrete. She appears to be the first person to have done this. Her work may someday lead to the bioengineering of some of these microbes, enabling the biological repair of cracks in sidewalks and bridges. Extending the lifespan of concrete would reduce the greenhouse gas emissions associated with its production. Corona, the daughter of Junhong Chen and Zheng Li, is captain of the varsity girls' tennis team, a member of the math team, and founder and president of the science fair and research club at the University of **Chicago Laboratory High School**. She has performed in Carnegie Hall after winning the American Protégé Piano Concerto Competition and plays the violin and piano for her school's chamber music group.



## Madeleine de Belloy She/Her/Hers

Lycée Français de San Francisco CALIFORNIA

**Madeleine de Belloy**, 17, of **Tiburon**, helped untangle knot theory for her Regeneron Science Talent Search **mathematics** project. If you take a shoelace, tie a knot, and then glue the ends of the shoelace together, you get a knot that cannot be untied. Mathematicians care when one such knot can be turned into another. For her project, Madeleine studied mosaic depictions of these mathematical

knots, in which the knots are represented by small square tiles inside a larger square, much like an artistic mosaic on a table. Though all knots can be symbolized by a mosaic, some would require a lot of tiles and a very large table to put them on. Madeleine explored ways to predict which knots can fit on a table of a specific size. She also showed that a famous knot, called the 83 knot, cannot be represented with 36 tiles arranged in a 6-by-6 square. Madeleine, the daughter of Marisa Barbour de Belloy and Alexis de Belloy, attends **Lycée Français de San Francisco**. She has won a Gold Medal in the French Math Olympiad, and won a Google Play National Competition for a game she created that aims to make eating bugs fun, a cause she also champions through her climate-friendly food website Cool2Eat.



## Cindy DeDianous She/Her/Hers

Scarsdale High School NEW YORK

**Cindy DeDianous**, 17, of **Scarsdale**, conducted research on diabetic retinopathy for her Regeneron Science Talent Search **neuroscience** project. Diabetic retinopathy occurs after a person's high blood sugar levels damage the retina, and it is the leading cause of irreversible blindness in working-age adults. However, it can only be detected after damage to the eye's blood vessels has already occurred. Moreover, once the

condition is detected, treatment often only slows vision loss. Cindy's research on the eyes of diabetic mice demonstrated that damage to the retinal neurons actually began much earlier, within two weeks of the mice becoming diabetic. Cindy believes her research provides evidence that early diagnosis and treatment should focus on detecting retinal neuron damage to help prevent vision impairment. The daughter of Ivy and Jean-Luc DeDianous, Cindy is the co-captain of the **Scarsdale High School** speech and debate team and co-editor-in-chief of the school's scientific journal, which she co-founded. She also volunteers at the local public library, leading high school students in monthly discussions about books that address issues like racial justice and climate change and planning other community service projects.



#### August Deer He/Him/His Geffen Academy at UCLA CALIFORNIA

**August Deer**, 18, of **Venice**, helped make distributed learning more secure for his Regeneron Science Talent Search **computer science** project. Developers of popular tech devices like voice assistants and recommendation algorithms hope to one day employ a mathematical technique called federated learning. This will allow companies to improve services by utilizing the users' private data without sharing

it outright. Currently, even with federated learning, a malicious attacker might reverse engineer the process to acquire that data. August helped develop an improvement to federated learning to ensure that such attacks are made much more difficult. His key contribution was modifying an existing algorithm to work well even if a user's data suddenly became unavailable. While his theoretical research still requires real-world testing, he believes it has the potential to protect people's privacy while they use the web-based services they enjoy. August attends **Geffen Academy at UCLA** in Los Angeles. He is active in theater and plays classical piano. He also takes part in the UCLA Olga Radko Endowed Math Circle where he teaches advanced math to middle schoolers. The son of Laurie and Jonathan Deer, August is planning a career in mathematical research.



### Angie Fogarty She/Her/Hers Greenwich High School CONNECTICUT

**Angie Fogarty**, 17, of **Old Greenwich**, developed an inexpensive sensor that could potentially be used to prevent date rape for her Regeneron Science Talent Search **chemistry** project. Alcoholic beverages spiked with antihistamines can be used to carry out sexual assaults. Angie developed an easy-to-use, inexpensive sensor kit with a paper strip containing two dyes. The strip changes color when exposed

to a couple of drops of a potentially spiked liquid under the light from a UV flashlight, included in the kit. If the liquid contains a suspicious substance, the strip remains red; if not, it turns green. Finding in her tests that the acidity of the beverage affected the reaction, she added a step: adding a tiny amount of sodium hydroxide – now also included in the kit – to standardize the pH. Angie attends **Greenwich High School** where she is vice president of the science team and excels on the constitutional debate team. The daughter of David Fogarty, Angie is the vice president of her local B'nai B'rith organization and has worked with the Anti-Defamation League to raise awareness of antisemitism. She also volunteers with several organizations that help children with special needs and serves as a head coach of a Special Olympics sports team.



#### Ambika Grover She/Her/Hers Greenwich High School CONNECTICUT

**Ambika Grover**, 17, of **Riverside**, engineered a targeted therapy for patients of ischemic stroke, which is caused by blood clots that deprive the brain of oxygen, for the **medicine and health** project she submitted to the Regeneron Science Talent Search. Currently, tissue plasminogen activator (tPA) is used to treat ischemic stroke. Its shortcomings include the risk of bleeding elsewhere and an inability to stop new

clots from forming. To create her targeted therapy, Ambika used magnetic iron oxide nanoparticles coated with a layer of anti-coagulant to prevent more clots from forming and a layer of tPA to break up the clot. She then enclosed the nanoparticles in a shell to create an injectable microbubble and coated it with small proteins, called peptides, which are attracted to blood clots. She observed that her microbubbles were twice as effective as tPA alone at dissolving clots and show promise as a potential ischemic stroke treatment. At **Greenwich High School**, Ambika is president of the Girls Who Code Club, the economics club and the debate team and is one of 12 debaters selected from 140,000 to compete internationally with the USA Debate Team. The daughter of Jyoti and Rahul Grover, she also plays the viola in a string quartet.



#### Hannah Guan She/Her/Hers Basis San Antonio Shavano Campus TEXAS

Hannah Guan, 16, of San Antonio, created the Multi-Dimensional Interpretable Interaction Network (MDiiN) to better understand the dynamic process of aging for her Regeneron Science Talent Search **computational biology and bioinformatics** project. Hannah has researched aging for the past five years and believes that longitudinal measures (data captured over time) represent the aging process more

accurately than cross-sectional data, which capture only a moment in time. Hannah applied her math and coding backgrounds to combine a stochastic differential equation with a three-dimensional interaction network, capturing how health variables interact over time to model the aging process. MDiiN was the result. Hannah says that MDiiN can demonstrate how an individual's health evolves over time and what variables are most responsible for the changes. The daughter of Yu Zhang and Weihua Guan, Hannah attends **BASIS San Antonio Shavano Campus**. At age 11, she founded and became CEO of San Antonio Math Include, now an international program, and is editor-in-chief of *Mathemagic*. Hannah also founded and leads four STEM clubs and created and led the first-ever San Antonio Speak Up Teen Mental Health Survey.



### Fenghuan (Linda) He She/Her/Hers Commonwealth School

MASSACHUSETTS

**Fenghuan (Linda) He**, 17, of **Newton**, studied exoplanetary systems and how those planets' orbits may have been changed by close encounters with other objects for her **space science** project for the Regeneron Science Talent Search. The term "exoplanets" refers to any planet outside our own solar system. To collect her data, Linda customized two computer programs, REBOUND and GALA, which describe

solar system dynamics and galactic evolution, respectively, and she wrote custom code to mesh the two pieces of software. This allowed her to estimate the number of exoplanetary systems expected to have encountered a primordial black hole (or a similar compact astrophysical body) and to calculate the resulting changes in orbit. Once enough exoplanets have been discovered and cataloged, Linda's methods can potentially be used to test for the early existence of objects like primordial black holes. At **Commonwealth School in Boston**, Linda is founder and captain of the physics club and heads the math team. She is founder and CEO of GirlsxMRO, a nonprofit group teaching math research to middle school and teenage girls that has already reached more than 385 students in 14 countries. Linda's parents are Meijun Xu and Fangli He.



#### Michelle Hua She/Her/Hers Cranbrook Kingswood School MICHIGAN

**Michelle Hua**, 18, of **Troy**, brought still video frames to life for her Regeneron Science Talent Search **computer science** project. Computers get more powerful all the time but still struggle to do things humans find easy. For example, they have a hard time understanding how a dancer's body moves in space during a pirouette. Michelle first taught the computer the simple task of looking for joints and the silhouette in a

video frame. She then taught it to estimate how the rest of the body is oriented in space, using the joints and silhouette as clues. By breaking the problem into these steps, Michelle's algorithm works better than existing methods of reconstructing a 3D human model from a video frame, and like a keen student, it requires fewer examples of correctly labeled data to learn how to solve the problem. Michele, who has had prior research published in the journal *Computer-Aided Geometric Design*, attends **Cranbrook Kingswood School** in Bloomfield Hills and is the co-founder of the Sunshine Dance Group, which performs at local events and competitions. As a competitive rhythmic gymnast for 11 years, Michelle won two silver medals at the 2022 USA Gymnastics Championships. She is the daughter of Juan Qian and Jing Hua.



## Linden Chi James They/Them/Theirs

North Carolina School of Science and Mathematics NORTH CAROLINA

**Linden Chi James**, 17, of **Durham**, investigated the potential of the thyroid hormone T3 to treat traumatic brain injury (TBI) in humans using wax moth larvae as the model for their Regeneron Science Talent Search **cellular and molecular biology** project. Wax moth larvae (caterpillars) share physiological similarities with humans, including central nervous system cells and Juvenile Hormone, a caterpillar version of human

T3. For their research, Linden inflicted groups of caterpillars, outside the control group, with TBI, treated them with Juvenile Hormone and then analyzed their blood (hemolymph) for concentrations of immune cells and the presence of toxic molecules that are markers of TBI. Agility tests were run before and after treatment to measure and compare caterpillar motor function. They believe their results show that T3 may be a promising treatment for TBI in humans. Linden attends **North Carolina School of Science and Mathematics**, where they have been the design-competition lead for the robotics team and help teach and tutor Spanish. Involved with social justice, Linden volunteers with Kids Voting Durham and received a grant to create an LGBTQ+ library. Their parents are Jules and Kelly James.



## Thaddaeus Kiker He/Him/His

Sunny Hills High School CALIFORNIA

**Thaddaeus Kiker**, 18, of **Fullerton**, developed a machine learning approach to predict the presence and properties of quasi-periodic oscillations (QPOs) in black holes for his Regeneron Science Talent Search **space science** project. While scientists have long known about QPOs and proposed theories for their occurrence, they don't know exactly why X-ray light from black holes flickers in these ways. Thaddaeus trained

his models to make these predictions based on spectral properties like accretion disk temperature. Then he developed open-source software to allow other researchers to apply his methods to their own work. Thaddaeus hopes his work will help "to unlock mysteries about QPOs and their black hole progenitors" when extended to multiple systems simultaneously. At **Sunny Hills High School**, Thaddaeus swims and heads the research laboratory, which he founded at his old high school and brought with him when he moved to California. The club's first research project about young stars was published in a peer-reviewed journal, and they have since worked on genomics and exoplanet related projects as well, unexpectedly discovering a rare type of star along the way. Thaddaeus is the son of Anna and Jason Kiker.



#### **Elane Kim** She/Her/Hers Stanford University Online High School CALIFORNIA

**Elane Kim**, 18, of **Walnut Creek**, studied the effect of a cytotoxic cancer drug on the loss of taste, a common side effect of chemotherapy, for her Regeneron Science Talent Search **medicine and health** project. The tongue's taste buds hold receptor cells (TRCs), which convey the sense of taste. Elane began her project by analyzing specialized microscopic images of immunofluorescent stained tissues from the part

of the taste bud where TRCs proliferate from stem cells. She observed that TRC stem cells naturally grow in uneven patterns. Elane then studied how the location and stages of early TRC stem cells changed in response to a cancer drug associated with loss of taste and found that the cells' overall growth decreased in response to chemotherapy, regardless of where the cells were located in the taste bud papillae. Elane attends **Stanford University Online High School** in Redwood City. She is the founder and editor-in-chief of *Gaia Literary Magazine*, which focuses on environmental activism, and editor-in-chief of The Chrysalis, the school's literary magazine. The daughter of Ann Kim, Elane is a published, award-winning author of poetry and short stories and in 2022 was named a Davidson Fellow in Literature.



#### **Emily Kim** She/Her/Hers Jericho Senior High School NEW YORK

**Emily Kim**, 17, of **Jericho**, examined the potential of activated carbon to remove synthetic dyes for her Regeneron Science Talent Search **environmental science** project. Her interest in this topic was stirred when she learned that biotoxic dye waste from the fast fashion and textile industries contributes to about 20% of the world's industrial pollution. Emily began by investigating activated carbon's ability to remove

two differently structured and commonly used azo dyes. She found that adsorption, by which the activated carbon pulls the dye molecules from the water, removed about 99% of the first dye but only 22% of the second. Then she added UV light, which increased the removal of the second dye to 92%. While further research is needed, Emily believes her experiment demonstrates promise in using activated carbon to reduce pollution from the fast fashion industry – which she says would be efficient and cost-effective. Emily attends **Jericho Senior High School**, where she is president of the Research and Heritage Committee Club. Since learning about the environmental harms caused by fast fashion, she has launched a nonprofit that raises awareness of the issue and collects and recycles clothing.



**Evan Kim** He/Him/His Tesla STEM High School WASHINGTON

**Evan Kim**, 17, of **Redmond**, used machine learning software to identify new hypothetical superconductors for his Regeneron Science Talent Search **physics** project. A superconductor is an element or alloy that can conduct electricity perfectly, without resistance. Still, to do so, it needs to be supercooled, usually to near minus 459 F. A few "high-temperature" superconductors (HTS) have been identified that

are capable of working at temperatures as warm as minus 280 F, which is above the practical temperature of liquid nitrogen. Evan used a type of machine learning to mimic the characteristics of known superconductors in hopes of discovering similar elements and alloys. Previous attempts, which Evan refers to as "guess-and-check" techniques, had an average success rate of only 3%, but according to an established computer model, more than 70% of his newly predicted compounds appear to be superconductors, and at least one appears to be an HTS. Evan attends **Tesla STEM High Schoo**l, where he is president of the physics and science bowl clubs. He also coaches a middle school math club and volunteers with the Online Physics Olympiad. Evan is the son of Justin Kim and Hyeweon Park.



#### **Ryan Lee** He/Him/His Palo Alto High School CALIFORNIA

**Ryan Lee**, 18, of **Palo Alto**, studied the effects of impaired mitochondria, a cell's energy source, on neurodegeneration for his Regeneron Science Talent Search **cellular and molecular biology** project. Neurons can change their shape and size in response to new experiences, a property known as structural plasticity. Ryan proposed that interrupting the neurons' energy source by preventing mitochondrial

fission (splitting) might affect this plasticity. For his research, he used fruit fly circadian neurons, which expand at dawn and retract at dusk, from genetically modified fruit flies with reduced levels of a protein critical for mitochondrial fission. Ryan found that impairing the fission lowered the cell's structural plasticity and led to a complete loss of synapses as the fruit flies aged. He believes his findings suggest that a cellular energy crisis could be an underlying cause of diseases like Alzheimer's. At **Palo Alto High School**, Ryan served as "build captain" for the robotics team and co-captain of the Technology Student Association TEAMS Competition club, which competes nationally. The son of Emily and Roger Lee, he is an Eagle Scout, a search-and-rescue responder with California Emergency Services and an award-winning photographer.



## Miah Christina Margiano She/Her/Hers

Saint Anthony's High School NEW YORK

**Miah Christina Margiano**, 18, of **Syosset**, is a survivor of childhood leukemia who studied neuroblastoma (NB) for her Regeneron Science Talent Search **cellular and molecular biology** project. Miah hopes to improve therapies for people with NB, the deadliest and most common cancer diagnosed in children under five. NB develops from immature nerve cells and exists in both high-risk and low-risk forms, with a

survival rate of just 50% in high-risk neuroblastoma. In low-risk NB, the cancerous tumor tends to respond well to therapy and may disappear with little medical intervention, so it would be useful to identify genetic differences between high-risk and low-risk NB. Miah used computational analysis to identify a genetic sequence for a long non-coding RNA that was expressed in higher amounts among low-risk patients. This may help regulate tumor growth pathways and be associated with increased survival. Her findings present a promising target for future research. At **Saint Anthony's High School** in Melville, Miah started a science research fair to help fellow students sharpen their communication skills. Miah also founded the nonprofit Miah's Hope to raise awareness about pediatric cancer. She is the daughter of Michelle Ricaurte.



## Marissa Lilianna Martinez She/Her/Hers

Monte Vista High School COLORADO

**Marissa Lilianna Martinez**, 18, of **Del Norte**, developed a diagnostic scoring tool to assess habitat quality for an endangered bird, the southwestern willow flycatcher, for her Regeneron Science Talent Search project in **animal sciences**. First, she gathered original data in the Upper Rio Grande watershed about habitat, vegetation coverage and food availability in potential sites both occupied and unoccupied by the birds.

Then, she statistically analyzed these factors, which revealed significant differences between the occupied and unoccupied areas. Using these differences, Marissa created a diagnostic tool that determines whether a habitat is suitable or poor. She believes this tool could be used to assess the suitability of other potential willow flycatcher habitats in this watershed while identifying problem areas and suggesting strategies for land management. Marissa, the daughter of Lisa Martinez, attends **Monte Vista High School**. Last summer, she helped with a large-scale amphibian survey while volunteering with the Bureau of Land Management. In her spare time, she enjoys hiking and fishing and hopes to become a field biologist to deepen her understanding of how organisms interact with the natural environment.



### Samantha Maya Milewicz She/Her/Hers

Byram Hills High School NEW YORK

**Samantha Maya Milewicz**, 17, of **Armonk**, studied how the body's immune reaction to traumatic brain injury (TBI) can lead to secondary injury by damaging the protective blood-brain barrier (BBB) for her Regeneron Science Talent Search **neuroscience** project. One element of this protection is claudin-5, a protein that helps hold the cells that line the brain's blood vessels tightly together. For her research, Samantha used a

model of the BBB that mimicked the conditions of a TBI. She found that following a TBI, the body overproduces a protein called MMP-9; this causes the claudin-5 to degrade and this decreases the barrier's protective effect. Using different agents to reduce MMP-9 overproduction, Samantha was able to restore BBB function in the model, providing insight into MMP-9's potential as a target for future therapeutic development. The daughter of Meredith and Steven Milewicz, Samantha presides over four clubs at **Byram Hills High School**, where she is a member of the principal's advisory committee and editor-in-chief of the school paper. She also volunteers as a firefighter, is a nationally certified EMT and a freelance photographer who displays and sells her artistic works at galleries.



#### Max Misterka He/Him/His Misterka Homeschool VIRGINIA

**Max Misterka**, 16, of **Harrisonburg**, studied q-calculus for his Regeneron Science Talent Search **mathematics** project. In calculus, students learn about the derivative and some of its rules. In *q*-calculus, students work with a quantized derivative, called the *q*-derivative, which has analogous rules. Initially, Max set out to prove properties about a related topic concerning F-de Rham complexes, but had a key insight,

and introduced a new tool called the s-derivative. Using this tool, itself a generalization of the *q*-derivative, Max proved far more than he anticipated by showing that his s-derivative satisfied many of the analogous rules of their *q* counterparts. Max hopes that his s-derivatives will prove useful in quantum physics and spur mathematicians to think of other ways to use and generalize the *q*-derivative. The son of Shannon Fitzgerald and Jason Misterka, Max is **homeschooled**. He enjoys playing basketball and has sung in a local choir for six years. An accomplished pianist, he has won the James Madison University Young Composers' Contest four times. He loves pure research and says, "Real math is about being creative, noticing and exploring patterns and giving logical arguments to show why the patterns happen."



### **Neel Moudgal** He/Him/His Saline High School MICHIGAN

**Neel Moudgal**, 17, of **Saline**, developed a computer model that can predict the structure of various RNA molecules to make it easier to diagnose and treat disease for his Regeneron Science Talent Search **computational biology and bioinformatics** project. Existing tools predicting RNA structure use measurements of the magnetic vibration of atoms known as "chemical shift data" collected from a nuclear magnetic

resonance spectrometer. These methods rely on assigning chemical shift values to each atom in a given molecule, which sometimes proves impossible. Neel's computational model contains a library of possible shapes for a given RNA molecule based on its atomic structure. A statistical method assigns weights to each structure in the library, favoring structures that closely resemble experimental data. By using 2D histograms for reweighting, his model eliminates the need to assign chemical shift data. Neel is first author of a peer-reviewed article on his work. At **Saline High School**, Neel is captain of the varsity quiz bowl team, a programmer for the robotics team and a teacher's assistant for special needs children. The son of Varsha and Vivek Moudgal, he is a second-degree black belt in Taekwondo.



#### **Ishika Nag** She/Her/Hers Oviedo High School FLORIDA

**Ishika Nag**, 17, of **Oviedo**, developed a reusable and rechargeable face mask coated with nanoparticles that offers safe and effective protection from both air pollution and viruses for her **environmental science** project for the Regeneron Science Talent Search. After a 2016 visit to a pollution-prone city in India, Ishika was inspired to develop a cost-effective face mask. Then, during the pandemic with its associated

shortage of single-use face masks, she added the objective of making her masks reusable. She had layers of her masks coated with combinations of non-toxic nanoparticles chosen for their virus- and particulate-blocking properties. She then tested them in her family's patio-turned-science lab. Ishika also found that the masks could be safely reused by plugging them into a battery pack or wall outlet to restore their electrostatic charge. Ishika has two patents pending, has presented her work at conferences and is the sole author of two peer-reviewed journal articles. The daughter of Sukanya and Pratyush Nag, she attends **Oviedo High School**. In her spare time, Ishika founded an engineering club to inspire elementary schoolers, and she has coached its third graders to win regional and national mousetrap car competitions.



#### Lavanya Natarajan She/Her/Hers Viera High School

FLORIDA

**Lavanya Natarajan**, 17, of **Melbourne**, developed a device that might help reduce the amount of methane being released from municipal landfills for her **engineering** project for the Regeneron Science Talent Search. Landfills produce gas that is roughly 50% methane – and alarmingly, that methane traps heat in the atmosphere up to 80 times more effectively than carbon dioxide. Interested in reducing global warming,

Lavanya developed a relatively inexpensive wireless device that remotely monitors a landfill's greenhouse gases and other parameters. The data can then be accessed using a smartphone. Ideally, methane is pumped out of landfills when concentrations get high, but measuring it is cumbersome, so pumping gets delayed, which means that much of the methane escapes. This new device should make it easier to pump out the methane appropriately. She has tested her device, first in the lab she set up in her family's garage and then at an actual landfill. The daughter of Sanjay Natarajan and Lakshmi Narayanan, Lavanya led the varsity tennis team at **Viera High School**, where she also led a successful fund-raising effort to repair their old tennis facility. Additionally, she taught coding and mentored kids on how to solve Rubik's cubes.



## Oziomachukwu Chidubem Obi He/Him/His

North Carolina School of Science and Mathematics NORTH CAROLINA

**Oziomachukwu Chidubem Obi**, 16, of **Greenville**, investigated the ability of a combination of drugs to combat neurodegeneration in multiple sclerosis (MS) for his Regeneron Science Talent Search **neuroscience** project. In MS, the body's immune system attacks the fatty myelin sheath surrounding the axon of the neuron (nerve cell), disrupting the smooth flow of electrical impulses and increasing the

time neurons need to recharge between impulses called the "refractory period." Ozioma combined Ibudilast and Interleukin 4, two drugs used for multiple sclerosis treatment, and tested them on an earthworm model of MS that he created. He compared the effectiveness of the combined drugs to that of individual treatments by determining the changes in refractory period length and observed that the combination worked better than the individual treatments in restoring normal neuron function. At **North Carolina School of Science and Mathematics** in Durham, Ozioma is a varsity swimmer, captains the quiz bowl team and leads the Black Student Union. The son of Ogugua and Reginald Obi, Ozioma is concertmaster of the school orchestra and was threetime first violinist in the All-State Honors Orchestra.



#### **Emily Ocasio** She/Her/Hers New School of Northern Virginia VIRGINIA

**Emily Ocasio**, 18, of **Falls Church**, used artificial intelligence and natural language processing (NLP) to measure the impact of a homicide victim's demographics on press coverage for her **behavioral and social sciences** project submitted to the Regeneron Science Talent Search. Emily scoured publicly available FBI homicide records from Massachusetts between 1976 and 1984 and matched victims with

their corresponding Boston Globe articles. She then used NLP to assess each article for the amount of humanizing or impersonal language used to describe the victim. Coverage is considered humanizing when it includes personal information such as a victim's family, occupation or interests. Emily's results showed that news reports included fewer humanizing details in articles about Black male homicide victims than in those about white males. There were also fewer humanizing details in articles about young Black female victims. Emily hopes her findings will help raise awareness of media coverage bias. At **New School of Northern Virginia** in Fairfax, she is the student government president and leads its fairness committee. She is also CEO of a nonprofit called the GirlsComputingLeague. Her parents are Trina and Wendell Ocasio.



#### **Siddhu Pachipala** He/Him/His The Woodlands College Park High School TEXAS

**Siddhu Pachipala**, 18, of **The Woodlands**, aimed to develop a machine-learning tool that uses patients' writing to assess their suicide risk and best course of treatment for his Regeneron Science Talent Search **behavioral and social sciences** project. Treating high-risk patients has been shown to reduce suicide attempts, but existing assessments have led to under-detection. Using linguistic analysis, Siddhu evaluated

diary entries from existing suicidality assessment data. He then wrote code to predict someone's suicide risk based on two language properties. One is syntax – or grammatical qualities – and the other is semantics, or meaning. Of his two models, the one that found correlations between semantics, suicide risk and course of treatment appeared to be more accurate than the one looking at syntax. He believes this suggests that using semantics to gauge psychological health merits future study. Siddhu attends **The Woodlands College Park High School**. The son of Sharmila Naidu and Krishna Pachipala, he also works as a research intern for the University of California's EdgeLab. He has researched political party affiliation and belief polarization, and has also developed an ASL interpreter that accounts for ethnic dialects.



### Joseph Miguel Robertazzi He/Him/His

Ossining High School NEW YORK

**Joseph Miguel Robertazzi**, 18, of **Ossining**, investigated whether a site of reduced strength in the Earth's magnetic field in the southern hemisphere influences the migratory patterns of birds for his **animal sciences** project for the Regeneron Science Talent Search. Using publicly available data, he employed methods that he developed himself in the programming language Python to analyze the migratory patterns of

four species of long-distance birds that fly through an area known as the South Atlantic Anomaly. He found that the largest groups of bird species tend to shift away from the anomaly, centered over South America, where the strength has weakened. He believes this marks the first time a researcher has used Python to investigate the anomaly's impact on American migratory bird populations, opening the door for future research in the area of magnetoreception in birds and magnetic anomalies. Joseph attends **Ossining High School**, where he captains the varsity cross country team, plays the cello and takes part in the school's engineering club, for which he recently had middle school students design a robot during a summer robotics workshop. The son of Linda Salvador and Raphael Robertazzi, Joseph hopes to become a data scientist.



### Joshua Logan Shunk He/Him/His Perry High School

ARIZONA

**Joshua Logan Shunk**, 18, of **Gilbert**, improved training of neural networks for his Regeneron Science Talent Search **computer science** project. During the COVID-19 pandemic, Joshua made a computer program that could look at chest x-rays and predict whether patients had COVID-19 or pneumonia. Joshua found that sometimes while training his program to find patterns, it would find some that were not really

there. For example, it associated wider chests with pneumonia. This led Joshua to study "regularizers," which are tools that gently guide algorithms to look for the right kinds of patterns. For his project, Joshua developed a variant of an existing regularizer, which he calls "neuron-specific dropout." Joshua's variant works especially well on networks that find patterns in images, allowing them to train faster and find patterns with greater accuracy while using less data. Joshua attends **Perry High School** where he is the team captain of the Varsity Division I ice hockey team. He has won two all-academic awards and an all-state honor through the Arizona High School Hockey Association. The son of Susan and Benjamin Shunk, Joshua is planning to study computer science and cognitive neuroscience.



## Diego Emilio Suchenski Loustaunau He/Him/His

Massachusetts Academy of Math & Science MASSACHUSETTS

**Diego Emilio Suchenski Loustaunau**, 17, of **Worcester**, sought methods to improve the efficiency of cancer-fighting drugs for his Regeneron Science Talent Search **biochemistry** project. Cancer cells undergo multiple and frequent DNA changes that may cause rapid growth and drug resistance. A group of proteins called the APOBEC superfamily are responsible for over half of these damaging DNA changes. Diego

used computational biology to design versions of inhibitors of the specific protein APOBEC3G. He simulated adding fluorine to oligonucleotides containing the anti-mutagenesis drug zebularine and found it improved the drug's ability to lock on to the dangerous protein and thereby prevent cellular DNA changes. Future experiments and refinement of these inhibitors may help researchers develop more effective cancer treatments. The son of Kathleen Suchenski and Esteban Loustaunau, Diego is involved in many clubs at the **Massachusetts Academy of Math & Science**, but a favorite pastime is writing. "Whether it's short stories that project surrealism into my emotions, vignettes about chemical groups, or even poetry about napping, writing has helped me make sense of so many different parts of my life and the world."



## Jason Christopher Wang He/Him/His

Brentwood High School TENNESSEE

Jason Christopher Wang, 18, of Brentwood, explored how the connections among cancer cells are affected by changes in the signals that control when and how versions of specific proteins are expressed for his Regeneron Science Talent Search cellular and molecular biology project. Healthy cells stick together using a protein called cadherin. In cancer cells, this protein may become defective, allowing the

cancer cells to roam free (metastasize). Using a mouse cell line, Jason identified how and why different versions of a signaling protein, called Ras, affect this process. His results provide insight into early changes at the molecular level, which he hopes will advance the understanding of the fundamental mechanisms of cancer growth, allowing for more efficient screening and earlier cancer detection. Jason is an elite swimmer and record holder at **Brentwood High School**, and a two-time USA Scholastic All-American with records in backstroke and breaststroke. He has taught English to young children in Costa Rica, plans to study biomedical engineering in college, and aspires to create his own biotechnology startup. Jason is the son of Yalin Chang and Gordon Wang, who introduced him to the microscope, a most cherished memory.



#### **Nolan Wen** He/Him/His American Heritage School Boca-Delray FLORIDA

**Nolan Wen**, 17, of **Boynton Beach**, developed a way to adjust the mechanical and adhesive properties of hydrogels for his Regeneron Science Talent Search **chemistry project**. Hydrogels are polymers that can absorb large amounts of water without dissolving and are being investigated for potential applications in wound healing and tissue regeneration. After conducting a literature review on an aspect

of tissue engineering, which resulted in his publishing a paper in a peer-reviewed journal, Nolan decided to test materials that could be added to hydrogels to adjust their properties and microstructure to aid in these biomedical applications. He found that adding small amounts of synthetic clay nanoparticles allowed him to adjust the properties of the hydrogels as he desired. Nolan hopes his research will advance the efforts of other scientists to create entire organs in laboratories for human implantation. The son of Haibo and Li Wen, Nolan attends the **American Heritage School Boca-Delray**, where he is vice president of the Model UN and president of the local branch of an organization that teaches rural Cambodians English remotely. He is a pianist and enjoys playing basketball, soccer and football.



#### **Vivian Wu** She/Her/Hers Palo Alto High School CALIFORNIA

**Vivian Wu**, 18, of **Palo Alto**, investigated whether formic acid, a popular agent used by beekeepers to kill varroa mites, negatively affects the foraging abilities of honeybees for her Regeneron Science Talent Search **animal sciences** project. Vivian used radio frequency identification tags to track the number and duration of flights of both developing and mature worker bees. She analyzed her data using a Python algorithm

she wrote herself. When formic acid was applied, test bees experienced declines in the duration and number of foraging trips and the number of days spent foraging. These numbers eventually recovered, but only to lower levels than her control bees. Vivian concluded that the use of formic acid significantly reduced the bee colony's ability to forage, likely due to the acid's impact on energy production at the cellular level. This research warrants further investigation into varroa mite treatment options. Vivian attends **Palo Alto High School**, where she co-captains the girls' varsity basketball team and a STEM team. She is also an Eagle Scout and translates STEM materials into Chinese for a local nonprofit. The daughter of Hai Wu and Yumei Xiong, Vivian wants to study environmental science in college and become a researcher.



**Ellen Xu** She/Her/Hers Del Norte High School CALIFORNIA

**Ellen Xu**, 17, of **San Diego**, developed a convolutional neural network, a subset of machine learning used for image analysis, to help diagnose Kawasaki Disease (KD) for her Regeneron Science Talent Search **medicine and health** project. As the leading cause of acquired heart disease and coronary artery aneurysms in children between the ages of 1 and 5, a KD diagnosis is based on five visual signs that can easily be

confused with other diseases. To improve identification, Ellen pre-trained her model with images of KD and lookalike diseases from the Internet and images provided by parents of KD children. To generate a larger dataset, she altered the images by adding a variety of random photographic transformations. Ellen's work indicates that her model can distinguish between children with and without clinical manifestations of KD with 85% specificity using a smartphone photo of the child. Ellen is first author of an article on her research published in a peer-reviewed journal. The daughter of Lin Jiang and Hao Xu, Ellen is co-editor-in-chief of the **Del Norte High School'**s award-winning literary magazine, founder of a non-profit which has taught cybersecurity to girls of military families, and a nationally and internationally ranked saber fencer.



#### **Jeffrey Xu** He/Him/His Lowell High School CALIFORNIA

**Jeffrey Xu**, 17, of **San Francisco**, investigated the structure of an important immune cell surface receptor for his **cellular and molecular biology** project for the Regeneron Science Talent Search. These cellular receptors tell the immune cells where to go and what to do in the body. Interested in exploring the intersections between immunology and oncology, Jeffrey examined the structure of one of these receptors,

CCR6, which plays a crucial role in how immune cells migrate to cancer cells and infection sites. He altered the protein structure of the receptor and compared how that alteration affected the mobility of the immune cells. This allowed him to identify multiple locations on the CCR6 protein that he believes are important for future study. He hopes this work will lead to improved medical treatments that rely on either enhancing or diminishing how immune cells migrate. Jeffrey attends **Lowell High School**, where he is the secretary of the science research program, plays the violin, and was a concertmaster for the school's advanced orchestra. Jeffrey, the son of Yan Wang and Xiang Xu, is also an award-winning swimmer. In his spare time, the amateur magician enjoys performing sleight-of-hand demonstrations and card tricks.



**Ethan Zhou** He/Him/His McLean High School VIRGINIA

**Ethan Zhou**, 18, of **Vienna**, worked on a type of machine learning for his Regeneron Science Talent Search **mathematics** project. Ethan's work is especially useful for algorithms that predict events that are naturally revealed over time. For example, the program may be tasked with predicting Tuesday's weather and then predicting Wednesday's weather once it learns whether it was right about Tuesday. Over time,

the predictions get better and better as the algorithm learns from its mistakes. Ethan investigated how well these algorithms can perform when confronted with something very unpredictable. He developed new bounds in both the single-variable case, when the prediction depends on a single number like temperature, and multi-variable cases, when a prediction involves more than one numerical input, like temperature, humidity and wind speed. At **McLean High School**, Ethan is a three-time USA Math Olympiad qualifier and heads the math league, where he helped double the size of the club. He is also a prize-winning pianist, a skill he has honed for more than a decade. The son of Jia Hong and Guangming Zhou, Ethan has also tutored at the Hope Chinese School for five years.



#### **Kevin Zhu** He/Him/His Jericho Senior High School NEW YORK

**Kevin Zhu**, 18, of **Old Westbury**, used computational methods to identify new biomarkers that may enable earlier and easier detection of certain cancers for his **genomics** project for the Regeneron Science Talent Search. Although the biology of cancer is incredibly complex, its origin is conceptually simple: genetic "mistakes" develop in the DNA of previously healthy cells, which change how they replicate,

making them cancerous over time. Two relatively unstudied ways this occurs in DNA are recurrent repeat contractions (rRCs) and micro-changing short tandem repeats (mcSTRs). Kevin used a database of genomic information to identify these types of genetic changes in cancer subtypes and was able to show that they appear to cluster in areas associated with known DNA changes that lead to cancer. He then performed *in vitro* experiments which validated his results by showing that rRCs and mcSTRs could potentially be identified in blood plasma, meaning that these could serve as future cancer biomarkers in the blood. An accomplished pianist, Kevin attends **Jericho Senior High School** and is the CEO of The Incandescent, an organization promoting teenage mental health through creative arts and mentorship. His parents are Julia and Nelson Zhu.



#### **Sally Zhu** She/Her/Hers The Harker School CALIFORNIA

**Sally Zhu**, 17, of **Saratoga**, made waves with her Regeneron Science Talent Search **mathematics** project. Many people are familiar with how waves move on the surface of water in a fish tank, but there are also waves that travel below the surface, called internal waves. Understanding these waves mathematically is difficult because they bounce off of walls in an extremely complex way. In her project, Sally addressed

this difficulty by showing that internal waves that undergo "chess billiard flow" in a two-dimensional square fish tank will always go from choppy to smooth if a certain number, called the rotation number, of the tank is a Diophantine number (an irrational number that cannot be neatly approximated with rational numbers). Not only did Sally add to the field theoretically, but she also performed numerical experiments on a computer and generated plots to intuitively explain her theoretical results, which she hopes will help scientists in fluid dynamics and oceanography. The daughter of Huican Zhu and Hong Wei, Sally attends **The Harker School** in San Jose. In addition to her expertise in math, Sally has a published research note in astronomy and is the editor-in-chief for her high school's newspaper, the *Harker Aquila*.



#### **Sophie Zhu** She/Her/Hers Williamsville East High School NEW YORK

**Sophie Zhu,** 16, of **Buffalo**, studied factorization, one of the oldest and most fundamental topics in **mathematics** for her Regeneron Science Talent Search project. Every positive whole number admits a unique factorization into prime numbers, meaning that it can only be written as the product of prime numbers in one way. In her project, Sophie studied this problem, but in a much more abstract setting.

Instead of whole numbers, Sophie studied when semirings of evaluated Laurent polynomials admit factorization by addition. She went even further by characterizing precisely when these semirings satisfy the ascending chain condition in terms of certain factorization properties. She has published two peer-reviewed journal papers on abstract algebra and is the sole author of one of them. The daughter of Hui Zhu, Sophie has served as a youth fellow and ambassador of the Just Buffalo Literary Center. She also writes poetry, studies literary criticism and promotes literary arts to her city's youth. At **Williamsville East High School** in East Amherst, Sophie is co-editor-in-chief of the literary digest and heads the math club. An award-winning pianist, she has performed classical music at Carnegie Hall.

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Pachipala, Siddhu	Behavioral and Social Sciences	
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#### **About Regeneron**

Regeneron is a leading biotechnology company that invents, develops and commercializes life-transforming medicines for people with serious diseases. Founded and led for nearly 35 years by physician-scientists, Regeneron's unique ability to repeatedly and consistently translate science into medicine has led to numerous FDA-approved treatments and product candidates in development, almost all of which were homegrown in Regeneron's laboratories. Regeneron's medicines and pipeline are designed to help patients with eye diseases, allergic and inflammatory diseases, cancer, cardiovascular and metabolic diseases, pain, hematologic conditions, infectious diseases and rare diseases.

Regeneron's long-standing commitment to corporate responsibility is crucial to achieving our mission of delivering vital medicines to patients. We leverage the unique knowledge and expertise within our company to focus on three goals: improving the lives of people with serious diseases, fostering a culture of integrity and excellence and building sustainable communities. Our most significant philanthropic commitments focus on fostering future scientific leaders through STEM education outreach and equity, including the Regeneron Science Talent Search and Regeneron International Science and Engineering Fair. Regeneron is proud to be included on the Dow Jones Sustainability World Index, the Civic 50 list of the most "community-minded" companies in the United States and *Newsweek* America's Most Responsible Companies.

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