Thermo Fisher Scientific

Junior Innovators Challenge

A program of Society for Science

+

Thermo Fisher Scientific Junior Innovators Challenge 2024

FINALISTS

2024 Thermo Fisher Scientific Junior Innovators Challenge (JIC) October 25–October 30, 2024

The Thermo Fisher Scientific Junior Innovators Challenge (JIC), a program of Society for Science, is the premier middle school science and engineering research competition in the United States.

The Thermo Fisher JIC is the only middle school Science, Technology, Engineering and Math (STEM) competition that leverages Society-affiliated fairs across the nation. The top 10% of 6th, 7th and 8th grade students from these fairs are nominated to compete in the 2024 Thermo Fisher JIC. The Top 300 Junior Innovators are selected by scientists, engineers and educators through comprehensive scoring of their online applications.

From the Top 300, 30 finalists are selected to participate in Finals Week in Washington, D.C., and compete in team STEM challenges that test their abilities in critical thinking, collaboration, communication and creativity through project-based learning. Top awards total more than $100,000, and include the $25,000 Thermo Fisher Scientific ASCEND Award, STEM summer camps and more.

Society for Science thanks the following for their support of the Thermo Fisher JIC:

Title Sponsor

Thermo Fisher Scientific

Competition Sponsors

- Broadcom Foundation
- U.S. Dept. of Defense/DoD STEM
- Robert Wood Johnson Foundation
- The Lemelson Foundation
- TIES
- Wolfram Research

Educational Partners

- Smithsonian Environmental Research Center
- Society for Science's ~300 affiliated state and regional science and engineering fairs
- Parents/guardians, teachers and mentors of all the Thermo Fisher JIC nominees

Table of Contents

Why Middle School?

Middle school is a time of transition, when many students begin to drift away from their interests in science and engineering. During this critical period, it is important to bolster young people's confidence in STEM. The Thermo Fisher JIC provides a means for students to be celebrated for their accomplishments in STEM at this significant time.

Participants in the Thermo Fisher JIC are inspired, mentored and encouraged to continue to follow their passion for scientific research through high school and beyond so that they are prepared to pursue exciting STEM careers.

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

The Process

To participate in the Thermo Fisher JIC, 6th, 7th and 8th grade students enter an independent science or engineering project in their Society-affiliated state or regional science fair. Judges nominate the top 10% of these competitors to enter the Thermo Fisher JIC. There are thousands of nominees each year.

Nominees go online to complete the comprehensive Thermo Fisher JIC application and the entries are scored by scientists, engineers and educators during the summer.

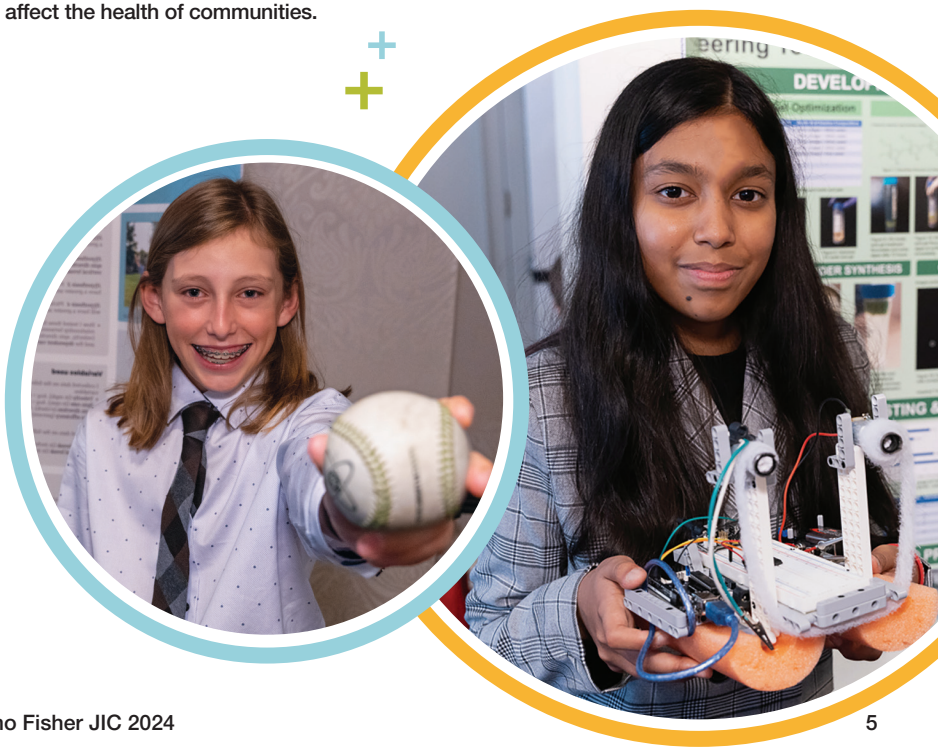
The Society announces the Top 300 Junior Innovators in late summer each year. The Top 300 and their teachers receive prizes to recognize their achievements.

Thirty competitors are selected from the Top 300 to compete as Thermo Fisher JIC finalists. Finalists receive an all-expense-paid trip to Washington, D.C., to showcase their projects and compete in teams to demonstrate their STEM acumen along with their skills in communication, collaboration and creativity. They also visit historical sites in the nation's capital that celebrate innovation.

Awards

Finalists receive a cash award of $500 from the Thermo Fisher JIC in recognition of their advancement to Finals Week. Based on their performance during three days of competition, finalists may receive top awards, including:

- **Thermo Fisher Scientific ASCEND Award (Aspiring Scientists Cultivating Exciting New Discoveries)** of $25,000, which recognizes the finalist who demonstrates the greatest mastery of science, technology, engineering and math. This finalist exemplifies how research, innovation and teamwork come together to achieve STEM goals.
- ***Broadcom Coding with Commitment®* Award** of $10,000, awarded to the finalist whose project and performance combine expert STEM knowledge and passion for helping or improving one's community through computation/coding.
- **DoD STEM Talent Award** of $10,000, awarded to a finalist who demonstrates excellence in science, technology, engineering or math, along with the leadership and technical skills necessary to excel in the 21st Century STEM workforce and build a better community for tomorrow.
- **Robert Wood Johnson Foundation Award for Health Advancement** of $10,000, which recognizes the student whose work and performance show the most promise in health-related fields, and who demonstrates an understanding of the many social factors that affect the health of communities.



- **Lemelson Foundation Award for Invention** of $10,000, awarded to a young inventor who exemplifies the ideals of inventive thinking by addressing a critical societal problem in order to improve the lives of others. This finalist demonstrates the application of empathy, STEM knowledge, design thinking and an entrepreneurial mindset in the research and development of a tangible product.
- **First and second place awards,** issued in each category of STEM, of $3,500 or $2,500, respectively, to be used toward a STEM summer camp experience. All STEM Award winners also receive an iPad.
- **Team Award,** sponsored by Teaching Institute for Excellence in STEM (TIES), which awards a $200 gift card to a science supply company in support of their interests in STEM to each member of the team that best demonstrates an ability to work together and solve problems through shared decision making, communication and scientific and engineering collaboration.
- The **Thermo Fisher Scientific Leadership Award** is bestowed upon the Thermo Fisher JIC finalist elected by his or her peers to speak on behalf of their class at the Awards Ceremony. The Class Speaker demonstrates the collegiality and spirited leadership that has earned the collective esteem of the class throughout the Thermo Fisher JIC competition and united them around common goals.

+ Honoring Finalists' Schools and Teachers

Thermo Fisher Scientific and the Society recognize the important contributions of the teachers who educate, mentor and support the Thermo Fisher JIC competitors by awarding a gift of $1,000 to each of the 30 finalists' schools to be used for STEM programs.

2024 Finalists

MAEDOT TINSAE AYALEW
Kenmore Middle School
Northern Virginia Science and Engineering Fair

CARINA ANDREEA BOBULESCU
Hunter College High School
Hunter College High School Science and Engineering Fair

OLIVER NICOLAS COTTRELL
La Jolla Country Day School
Greater San Diego Science and Engineering Fair

ZEALAND MURPHY DOBROWSKI
Missoula International School
Montana Science Fair

GISELLE DREWETT
Homeschool
Illinois Junior Academy of Science Region V Science and Engineering Fair

PARKER FLYNN
Homeschool
Virginia Piedmont Regional Science Fair

ALEXANDER GODSEY
Punahou School
Hawaii State Science and Engineering Fair

DALIA HABIB
Challenger School–Salt Lake
University of Utah Science and Engineering Fair

ARYA GOWRI HIRSAVE
Canyon Vista Middle School
Greater Austin Regional Science and Engineering Fair

SOPHIA HOU
Newark Academy
Bergen County Academy Science Challenge

OLIVIA HUANG
Englewood Cliffs Upper School
Bergen County Academy Science Challenge

BRODY JAWORSKI
Indian Springs Middle School
Fort Worth Regional Science and Engineering Fair

TINA JIN
The Harker School
Synopsys Silicon Valley Science and Technology Championship presented by the Santa Clara Valley Science and Engineering Fair Association

MIKAH ELIZABETH KAALUND
Central Middle School
Connecticut Science & Engineering Fair

SAMVITH MAHADEVAN
Canyon Vista Middle School
Greater Austin Regional Science and Engineering Fair

TYLER MALKIN
Central Middle School
Connecticut Science & Engineering Fair

JOCELYN MATHEW
Fairmont Private School–Anaheim Hills Campus
Orange County Science and Engineering Fair

YASH MEHTA
Durham Academy
North Carolina State Science Fair

GARY ALLEN MONTELONGO
Lorenzo De Zavala Middle School
Rio Grande Valley Regional Science and Engineering Fair

SAMHITA PARANTHAMAN
Mason Middle School
University of Cincinnati Science and Engineering EXPO

ANUSHKA SABLE
Wadsworth Magnet School
Georgia State Science and Engineering Fair

LEIF SPEER
Honey Creek Middle School
Hoosier Science and Engineering Fair Region 6

RHEA SREEDHAR
Fairmont Private School–Anaheim Hills Campus
Orange County Science and Engineering Fair

JAIRAM SUSARLA
The Honor Roll School
Science Engineering Fair of Houston

SOPHIE TONG
Challenger School
Synopsys Silicon Valley Science and Technology Championship presented by the Santa Clara Valley Science and Engineering Fair Association

HIRUNI WANSAPURA
Robinson Middle School
Beal Bank Dallas Regional Science and Engineering Fair

EZEKIEL WHEELER
Homeschool
Northwest Science Expo

MACKENSEY MCNEAL WILSON
Eastern Middle School
Connecticut Science & Engineering Fair

AIDEN YUN
The Nueva School
San Mateo County Office of Education STEM Fair

SOPHIA YUXIN ZHANG
Rowland Hall Middle School
University of Utah Science and Engineering Fair

2024 JUDGING PANEL

KATIE BOGGS, PHD
Judge Panel Chair
Senior Portfolio Liaison
NASA

JULIAN ALFORD, MS
Senior Engineer
Johns Hopkins University Applied Physics Laboratory

GENNIFER GOODE, PHD
Program Manager, Science Education
Fred Hutchinson Cancer Center

JOHN HALL, BS
Physical Scientist, Retired
Environmental Protection Agency

ERIC LOPATO, PHD
Laboratory Safety & Operations Manager
Mattiq

ANNABEL SEGARRA, PHD
Chair, Physiology Department School of Medicine
University of Puerto Rico

JENNIFER WHITNEY, PHD
Associate Professor
Department of Pharmacology & Physiology
Georgetown University

MAEDOT TINSAE AYALEW

Arlington, Virginia

The Effects of Seasonal Variation on the Kinematics of Coronal Mass Ejections Using the Solar and Heliospheric Observatory Satellite

Project Background: Maedot has always wanted to see the Aurora Borealis, or northern lights. “Despite my many attempts, I haven’t seen the northern lights,” she says. “This led me to the next best thing, research.” The Aurora Borealis is caused by coronal mass ejections (CMEs), clouds of plasma and magnetic fields spurting from the Sun’s corona. While they create a beautiful light show in places like Alaska, CMEs can also take out satellites and increase cancer risk for astronauts. Maedot decided to find out what time of year CMEs were at their strongest.

Tactics and Results: Maedot worked with a free database from the Large Angle and Spectrometric Coronagraph (LASCO) on the Solar and Heliospheric Observatory (SOHO) spacecraft. This instrument has been collecting data from CMEs since 1996. Maedot looked at the CME data for each month from 2018-2022. For each CME in the database, she took three measurements and used a mathematical formula to determine the CME’s velocity and acceleration. Maedot showed that the velocity of the CME’s was highest in the fall, and next highest in the spring, but the acceleration of the CME’s was highest in the spring, and next highest in the fall. The spring and fall are when the Earth and Sun’s magnetic fields are most closely aligned. “CMEs cause great damage to satellites,” Maedot says. CME’s can also harm astronauts. “By knowing what seasons have the greatest kinematics of CMEs, scientists can avoid those time periods.”

Other Interests: “Soccer has improved many parts of my life,” Maedot says. “I have to think quickly and make decisions in the moment.” She is also learning Amharic, the language her family spoke in Ethiopia. Maedot moved to the U.S. when she was three. “I’m still on my journey of relearning how to speak my native tongue, a part of me that I regret losing,” she says. Maedot wants to be an astrophysicist. “The universe has always held a sort of wonder to me.”

CARINA ANDREEA BOBULESCU

New York, New York

Breaking the Wave: Tsunami Barrier Placement for Maximum Wave Mitigation

Project Background: Tsunamis can cause huge devastation in just a few minutes, as waves multiple stories tall overwhelm people and buildings. But tsunamis are few and far between, and tsunami barriers are ugly and can harm wildlife and ocean industries. “I wanted to see if I could find a way to make the barriers more efficient, while at the same time addressing these problems,” Carina says. She decided to compare tsunami barriers on the shore with ones further out in the ocean.

Tactics and Results: Carina built a model shoreline with a large plastic box and a Styrofoam “shore,” along with water for a calm “ocean.” She then held a water-filled bag over the “ocean” end of her box and dropped it, creating a big wave. Carina measured how much water ended up on the other side of the shoreline. Then, she placed different barriers in front of her wave. She tested barriers on the shore, a partially submerged barrier close to the shore and a partially submerged barrier further out, each time creating a wave and measuring how much water overflowed the barrier. Carina showed that the shoreline barrier was the most effective, reducing “flooding” by 81.72 percent. The barrier closer to the shore reduced overflow by 63.45 percent, and the barrier furthest out reduced it by 52 percent.

Other Interests: Carina is a swimmer, on the student council, and enjoys the debate team and being in the model U.N. “I can argue about topics I care about in a great community,” she says. But she most enjoys reading. “It can both transport me to realms where anything is possible and give me fascinating information about the world that I live in,” Carina says. “I also really enjoy writing poems and short stories because I can express my thoughts through it.” She’d like to be a medical doctor, to apply her passion for science to making people’s lives better.

OLIVER NICOLAS COTTRELL

La Jolla, California

Automatic Hockey Puck-Passer Machine

Project Background: Oliver has always loved hockey, and wanted to be a professional hockey player when he was young. He's always looking for new ways to practice his skills. Oliver owns a machine to help him improve his puck handling, but he wanted a machine that would help him practice puck catching and passing. He was sad to find there was no machine to help him. "I decided to combine my love of hockey and electronics to help with hockey passing," he says.

Tactics and Results: When thinking about how to make a hockey puck passer, "I thought of pitching machines for sports like tennis and baseball," Oliver says. "It would be able to randomly fire the pucks at different locations while also having another mode to track the player via camera." His passing machine is a large cube with a lazy Susan inside, along with a tube to store hockey pucks and two motors to launch them. But launching pucks in just one direction wouldn't be good enough. Oliver also connected a camera to the top of the passing machine and connected the camera and motors with a Raspberry Pi. The tiny computer detects a blue ball on the player's helmet and can use that to launch pucks in the player's direction. It can also fire randomly, making the player work harder to catch the pass.

Other Interests: Oliver obviously plays hockey, but he also enjoys volleyball, soccer and even jiu-jitsu. "These sports allow me to stay in a good state of mind because of the natural enjoyment I get from competition and moving around," he says. He would now rather be a mechanical engineer than a pro hockey player. "When I first started with electronics it was something magical to me, it gave me the same feeling as when I played with my friends," he says. "The problem solving made it even better."

ZEALAND MURPHY DOBROWSKI

Missoula, Montana

Dehydration Observation: Can Hyperspectral Remote Sensing Be Used To Estimate Fuel Moisture Content?

Project Background: When conditions get dry, plants are the first to know. But until they begin to wilt, it's often hard to see that the greenery is losing moisture. "Direct measurements of fuel moisture content are time consuming and require destructive sampling," says Zealand. Dry plants make for excellent tinder for wildfires. If scientists could detect the water content of plants remotely, it "may help improve wildfire risk ratings." Zealand decided to measure the fuel moisture content (FMC) of leaves by using their color.

Tactics and Results: Zealand started with two peace lily plants. He watered the plants, waited half an hour and cut five leaves off each. Those leaves were allowed to dry in hot conditions while he measured their color with a spectrometer. Mass of a plant changes depending on how much water is in it, so Zealand weighed the leaves as they dried. He was able to show that weight accounted for 70–89 percent of the change in the leaves' color. This means that the color of the leaves could be used to measure their dryness. "The logical next step would be to use remote estimates of FMC in natural environments to improve fire risk ratings," he says.

Other Interests: Zealand loves basketball. "It is my dream to play basketball for a D1 college and have an academic scholarship," he says. He'd love to go to the University of California at Berkeley, "because my parents went there." Zealand also studies Aikido. He could be a physicist, or a chemist. "I really want to find the deep secrets of the world and want to know why the universe was created," he says.

GISELLE DREWETT

Palo Alto, California

Quantitative Analysis of Epigenetic Influences by Gut Microbiota-Derived Short-Chain Fatty Acids on RPI-1 Gene Expression in *C. elegans:* A Novel Investigation Into Dyslexia and ADHD-Related Pathways

Project Background: "Diagnosed as stealth dyslexic since childhood, I've always wondered if I could find a cure for something I struggle with daily," Giselle says. While taking a summer course in genetics, she learned about epigenetics — ways that the environment can change how DNA is expressed, without changing the DNA itself. Giselle also learned about the relationship between the gut and the brain, and how short-chain fatty acids (SCFAs) might impact brain function. SCFA production can be changed by things like exercise, sleep and the amount of fiber someone eats. Giselle decided to look at the relationship between SCFAs and important genes in dyslexia.

Tactics and Results: Giselle studied genes in *C. elegans*, a tiny nematode that is often used in science. In people, the gene DCDC2 is important in language processing. While nematodes don't talk, they have a similar gene, RPI-1. Giselle examined how the RPI-1 gene responds to SCFAs. She gave different nematodes either 10, 20 or 40 microliters of SCFAs in their dishes, and after three days, she examined how much of the RPI-1 was being expressed in their cells. Giselle showed that if nematodes got more SCFAs, they tended to express less RPI-1. "This implies that reaching a specific threshold of SCFA levels might influence dyslexia and ADHD symptoms through epigenetic mechanisms, involving changes in gene expression influenced by the environment rather than DNA," she says.

Other Interests: Giselle enjoys tennis, even though she says she's not very good at it. "It is through tennis that I learned how to be resilient, optimistic and keep trying," she says. Giselle wants to be a biologist. She blends her passion for science with love of drawing. "One of my favorite creations is 'Super Bio-Girl,' a character I came up with who fights diseases using genetic engineering," she says. "I think science needs to be creative because it allows us to link together concepts that might not usually connect."

PARKER FLYNN

Charlottesville, Virginia

Testing Corrosion: Types of Cathodic Protection of Steel

Project Background: Parker has an uncle with a boat. While he was learning about boats, Parker also ended up learning about the problem of corrosion. “Modern ships are mostly made of metals like steel. So, when they are in the salty water of the ocean (an electrolyte) they corrode quickly,” Parker says. Parker’s uncle uses zinc on the hull of his boat as a sacrificial metal to create something called cathodic protection against corrosion. Parker became curious as to which method of cathodic protection would work best.

Tactics and Results: Parker compared two types of cathodic protection — impressed current cathodic protection (ICCP) and sacrificial metals. ICCP uses a small voltage to provide a flow of electrons that protects the metal it’s on. Sacrificial metal — like the zinc on Parker’s uncle’s boat — corrodes faster than metal under it, giving off a flow of electrons to protect the underlying metal. Parker connected magnesium, zinc, nickel, copper or an AA battery to steel wool. Parker put each piece of steel wool in saltwater to mimic the ocean and waited 14 days to see how much each steel wool piece would rust. Parker showed that magnesium would do best to prevent rust, because it is the most reactive of the metals. “I also expected the AA battery sample to work better than the control sample since this method is used on modern ships today,” Parker says. “However, ICCP was very similar to the control.”

Other Interests: Parker is passionate about helping kids newly arrived to the U.S. “I run a sports club for international students, help provide meals and help run activities like hikes to help them make connections with local families,” Parker says. Parker loves the competition and exercise of sports and plays soccer, basketball, ultimate frisbee, pickleball, volleyball and runs track. Parker also plays the baritone ukulele. The teen is interested in materials science, especially corrosion science. “I have talked to several people in this industry, and there is so much more study needed on this topic,” Parker says.

ALEXANDER GODSEY

Honolulu, Hawaii

The Flammability of Native vs. Non-Native Grasses in Hawaii

Project Background: Alex has always deeply loved the outdoors. As a resident of Hawaii, he was horrified by the 2023 fires on nearby Maui and heard that non-native grasses might have played a role in its spread. “Non-native grasses were the reason that the fire was able to ravage the town, spreading and consuming,” Alex says. He feels a strong “kuleana” (responsibility in Hawaiian) to serve his community, and responsibility for “aina” (land in Hawaiian). So, Alex decided to compare the flammability of native and non-native grasses.

Tactics and Results: Alex started with six types of plant. He tested native pili grass, *(Heteropogon contortus)*, oahu sedge, *(Carex wahuensis)*, and mau’u’aki’aki grass *(Fimbristylis cymosa)*. He also tested non-native natal grass *(Melinis repens)*, witchgrass *(Panicum capillare)*, and five-finger grass *(Digitaria eriantha)*. He then needed to set them on fire with an epiradiator — a chamber that can heat things to combustion. Alex made his own with a hot plate and a pot. He heated each grass, both dry and fresh, to 500 degrees Celsius to mimic a fire, and measured how long it took to see sparks, and how long each grass burned. He showed that the native grasses were less flammable than non-native grasses. They took 38.6 seconds longer to ignite. The native grasses also burned for 74.1 seconds less on average than non-native grasses.

Other Interests: Alex adores the outdoors. “Through hiking, skiing and fishing, among others, I have grown to love everything about nature and have been lucky enough to experience its splendor,” he says. He’s even done a 19-day backpacking trip on the John Muir Trail in California. Alex also loves basketball, video games and movies. He’s interested in pursuing biochemistry. “Biochemistry is a field where you develop drugs, etc. to help cure people,” he says. “I think that it is interesting to see how STEM can be applied to saving lives.”

DALIA HABIB

Salt Lake City, Utah

Biomass to Biofuel

Project Background: Dalia loves going to farm festivals, and corn mazes are her favorite part. But she did wonder what happened after the farm festival was over. “I always questioned if there is a way to better use all of the wasted pumpkins, apples and corn,” she says. “If it can be recycled to help our planet or solve hunger problems in the world.” In reading up about waste, she learned about efforts to create efficient biofuels out of biomass that people can’t use. Dalia decided to use an enzyme to help break down biomass into alcohol-based biofuel.

Tactics and Results: Dalia wanted to test the enzyme cellulase, an enzyme that can break down the cellulose in plants. She tested seven different types of plant matter: sugar cane, corn kernels, corn stover (the stalks and leaves of corn plants), grass, sawdust, straw and maple tree leaves. She ground up each type of biomass, then added cellulase and yeast to convert the sugars to ethanol. Dalia showed that cellulase could double or even quadruple the ethanol the plants produced compared to the control. Those with high sugar (sugar cane, corn and corn stover) had the highest ethanol yield, while grass, sawdust, straw and maple tree leaves had the lowest. “The process is not cost efficient,” she says. “However, during emergencies and as the prices of fossil fuels increase and the stored amounts of energy deplete, it can be an alternative source of energy.”

Other Interests: Dalia loves to dance, especially hip hop and jazz. “I find delight in learning numerous choreographies and practicing them in my room, often dedicating hours to practice dance,” she says. Dalia also loves languages and is trying to become fluent in both Arabic and Japanese. She recently took up pottery and finds it both relaxing and challenging. Dalia would like to become an environmental engineer. “I aspire to address environmental challenges, promoting sustainability and enhancing human well-being on a global scale,” she says.

ARYA GOWRI HIRSAVE

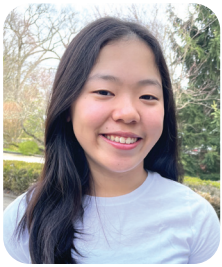
Austin, Texas

Effect of Various Antibiotics on Digestive Enzyme Activity

Project Background: When Arya's mother recently had surgery, "the doctors gave her antibiotics to prevent bacterial infection," she says. "But every time she would take the antibiotics, she would complain of a stomachache." Arya began to wonder why the antibiotics caused so many stomach upsets. She knew that the drugs could disrupt the gut microbiome, but could they interfere with digestion as well? Arya decided to test how different antibiotics might affect digestive enzymes.

Tactics and Results: Arya decided to test four different antibiotics — penicillin, erythromycin, ampicillin and neomycin. She put tablets of each drug into tubes containing different digestive enzymes and the nutrients they broke down. Arya tested amylase, which breaks down starch. To test bile salt/pancreatin, which breaks down fats, she used olive oil. She also tested pepsin, which breaks down proteins like albumin — which is found in things like eggs. She measured the effects of antibiotics on these enzymes with color-producing digestion assays. Arya showed that erythromycin reduced starch digestion by 50 percent, and fat digestion by five percent. Penicillin reduced starch digestion by 40 percent. Ampicillin reduced protein digestion by 10 percent and fat digestion by five percent. Neomycin, however, did not affect any of the digestive enzymes. "Based on these results, I conclude that neomycin is the safest antibiotic among the four tested, and does not result in G.I. tract side effects due to reduction in nutrient digestion," she says.

Other Interests: "Writing is my huge passion," Arya says. "Even though I don't want to take up writing full-time, I definitely want to publish at least a couple [of] books." She also adores crafting. "I will always be found on the weekends with a big Amazon cardboard box and a pair of scissors," she says. "I make so many things that it clutters my whole room and annoys my mother." Someday, Arya wants to be an aeronautical engineer, building spacecraft "so that I can help people discover new planets and worlds."



SOPHIA HOU

Livingston, New Jersey

The Effect of Methylcobalamin on *Vigna radiata* Germination Under Heat Stress

Project Background: Sophia and her mother both take vitamin B12 supplements. Sophia's mom takes one "because she is vegetarian, and plants do not contain substantial amounts of B12," Sophia explains. She knew that B12 helps people produce blood cells and is necessary for brain development. It is also an antioxidant — a chemical that can stop reactive molecules from forming. Antioxidants are important to helping bodies respond to stress. Sophia began to wonder if B12 could help plants respond to stress, too.

Tactics and Results: Sophia wanted to see if methylcobalamin, an activated form of B12, could change how quickly seeds germinate when they are at high temperatures. She tested 120 mung bean *(Vigna radiata)* seeds. "My grandmother and I grew *Vigna radiata* sprouts together when I was younger, and they are a staple in Asia," Sophia says. She separated her seeds into six groups. Three groups were germinated at 80 degrees, and three at 98 degrees. Each of the three groups received either zero, three percent or eight percent methycobalamin in their water. After a week, Sophia showed that the groups germinated at 80 degrees had no differences. At 98 degrees, seeds grown with methylcobalamin has longer lengths than seeds grown in water alone. This could mean that the seeds were under stress at the high temperature, and that methylcobalamin helped them by acting as an antioxidant.

Other Interests: Sophia is a competitive swimmer who has swum at the state championships and practices six days a week. She has a second-degree black belt in Tae Kwon Do. She also loves cooking, drawing and painting. "My most recent painting was of a groundhog," she recalls. She'd like to be a biologist. "I haven't decided on a field within biology that I would like to pursue, but I am interested in cancer biology, immunology and cell biology," she says. "There's so much to be discovered that can help people."

OLIVIA HUANG

Englewood Cliffs, New Jersey

Enhancing the Efficacy of Ingested Lactase by Altering Gastric pH

Project Background: Many of the people in Olivia's family are lactose intolerant — they cannot digest the sugar lactose commonly found in dairy products. Her family isn't alone: nearly two-thirds of people around the world are lactose intolerant. "To relieve symptoms when consuming dairy products, they have to take lactase medications," she says. Lactase is the enzyme that breaks down lactose. Sometimes, if her family members are eating a lot of dairy, they have to take a lot of lactase. Olivia began to wonder if there was a way to make the lactase pills work longer.

Tactics and Results: Using vinegar to simulate stomach acid, Olivia added milk to 12 test tubes. Half of the test tubes also got Tums, calcium carbonate tablets, to increase the pH. Then, she applied lactase to two of the test tubes, one with calcium carbonate and one without. She measured the pH of each tube and also measured the amount of glucose produced — a measure of the breakdown of lactose with lactase — for 60 minutes. Vinegar alone had a pH of 3, which rose to 4 when milk was added. Calcium carbonate increased the pH to 6. Olivia showed that alone, lactase produced 70 mg/dL of glucose alone. If it was combined with calcium carbonate, however, it produced 183 mg/dL of glucose. "These findings suggest that combining calcium carbonate with lactase will increase the efficacy of ingested lactase in lactose intolerant people," Olivia says.

Other Interests: Olivia developed her interest in science by reading science comics. Now, she animates math and science cartoons herself. "I created a website of educational videos and I recruited several classmates to help make them," she says. "I do this to help my fellow classmates learn STEM in a fun way that everyone can understand." She has a passion for medicine and for the environment and would like to become a doctor. Inspired by her sister's severe mushroom allergy, she would like to be a pediatric allergist.

BRODY JAWORSKI

Keller, Texas

Chemically Transforming Dead Leaves Into Adhesives

Project Background: Raking up the fallen leaves in his yard, Brody saw just how many bags of leaves went to the trash. “I saw in our neighborhood all the bags of dead leaves stacked up and saw it was a big waste,” he says. He wanted to see if it would be possible to turn the dead leaves into something more useful. Brody knew that leaves were full of cellulose, and that cellulose was made of long chains of glucose. Knowing glucose was sticky, Brody decided to see if he could turn dead leaves into a glue.

Tactics and Results: Brody collected dried oak leaves and also collected iron from soil with a magnet. After crushing the leaves, he mixed them with pineapple juice, hydrogen peroxide, hydrogen peroxide with his collected iron or cellulase (an enzyme that breaks down cellulose). Then he waited for either an hour or a day. Brody took a drop of the final mixture and put it between two sheets of cardboard, let it dry, and then measured how much force it took to pull the two sheets apart — a measure of how well his glue worked. The strongest glue was the pineapple juice with leaves (the positive control), then cellulase and then hydrogen peroxide. “The hydrogen peroxide with iron did not work as an adhesive as good as without iron because I think that the iron catalyst made the reaction too fast,” Brody says. He hopes that one day leaves could help make adhesive.

Other Interests: Brody likes to practice magic tricks and loves to read fantasy books. “Magic tricks are kind of like fantasy to me because I read a lot about wizards,” he says. He loves STEM subjects and hopes to become a mechanical engineer. “I know it is not related to mechanical engineering, but I really want to do chemistry too,” he says.

TINA JIN

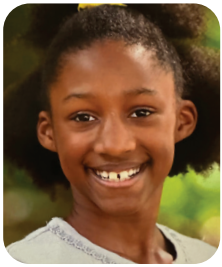
San Jose, California

Turning Animal Bone Waste Into Water Filtration: Enhancing Accessibility of Clean, Drinkable Water Through Innovation

Project Background: "When I was watching the news after dinner last summer, I was shocked to see children drinking dirty murky brown water," Tina says. "While I was picking which type of water to drink, some people couldn't even have clean water." She was upset to learn that one out of every three people don't have access to clean water, and that many water filtration products were expensive and used parts that were difficult to find. Tina decided to create a water filter with something that many people have lying around — animal bones.

Tactics and Results: Tina started by slicing cow bones into thin slices and filtering water through the bone slices. She focused on trabecular bone — a spongy bone with porous structures found in places like the skull and ends of the long bones. Tina tested different types of "dirty" water — black tea, rose tea, water with microplastics in it and water from local streams — by pouring them through the bone slices. She then analyzed the data to see what pore size in the bones produced the clearest water and showed that small pore size meant cleaner water. Tina ground up bones into powder and used them as her filter. Finally, she sent samples of her filtered water to the San Jose Water Company for testing, and they showed that her water reached drinkable standards. Tina then expanded her filters to use bones from pigs and sheep.

Other Interests: Tina is a competitive swimmer. "My swimming has taught me the determination it takes to achieve a goal, and I apply this knowledge to my other activities," she says. She would like to be a physicist. "I like to understand why things move and behave the way they do," she says. "For example, in Oobleck, the combination of water and cornstarch, the way it reacts with force is different from what we are used to because cornstarch has such a small particle size. Applied physics explains how these fascinating, fun and unknown or unpredictable substances behave."



MIKAH ELIZABETH KAALUND

Greenwich, Connecticut

The Synergistic Improvement of Indoor Air HEPA Filtration Using Concurrent Dehumidification

Project Background: As she spent a lot of time indoors during the COVID pandemic, Mikah realized that indoor air wasn't always very clean. "Low air quality originates from fireplaces, cooking appliances, household cleaning products, paints, insecticides, insulation and second-hand tobacco (or marijuana) smoke," she says. "All share one commonality; they each release hazardous chemicals, and lead to 3.2 million deaths annually. Even worse, 90 percent of Americans' time is spent indoors — where pollution tends to be 2-5x higher than outdoor concentrations." Mikah decided to study how dehumidifying air and filtering it could reduce indoor air pollution.

Tactics and Results: Mikah began by burning two cigarettes inside an airtight container with 45 percent humidity and analyzing the resulting air. She found second-hand smoke contained methane, ethane, propane and butane. Then, she burned cigarettes in her chambers and filtered the air with a $20 dehumidifier. She found that 73.8 percent of the secondhand smoke was gone in seven hours. When she added a $1 charcoal filter to her dehumidifier, she could filter 85.4 percent of the secondhand smoke in seven hours. She also showed that between 95 and 97 percent of the nicotine was removed as well and concluded that most of the nicotine was being removed by dehumidifying the air, rather than simply filtering it.

Other Interests: Mikah loves to dance and does ballet, modern, hip hop, jazz and contemporary dance. "I enjoy dancing because it's another way to express yourself. It requires such control over your body, and you use every part of yourself to convey emotion," she says. "When I'm dancing, or even just in the dance environment with my friends, it's like I'm in my own world and nothing else matters." When she grows up, Mikah wants to bring together her love of performing with her love of research. "I think there are creative ways to bring together the arts and science," she says.

SAMVITH MAHADEVAN

Austin, Texas

Novel Application of Olfactory Sensor Arrays in the Detection of Food Allergens Using Artificial Intelligence

Project Background: Like many people, Samvith suffers from severe food allergies. "I have eagerly eaten foods, only to feel the itchy mouth, throat contractions and swollen eyes that are all tell-tale signs of an allergic reaction," he says. He was frustrated that current allergen sensors were so expensive and require contact with food — making them not very useful in daily life. Inspired by how accurately ants seem to find food, Samvith decided to train a volatile organic compound (VOC) sensor, using machine learning, to identify allergens by "smell."

Tactics and Results: Samvith started with a low-cost VOC sensor ($60-80), and hooked it up to a kit to make it Bluetooth compatible. He trained the sensor with a machine learning program, exposing the sensor to samples of peanuts, eggs, pistachios, almonds, cashews and walnuts. "One of the main limitations of testing was that I am severely allergic to cashews and walnuts," Samvith says. "So, for training those allergens, I provided instructions to my mom and monitored the data collection remotely while my mom operated the sensor." After training his program over 2,048 rounds of testing, Samvith tested his sensor on real world products with allergens, like Twinkies, almond lace cookies, peanut butter caramel balls, curries and muffins. His "nose" was able to identify allergens at between 94 and 97 percent accuracy.

Other Interests: Samvith loves sports, including football, basketball, swimming, track and table tennis. He also likes to create graphic novels and animations. He also helps his community via the Young Changemaker Journey Program. With the program, Samvith got funding to install a bike rack at a shopping center to help people get around without cars. "It is extremely fulfilling to see the rack in daily use," he says. He would like to be a biomedical engineer.

TYLER MALKIN

Greenwich, Connecticut

Development of a Simple Salivary Rapid Diagnostic for the Detection of Iodine Deficiency

Project Background: Tyler has suffered from iodine deficiency in the past. “My neck swelled causing a goiter, and I was very tired. I was initially misdiagnosed with a thyroid disorder,” he says. He got the supplements he needed, but “many people with iodine deficiency are not so fortunate, and they end up with serious and sometimes permanent health issues.” Tyler knew that detection tests for iodine were expensive and required access to a lab. He decided to create a test that could be done at home.

Tactics and Results: Tyler wanted to create a test for iodine levels that would work with a person’s saliva. He made tiny gold nanoparticles and used sodium thiosulfate. Both iodine and the gold nanoparticles compete to bind to sodium thiosulfate, which means that more iodine would outcompete the gold. The gold nanoparticles are red on their own but show up as blue when they bind to sodium thiosulfate. So, when mixed with someone’s saliva, that means the mixture turns red or purple at normal saliva iodine levels because more nanoparticles are free. It’s blue when iodine levels are low, because all the gold nanoparticles are bound up. Tyler tested his with artificial saliva and showed that it reacted with the right color changes to different levels of iodine. Even though it contains a bit of gold, he estimates that the test can be produced for $2.

Other Interests: Tyler loves math. “I’m convinced that math is my native language,” he says. He even dressed up as Archimedes for Halloween — when he was nine. Tyler has faced a lot of medical challenges in his life and would like to become a biomedical engineer. “I have experienced first-hand how life changing biotechnology can be,” he says. “I envision a world that where you are born doesn’t dictate whether you get to be healthy, and I am so excited that my research can help kids just like me who don’t currently have access to my resources.”

JOCELYN MATHEW

Anaheim, California

Optimizing Microbiologically Contaminated Wastewater Treatment Using Microbial Fuel Cells

Project Background: When Jocelyn visited New Orleans last summer with her family, they ended up spending time in Cancer Alley, an 85-mile stretch between New Orleans and Baton Rouge filled with around 200 petrochemical plants. “I heard from local activists and their heartbreaking stories about the impact of industrial pollution,” Jocelyn says. “This experience has determined me to work towards a future where everyone has access to clean water.” When she got home, she decided to work on new ways to purify wastewater and decided to improve Double Chamber Microbial Fuel Cells (DCMFCs), where microbes break down waste products and produce electricity and clean water in the process.

Tactics and Results: In DCMFCs, bacteria in the anaerobic, oxygen-free anode section of the cell break down wastewater products and produce hydrogen ions. Those ions go to the cathode section, where they can combine with oxygen to produce clean water. “The anode is crucial as it produces bacteria and forms the biofilm, a structured community of cells,” Jocelyn explains. She tested different anode materials to determine which produced the most constant voltage over time. She built two DCMFCs out of large containers and compared anodes made of aluminum, zinc, iron and nickel over 120 hours each. She expected aluminum to perform best, but to her surprise, zinc performed most consistently. Jocelyn expected that acidic wastewater might have caused her aluminum anodes to degrade and hopes to improve the aluminum anode to make “more efficient and sustainable practices in managing wastewater.”

Other Interests: Jocelyn has always loved science, but social anxiety held her back from getting too involved. She decided to face her fears and is now captain of her debate team and proud of her public speaking skills. She’s even used it to benefit others. “I based my Girl Scouts Silver Award project on Social Anxiety Disorder, educating over 100 students, teachers and parents,” she says. Jocelyn would like to become an environmental engineer “to find sustainable solutions for issues like water pollution.”

YASH MEHTA

Durham, North Carolina

Using Motors To Simulate Braille

Project Background: On a visit to a school for the blind in Old Delhi, India, Yash realized that none of the students were using modern electronic braille readers — they were far too expensive. Yash decided he would try to build an inexpensive electronic braille reader that anyone could afford. He wanted to build it for less than $50.

Tactics and Results: Yash used tiny rotating motors to poke users' fingers in braille letter patterns. He tested with two different sizes of motor, arranging six of each motor in three rows, and experimenting with the distance between the motors. Yash connected the motors to an Arduino, which moved the motors based on text from a computer. His results showed that the smaller motors could not withstand the pressure of fingers, while larger ones could. He also compared the distances between motors to see which allowed people to read braille with accuracy. Testing his device with students at the school in Old Delhi, Yash showed that readers were most accurate when the motors were 6 millimeters apart, and that they could read his Braille motor-letters with 86 percent accuracy compared to printed braille. His current model cost only $35 and Yash has filed a patent for his device.

Other Interests: Yash has been playing the piano since he was three. He took up fencing when he was eight. "I love fencing because it's not just a physical game, but mainly a mental game," he says. "Thinking of what your opponent will do in the next point makes all the difference to win the match." While he had the usual early dreams of being a firefighter, now Yash would like to be an electrical engineer. "The journey from concept to creation, fueled by innovation and creativity is what entices me the most."

GARY ALLEN MONTELONGO

La Joya, Texas

Rock Til' You Drop: Investigating a Train's Harmonic Rock and Roll

Project Background: When 38 cars of a Norfolk Southern train derailed in East Palestine, Ohio in 2023, Gary happened to be doing an internship at the University of Texas Rio Grande Valley on railway safety. "It was the talk of the shop," he recalls. Gary became fascinated by what might have caused the derailment. Was it an unbalanced load? A bad suspension system? Gary decided to find out what impacts acceleration at resonance — the vibrations on a track that can make a train go off the rails.

Tactics and Results: Gary headed for the train tracks near his house. "I was able to document the difference between new trains and their suspension springs to older ones, visibly rusty and with less space between the spring coils," he says. He then built three sets of train tracks out of foam. He attached springs to each track — new stiff springs, midlife springs or old springs. He programmed an Arduino to measure the vibrations and ran a toy train over his tracks. He also attached weights to the train to observe the effect of unbalanced loads. "The beginning of life springs and midlife springs were able to take the uneven loads and go through the tracks smoothly," Gary says. But old springs created more vibrations and made the train more likely to derail on sharp turns when it was loaded with more weight. "Railway engineers need to pay attention to both weight distribution and the suspension system to ensure the safety and reliability of the trains," he says.

Other Interests: Gary loves to play baseball and football. "These sports bring my siblings and I together as we spend our afternoons pretending to be pros in a playoff game," he says. He also coaches younger students in baseball and loves to put science in his coaching, "So while they are learning the sport they are also learning about physical science." Gary wants to become a mechanical engineer and work for NASA or SpaceX.

SAMHITA PARANTHAMAN

Mason, Ohio

A Novel Two-Pronged Approach To Control Harmful Algal Blooms (HABs) and Mitigate Microcystin Levels in a Freshwater Ecosystem

Project Background: During the COVID pandemic, Samhita got a foldscope — a tiny paper microscope and excitedly used it to look at tiny creatures. "Out of curiosity, I collected water samples from a lake and prepared some slides to check for Harmful Algal Blooms since I had read about them," she says. Samhita then learned that more than 2 billion people around the world don't have access to clean water and decided to find a way to control harmful algal blooms.

Tactics and Results: Samhita, accompanied by her dog, collected water from Grand Lake in Ohio. She was looking for *Planktothrix* — a type of bacteria that forms harmful algal blooms. The algae produce the toxin microcystin, which can cause liver damage in people. Samhita treated some of the lake water with six percent hydrogen peroxide and compared it to control lake water for seven days. The peroxide made the algae break apart into filaments, but also made them release more than 50 parts per billion microcystin. Samhita then tested whether she could filter the microcystin out of the water using a coconut activated charcoal filter. She showed that the filter could bind to the microcystin and remove it from the water. Her method, Samhita says, "is cost-effective, environmentally friendly and does not affect the quality of water and the ecosystem."

Other Interests: Samhita loves to sketch and make jewelry. She started a non-profit with her sister called "Artsy Altruists." "We have a team of like-minded individuals who create and sell artwork/jewelry to raise funds for our school foundation, which helps at-risk students, and we also support local and international charities," she says. Samhita learned to speak and write Tamil and volunteers at a local Tamil school to help other kids learn, too.

ANUSHKA SABLE

Decatur, Georgia

PS-Risk: Plastic Microparticle Pollution in Human Blood Affects Immune Cells and Leads to Tumor-Like Structure Formation in the 3D Cell Culture Assays

Project Background: Anushka has been interested in the immune system since third grade, when she put her "clean" hands on an agar plate and learned that her body was protecting her from countless microbes. In 2022, she learned that scientists in the Netherlands were detecting microplastics — pieces of plastic far too small to see with the naked eye — in people's blood. "I wondered if this microplastic pollution might affect our blood cells and health," Anushka says. She decided to find out what effect microplastics might have on the immune system.

Tactics and Results: Working in a lab at Emory University, Anushka looked at the effect of microplastics and nanoplastics — even smaller plastic particles — on human blood immune cells. She showed that the immune cells took up bits of plastic into themselves, especially a type of immune cell called a monocyte. Anushka also looked for signs of inflammation by examining whether the plastics caused the cells to produce molecules called cytokines. They did not, but the microplastics did cause the cells to clump and stick together, forming what Anushka called "tumor-like" structures. She also developed a 3D cell culture model called a "plasticoma" to study whether microplastics might be involved in future development of cancer.

Other Interests: Anushka loves to crochet. "Crocheting helps me focus on the project at hand. It reduces my stress, helps me feel calmer and increases my hand-eye coordination, which assists me while studying, playing tennis or an instrument," she says. She also loves to give her completed projects to her friends and teachers. She would like to become a clinician scientist. "It will help me study and develop treatments for food allergies and eczema, from which my brother, myself and many children are suffering," she says.

LEIF SPEER

Terre Haute, Indiana

Does a Dendroclimatic Reconstruction of the Southern Hemisphere Show a "Hockey Stick Curve"?

Project Background: Leif has always been passionate about climate change. He's also passionate about science fair. "Last year's science project was the first time I really interacted with statistics, and I loved it," he says. "So this year, I wanted to do a project that combined my work with the environment with my interest in stats and math." Inspired by his dad, who is a dendrochronologist (someone who studies past environments by studying tree rings), Leif decided to use tree ring records to look at climate in the Southern Hemisphere.

Tactics and Results: Scientists have made historical temperature graphs using dendrochronology of the Northern Hemisphere. Those graphs show a "hockey stick curve" going up — evidence the climate is changing. But there was not yet a graph for the Southern Hemisphere, because there wasn't a lot of data. Leif gathered data from 275 tree rings from the International Tree-Ring Databank and carefully checked their quality, eventually selecting 41 tree-ring sets from South America, Tasmania and New Zealand. He standardized them and ended up with 19 samples that could provide a graph from 500 CE to 2011 CE. His graph showed that there was a major temperature increase during the past century compared to the 1400 years before it — evidence of climate change. But he did not see evidence of things like the Medieval Warm Period or the Little Ice Age, showing that the Southern Hemisphere had a slightly different climate from the Northern Hemisphere.

Other Interests: Leif is a passionate environmental activist and a member of an environmental group at his school: The EARTHlings. Together, they presented a climate resolution to their local city council. The resolution passed, and now Leif sits on the sustainability commission for the city of Terre Haute, making decisions about electric vehicle chargers and invasive species. He would like to be an environmental engineer. "I think that the climate crisis is the biggest issue of our time, and I want to do all that I can in the fight against it," he says.

RHEA SREEDHAR

Anaheim, California

Closed-Loop CO_2 Capture and Electricity Generation Using Algal Fuel Cells: A Comparative Study on *Spirulina* and *Chlorella*

Project Background: Rhea's home state of California "is experiencing droughts, record temperatures and atmospheric rivers that make the issue of climate change very real and urgent for me," she says. Rhea became interested in carbon capture, using algae to absorb carbon dioxide, or CO_2, through photosynthesis. Those algae can then be grown in a fuel cell, which can produce electricity. "While a few papers described the working of an algal fuel cell, there were no findings on the most efficient algae species for this purpose," she says. "I decided to identify two most photosynthetically active algae and test their effectiveness in CO_2 capture and electricity generation."

Tactics and Results: Rhea compared two species of algae, *Spirulina* and *Chlorella*. She created a CO_2 scrubber — a vessel of each species of algae — and used a Raspberry Pi to detect how much CO_2 the two species drew out of the air over the course of a week. She also built an algal fuel cell with the two species, measuring the electrical output every three hours for a week. Rhea showed that *Chlorella* sucked up 16 percent more CO_2 than *Spirulina*. When the two species were in fuel cells, *Chlorella* produced 70 percent more electricity. Algae like this, she says, could support long-term Mars missions, providing electricity and helping to recycle air. On Earth, she'd like to build a single self-contained unit that could absorb CO_2 and produce electricity. "My goal would be to have these units installed in people's gardens or roofs to reduce their carbon footprint," she says.

Other Interests: Rhea volunteers every Saturday at her local Hindu temple, preparing offerings and garlands for celebrations. "I enjoy bonding with my community and want to continue assisting them to preserve our long-lasting traditions," she says. She is a dedicated Girl Scout, volunteers weekly at a food drive for the homeless and is captain of her debate team. Inspired by her own eyesight, she'd like to become an optometrist.

JAIRAM SUSARLA

Sugar Land, Texas

Evaluating Various ML Models To Efficiently Uncover Exoplanets

Project Background: Jairam has been an astronomy fan for most of his life and was thrilled to learn about exoplanets — planets outside of our solar system — and "how several thousand had been discovered in just the past few years," he says. Most are discovered by space telescopes on the hunt for transits — the dark shadow an exoplanet will cast as it moves in front of its star. "Although the Transit Method is very accurate, the time it takes to validate an exoplanet from telescope data can take several months," Jairam says. He decided to use machine learning to find a faster way.

Tactics and Results: Jairam used data from the Kepler Space Telescope Exoplanet Hunting in Deep Space dataset. The dataset has measures of light changes from 5,087 stars, all of which have already been classified with whether or not they have an exoplanet. He divided up the data and used 90 percent of it to train six different machine learning models. Then he used the last 10 percent of the data to test the models once they were trained. Jairam showed that one of the models, the convoluted neural network (CNN), had 99.82 percent accuracy. Its precision score was 0.83 (meaning that it said one out of six stars had an exoplanet when they did not). He hopes that his model will eventually make detecting and validating new exoplanets easier and much faster.

Other Interests: Jairam is a brown belt in Kuk Sool Won, a Korean martial art. He loves buzzer-based science competitions like the National Science Bee, where he always picks astronomy as his topic. He was deeply inspired by Carl Sagan's "Cosmos" series and hopes to become an astrophysicist one day. "The possibility of finding planets outside of our solar system and life on other planets is very exciting to me," he says.

SOPHIE TONG

Palo Alto, California

Investigating the Visual Information Degradation in Adverse Weather

Project Background: People have a hard time seeing in dark nights or fog, making driving risky. Computer systems aren't too different. "I was surprised to learn how big of a challenge bad weather was in outdoor vision applications," Sophie says. "For example, bad weather is often considered the bottleneck of Automated Driving Systems." Not only that, she learned that between 1982 and 2013, fog was associated with 40 percent of airline deaths when weather was bad. Sophie decided to develop computer algorithms that could analyze scenes in the dark and fog.

Tactics and Results: "Since vision in adverse weather was a broad topic, I limited the scope to nighttime fog under the illumination of artificial light," Sophie says. She built a sealed, lightproof fog chamber and mounted a camera and two lights inside it to simulate a car with its headlights on. Using laser lights, Sophie took measurements from the mounted camera to study how much the light attenuated over eight different levels of fog. She also used a fixed black and white image to see how much sharpness and contrast degraded. With her data, she tested three algorithms to estimate fog density, calculate the distance between objects and recover a sharp image from the foggy scenes. Her three models performed at 78, 80 and 88 percent accuracy.

Other Interests: Sophie got elected as Vice President of her student council, and she won using something surprising: humor. "My campaign was based on jokes about my height," she says. "I now have the goal to help students find their own superpower and to approach problems with a sense of humor and positiveness." While confident in her sense of humor, Sophie says she has imposter syndrome about her research, but she's determined to focus on her love of science. "I'm sharing this experience to show other STEM kids that imposter syndrome is a hurdle, not a roadblock," she says.

HIRUNI WANSAPURA

Plano, Texas

Sycamore Seed-Inspired Fan Blade Design for a Portable Air Purifier

Project Background: Hiruni has struggled with asthma, which is exacerbated by air pollution. When she began to study air filtration, she realized that "less than 30 percent of the world's population has access to HVAC systems, and cost-efficient air filtration can significantly benefit those without access to clean air." For her previous science fair project, she developed an air filter using activated carbon, snake plant fibers and coconut fibers. This year, she wanted to improve on her project by creating a fan blade inspired by a sycamore seed.

Tactics and Results: "I have a strong interest in biomimicry, which involves drawing inspiration from and mimicking designs that exist in the natural world," Hiruni says. Sycamore seeds, she found, can increase their lift as they fall from the tree, spinning around as they fall — like a fan blade. Hiruni analyzed the fall rate of 27 sycamore seeds and used their shapes to design and 3D print fan blades modeled on the seeds. Hiruni tested her sycamore seed blades against standard fan blades in an airflow test and showed that sycamore seed blades had higher air speed and flow than regular fan blades. She then compared the two fans inside an air filtration system, where Hiruni measured how well the fan blades could disperse incense smoke. She showed that her sycamore fan and filter system dispersed smoke at 48% efficiency over 30 minutes. "By improving air filtration methods, we can positively impact the lives of many individuals and communities by providing them with a healthier living environment," she says.

Other Interests: Hiruni plays the violin for her school orchestra, and she also has a talent for writing short stories and poetry. She donates the money she earns from her writing to causes she cares about, including cancer research and animal rights. She'd like to be a biomedical engineer, she says, so she can "contribute to the development of cutting-edge technologies that can improve healthcare and ultimately make a difference in people's lives."

EZEKIEL WHEELER

Portland, Oregon

An Affordable, Portable Orbital Desktop Satellite Tracker

Project Background: Zeke was eight years old when he decided he wanted to contact the International Space Station (ISS) using ham radio. Of course, since a ham radio alone isn't enough to contact the ISS, Zeke would need to track it. He built his own satellite tracker with a 10-foot-long antenna and two more small trackers out of Legos. "I wanted to provide a fun, hands-on way to teach students about mechanical and electrical engineering," he says, so he decided to 3D print a desktop satellite tracker.

Tactics and Results: In his previous models, Zeke had used a potentiometer to measure the position of his antenna to track the ISS. But they require calibration and can't always rotate as much as he needed. So he decided to see if an accelerometer — a device measuring acceleration — and a magnetometer — which measures magnetic field — could do it instead. He designed and 3D printed his parts and programmed a microcontroller and an LCD screen with a list of stars, satellites and planets to track. He was able to track objects to within 7.1 degrees of error. "That means when I try to get a signal from satellites, I should be well within the beam width of my antenna." His proposal to Amateur Radio on the International Space Station was accepted this year, and he is excited to guide students as they speak to an astronaut on the ISS using his ham radio and tracker.

Other Interests: Zeke has always been excited by engineering. "When I was one year old, I had a battery, switch and a lightbulb drilled to a piece of wood that I made with my dad. Once I figured out how it worked, I would run around the house with it, saying 'Battery, switch, lightbulb!'" he says. But he also loves horseback riding, survival skill training, making primitive tools and piloting small planes.

MACKENSEY MCNEAL WILSON

Riverside, Connecticut

Shedding Light on the Prevalence of Harmful Butylated Hydroxytoluene Preservative in Artificially Formulated Dog Foods

Project Background: Macky has two dogs that she adores. “In the past, one of my dogs had significant skin irritations, and we didn’t know what was causing it,” she says. “What finally solved the problem was changing her food, which eventually cleared the skin problem, and she was as good as new.” This made Macky want to find out exactly what could be in dog food that caused dogs trouble. She came across butylated hydroxytoluene (BHT), a preservative. It is used in a lot of human and pet foods.

Tactics and Results: Macky sourced three popular brands of dry dog food from her friends and family. She ground up 10 grams of each one and soaked them in ethanol. Once they had dried out, she used a spectrometer to find BHT in the foods. She also used a technique called high performance liquid chromatography to analyze each food and determine how much BHT was in each one. “I started my project thinking the brands researched wouldn’t include BHT due to the fact it wasn’t stated on the nutritional labels,” Macky says. “However, the brand Acana included 0.101% of BHT, Wilderness included 0.124% and Wellness included 0.104% of BHT.” Macky is concerned that BHT is not good for pets. “If I continued this topic, my next step would be to suggest that more information be communicated on nutritional labels of dog foods, so that consumers could make more-informed decisions,” she says.

Other Interests: Macky loves to play field hockey. “I enjoy field hockey because it allows me to set goals and strive for them,” she says. She also is part of the Greenwich Youth Conservation program, where teens work on beaches, trails and parks. “We plant trees, remove invasive species, clean up trash and maintain walking trails throughout the town,” she says. Unsurprisingly, Macky wants to be a veterinarian. “Ever since I was younger, animals have always fascinated me, and being able to research what they are eating and the harmful effects really is important to me,” she says.

AIDEN YUN

Hillsborough, California

A DICOM Viewer for Radiologists Employing Bidirectional Siamese Masked Auto-Encoders, a Novel, State-of-the-Art Method of Lung Cancer Classification and Detection in Low-Dose CT Scans

Project Background: A few years ago, Aiden's mom had a breast cancer scare. Luckily, his mother did not have cancer, even though the system that diagnosed her said her chances were between 50 and 95 percent. "I was surprised by this level of confidence, or lack thereof," he says. When he heard that lung cancer screening standards had been expanded, "I figured it was a great opportunity to do something I'd wanted to do for a long time." Early detection is crucial for lung cancer treatment, and Aiden decided to develop an AI-powered system that would help doctors diagnose it more accurately.

Tactics and Results: Aiden collected lung computed tomography (CT) scans from three different public datasets, the National Lung Screening Trial, the Lung Image Database Consortium and Lung Nodule Analysis 2016. Using these, he trained a computer model using a type of self-supervised learning called Masked Auto Encoding, which trains the computer model by hiding certain pieces of data and requires the model to fill in the blanks. Aiden then tested his model against the data in his lung CT dataset and compared his own model's performance to current models in use. "My method outperforms two current state-of-the-art self-supervised learning methods in lung CT scan classification, demonstrating its promising potential," he says. Aiden also researched how radiologists do their work and incorporated his model with a DICOM viewer, used for medical images. Eventually, he hopes to get a partnership and bring his model to the clinic.

Other Interests: A competitive squash player, Aiden has been a member of the USA national team, and was ranked first in the country in the boys <13 division. He also loves taking math classes at the Art of Problem Solving school and participating in math and computer science competitions. He hopes to be a computer scientist and found his own company. "I think people are too complacent toward the world's issues," he says. "We need to take decisive action before it gets worse."

SOPHIA YUXIN ZHANG

Salt Lake City, Utah

Green Solution for Blue Gold: Examining Three Types of Biodegradable Hydrogels on Water Conservation in Irrigation

Project Background: Living in Salt Lake City, Sophia has been concerned by the nearby lake. “Plagued by excessive water use compounded by climate warming, the Lake had precipitously declined since the 1990s and hit historic lows for two consecutive years in 2021 and 2022, threatening an ecological collapse, huge economic costs and public health emergencies,” she says. Sophia soon learned that the problems facing the lake are problems of water management. Since the majority of water use in 2022 went to agriculture, she decided to study how hydrogels could help conserve water for irrigation.

Tactics and Results: Sophia put together different hydrogels. These are materials that can absorb, hold and then release water. She made three types of hydrogels out of starch, agar and hydroxyethyl cellulose (HEC). “I enjoyed synthesizing the hydrogels, watching the mixture transform into a Jello-like substance right before my eyes,” she says. Sophia then measured how well they absorbed water, retained it, and then re-absorbed water again. She showed that the HEC-based gel performed best at a range of temperatures, both alone and when put in soil. But all of her gels helped soils retain water.

Other Interests: Sophia is a competitive chess player and has been listed in the top 100 Women and Girls Player lists by the US Chess Federation. She’s also a competitive swimmer. “I love the feeling of challenging myself by pursuing my best time and the sense of belonging when competing for my team and cheering for or being cheered for by my teammates,” she says. She was selected as a Kid Reporter for Time for Kids in 2023 and wants to be an aeronautical engineer.

SOCIETY FOR SCIENCE

About Society for Science

Society for Science is a champion for science, dedicated to promoting the understanding and appreciation of science and the vital role it plays in human advancement. Established in 1921, Society for Science is best known for its award-winning journalism through Science News and Science News Explores, its world-class science research competitions for students, including the Regeneron Science Talent Search, the Regeneron International Science and Engineering Fair and the Thermo Fisher Scientific Junior Innovators Challenge, and its outreach and equity programming that seeks to ensure that all students have an opportunity to pursue a career in STEM.

A 501(c)(3) membership organization, Society for Science is committed to inform, educate and inspire.

Learn more at **www.societyforscience.org**
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ThermoFisher SCIENTIFIC

About Thermo Fisher Scientific

Thermo Fisher Scientific was built to serve society, with a Mission to enable our customers to make the world healthier, cleaner and safer. We understand the important role we play in improving lives worldwide as we help our customers diagnose disease, develop new treatments, protect our planet and keep communities safe.

As a global life sciences leader, we are committed to cultivating generations of Science, Technology, Engineering and Math (STEM) professionals that more fully reflect our society to fuel innovation, advance science and solve the world's most complex problems.

The Thermo Fisher Scientific Junior Innovators Challenge (JIC) builds on our longstanding commitment to widespread and equitable access to STEM education. Together with Society for Science, we are helping to increase the number of students who enter the Thermo Fisher JIC and nurture a future STEM talent pool that is more diverse than ever.

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