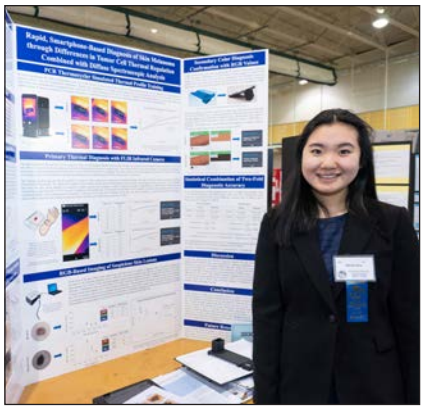
CONNECTICUT SCIENCE & ENGINEERING FAIR
at the
INTEL INTERNATIONAL SCIENCE & ENGINEERING FAIR
Phoenix, Arizona, May 12 - 17, 2019

www.ctsciencefair.org

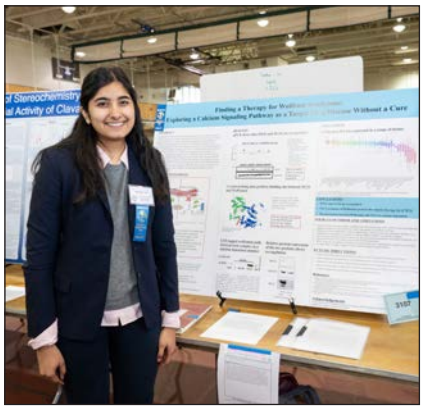
Meet Our 2019 ISEF Competitors

Connecticut Science & Engineering Fair ISEF Competition Participation Winners– l-to-r: Raina Jain, Melissa Woo, Saira Munshani, Cynthia Chen, Annika Morgan, Srikar Godilla, Cristian Rodrigues, Sirina and Anisa Prasad

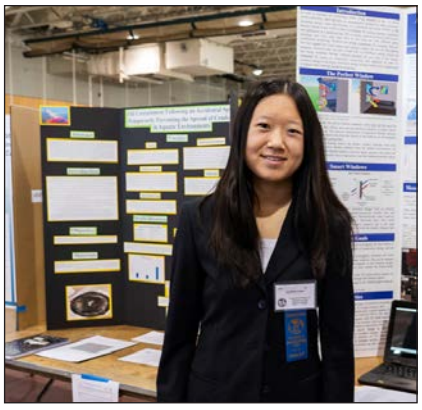
Raina Jain, Junior
Greenwich High School
1st Place - Collins Aerospace Engineering
1st Place - The Jackson Laboratory Life Sciences



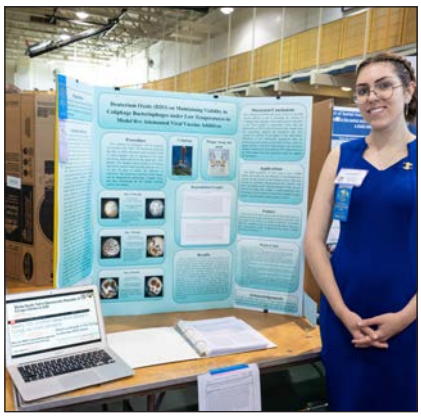
Melissa Woo, Junior
Greenwich High School
1st Place - Alexion Biotechnology



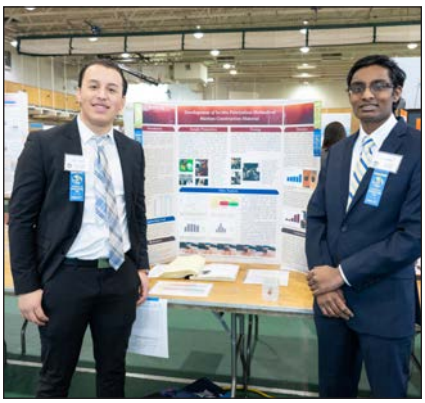
Saira Munshani, Junior
Hopkins School, New Haven
3rd Place - The Jackson Laboratory Life Sciences



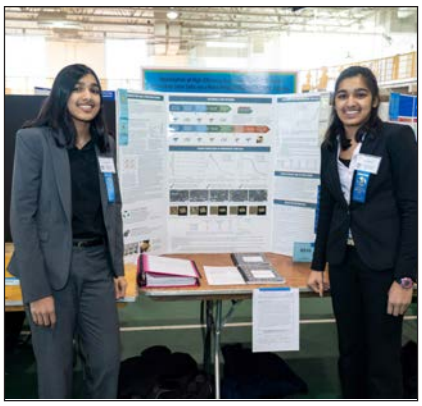
Cynthia Chen, Junior
Greenwich High School
1st Place - Lockheed Martin Physical Sciences



Annika Morgan, Senior
Joel Barlow High School
4th - Place The Jackson Laboratory Life Sciences



Cristian Rodrigues and Srikar Godilla, Seniors
CREC Academy of Aerospace and Engineering, Windsor
1st Place - CASE • PepsiCo/ • IBM
Urban School Challenge

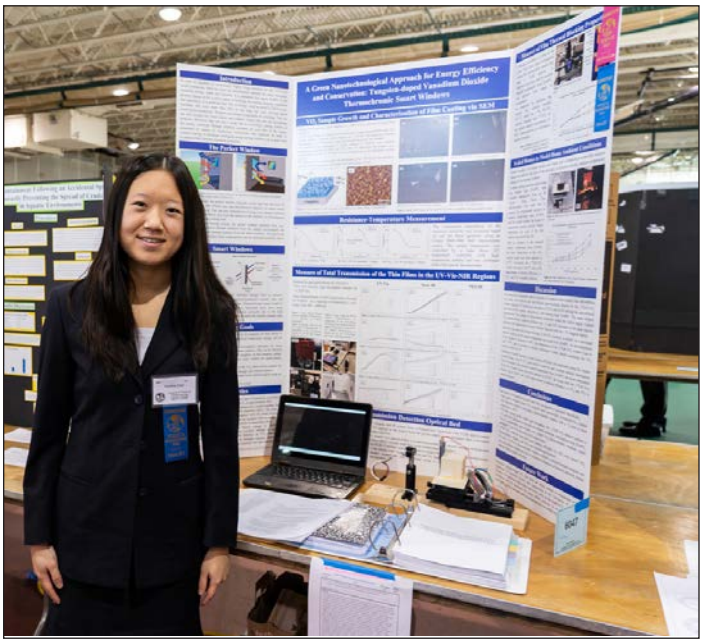


Sirina and Anisa Prasad, Seniors
Staples High School, Westport
1st Place - Lockheed Martin Physical Sciences Team

Cynthia Chen

Junior
Greenwich High School, Greenwich

ISEF Category- Energy: Physical



Cynthia Chen is a junior at Greenwich High School in Greenwich, CT. At CSEF, she was awarded the H. Joseph Gerber Medal of Excellence. Cynthia has a strong interest in exploring environmental issues. Last year, for her work on optimizing plant iron content, she was a gold medalist at the Genius Olympiad, and her paper was accepted for publication in the International Journal of High School Research. This year, her research involves an improved, intelligent, thermochromic window that regulates infrared light throughput based on temperature, creating savings for a building's energy systems.

Cynthia's passion for science has taken her in other directions. She is co-president of her school's forensics club, and organized a forensics-related talk at GHS. Two years ago, she co-founded a renewable batteries company, which has won several accolades and was invited to attend a national investment forum in NYC. Recently, her team advanced to the national finals round of the Diamond Challenge. She has also worked as a physical therapy assistant for the Stamford Hospital.

Furthermore, Cynthia has been an intern for U.S. Representative Jim Himes for the past two years, and is part of her school's We The People Team, where her unit placed first at the state competition. Finally, Cynthia is an internationally recognized violinist, was assistant concertmaster at the 2018 Connecticut All-State Festival, and is currently concertmaster of Principal Orchestra at Norwalk Youth Symphony. In her free time, she enjoys cooking and photography.

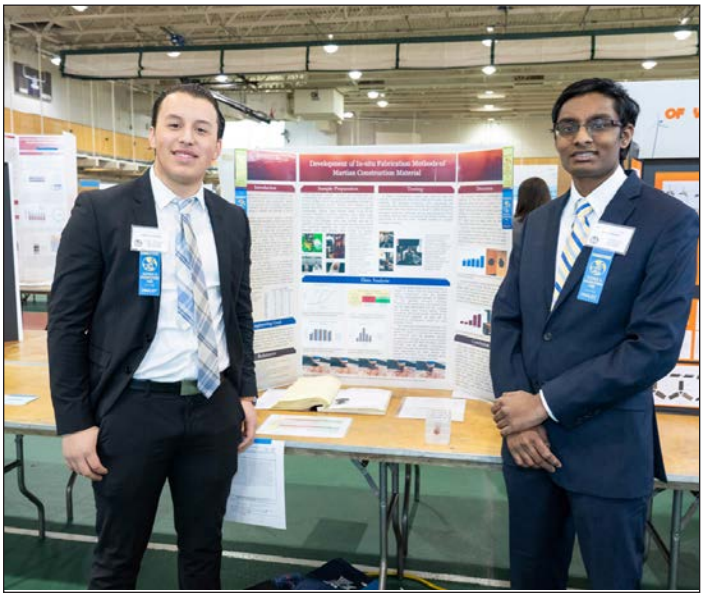
A Green Nanotechnological Approach for Energy Efficiency and Conservation: Tungsten-doped Vanadium Dioxide Thermochromic Smart Windows

Vanadium dioxide is a "functional material" that has gained notoriety in fundamental research and smart-window applications. It responds to environmental temperatures, making reversible structural changes from an infrared-transparent semiconducting state to an infrared-translucent metallic state when heated beyond its transition temperature (Tc). Application of VO_2-thermochromic smart windows has been limited, however, due to the Tc values higher than desired ambient temperature. In this research, tungsten-doped VO_2-windows were synthesized, to lower the transition temperature to <30^oC, and improve the transmission properties. The temperature-dependent optical properties of windows were studied from 400-4000nm via visible, near-infrared, and mid-infrared spectroscopies. Their ability to control infrared light transmission as a function of outside temperature was determined via thermal imaging. Results for the 1.7%W-VO_2 window highlight %Transmission decreases of 25.3% and 42.8% through the near-infrared and mid-infrared regions, respectively, with heating from 29-60^oC. Decreased transmission of W-VO_2 windows is evident via a decreased thermal footprint; as the sample temperature was raised from 20-60^oC, the VO_2 window reached 58.1^oC, determined by radiation, while the 1.7%W-VO_2 windows reached only 37.9^oC. Finally, modeling of overall increase in room energy efficiency was performed using 8in3 model-wooden homes, with W-VO_2 (and control) windows, and constant infrared illumination. With an increase in the external window-temperature from 29-60^oC, the home temperature of the VO_2-window house rose from ambient to 29.5^oC; the house with the 1.7%W-VO_2 window rose to 28.8^oC, for a 16% improvement in energy efficiency vs VO_2, and 37% vs normal windows.

Srikar Godilla & Cristian Rodriguez

Seniors
CREC Academy of Aerospace and Engineering, Windsor

ISEF Category- Materials Science



Cristian Rodrigues and Srikar Godilla

Srikar Godilla is a senior at the Academy of Aerospace & Engineering in Windsor. This is the second year that Srikar will be attending the International Science and Engineering Fair. Srikar has passion for Math, Physics and Chemistry. He wishes to major in Materials science & Engineering. He is interested in Nanomaterials research and hopes to be an entrepreneur in that field. Srikar is also passionate about robotics. He has been a part of his robotics team for the last four years. He is proud to have led his team to the State Finals this year as President and will continue to assist his robotics team as a college student. Srikar is also devoted to introducing robotics to elementary and middle school students and has organized numerous robotics demonstrations. He also takes pride in mentoring members of his robotics team in CAD design, coding, and engineering design. He often relaxes by playing video games, programming, or designing objects in CAD.

Cristian Rodriguez is a senior at the Academy of Aerospace & Engineering in Windsor. This is the second year that Cristian Rodriguez will be attending the International Science and Engineering Fair. Cristian has a passion for chemistry, and has been studying it on his own for many years in his own DIY lab. From self studies and private research pursuits, Cristian hopes to own a private research facility and wishes to major in chemical engineering. He holds many leadership positions including presidency of the Society of Hispanic Engineers, and Student council. Apart from the sciences he is very interested in musicals and theater.

Development of In-Situ Fabrication Techniques of Martian Construction Material

Future Martian explorers will require construction material to build structures and shelters. The cost and lengthy process of shipping material from Earth to Mars makes it an impractical approach to solving this problem. The goal of this research project is to develop a method by which astronauts can fabricate construction material on-site in addition to suggesting landing sites where materials are abundant.

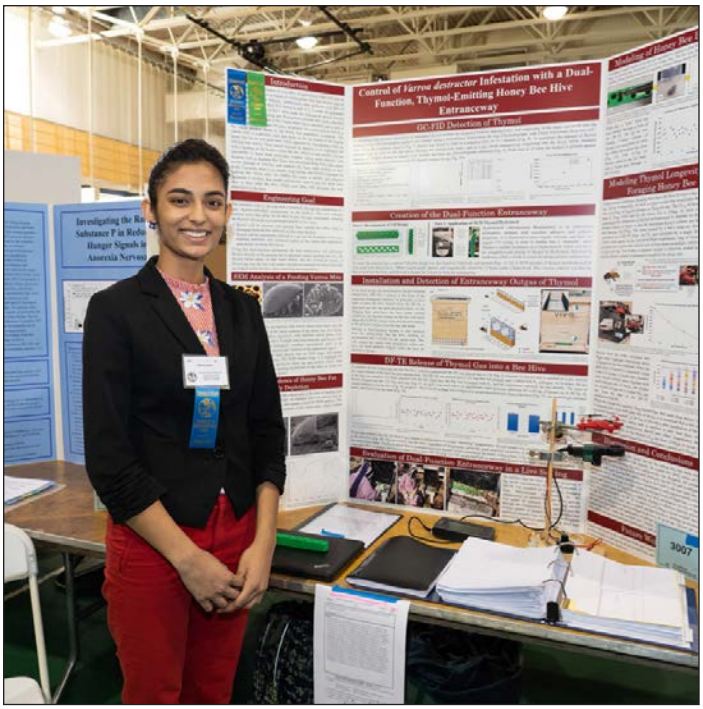
The first phase of this research project involved finding the optimum conditions for manufacturing bricks using simulated Martian regolith. A load of 6 tons was applied via cylindrical die to the simulated dirt contained in a compression mold to form circular “bricks”. Bricks made of various grades of regolith were tested under compression to understand the effect of soil particle size on brick strength. It was found that bricks formed with superfine grade regolith (< 500 microns diameter particulate) had the greatest ultimate compressive strength.

The second phase of this research investigated the effect of adding organic (potato starch and cornstarch) and inorganic (Sulfur) binders. Sulfur was chosen as the inorganic binder because Mars is a sulfur-rich planet and the plant-based binders were chosen based on their ability to be grown on the planet. It was found that regolith mixed with molten Sulfur and then compressed into a brick produced a composite material that had the greatest ultimate compressive strength out of all our samples - similar to that of conventional concrete. Sulfur samples also proved to best withstand harsh Martian conditions according to hardness, and impact tests done.

Raina Jain

Junior
Greenwich High School

ISEF Category- Animal Sciences



Most of my childhood was spent playing legos. I loved the puzzle-like aspect of legos - having to figure out what pieces would create a cool-looking car, or engineer a new design for a plane. However, there was also an aspect of creativity bred by restriction when playing with legos. The pieces only fit in certain ways, but creative thinking could result in something truly magnificent. My love for science is rooted in a very similar place. A lot of scientific questions need to be solved, with limited tools and instruments available to scientists. Working within the realm of the resources and knowledge that is available, raises a challenge to scientists, but I think that is a key to both pushing science forward, and building legos.

Andy Bramante, my research mentor at Greenwich High School, further introduced me to the applications of science, and helped me develop a device that eliminates varroa mite infestations in honey bee hives. I hope to place this device in the hands of beekeepers, to see this device being implemented in the “real world,” which I believe is a truly rewarding experience. When I’m not in the lab, my hobbies include reading science articles, running, and being outdoors. In the future, I would like to pursue a career as a science researcher, an interest that was sparked by Mr. Bramante’s science research class.

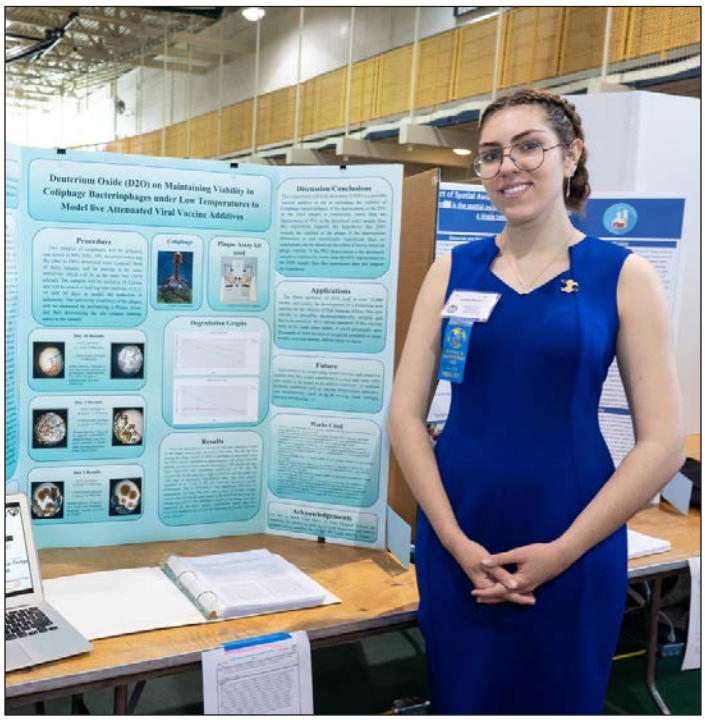
Control of Varroa destructor Infestation with a Dual-function, Thymol-Emitting Honey Bee Hive Entranceway

AIn the last decade, one-third of all honey-bee colonies have vanished, in Colony Collapse Disorder (CCD). The root cause of CCD has been debated, with focus on pesticides, and varroa mite (vm) infestation of hives. Recent literature provides evidence that vm feed on fat bodies of honey-bees, which when depleted, weakens the honey-bee so that pesticides can cause death. Therefore, a simple and effective method to remove vm from hives is urgently needed, and is the focus of this research. To begin, a beehive entranceway was designed, that released thymol “miticide” onto the bees upon contact, as they enter/leave the hive. The entranceway is dual-function, also time-releasing gaseous thymol into the hive. A 20x20x150mm entranceway, with 13 alternating 9mm circular holes, was 3D-printed and coated with a 50/50-%w/w mixture of thymol/Hydromed-D in ethanol. The entranceway was placed onto a beehive, where bees demonstrated indifference to the entranceway. Under normal bee-behavior, GC-FID analysis of bee-body highlights as much as 28μg of thymol released onto the bee by contact-per-day. With a demonstrated 4-day exponential decay, the vm LC50 for thymol (56μg) is reached only four days after entranceway installation. Similar analysis of the 4L headspace for a (19.75”x16”x20”) hive revealed 5.44μg/L of thymol released, acting as ongoing vm control throughout the hive. Entranceway release of thymol surpasses that of the most widely-used thymol varroacide, and is temperature-independent throughout the practical range of use (2°C-45°C). Finally, GC-FID modeling suggests a 1-month lifetime of the entranceway, which is easily recharged without disturbing the hive.

Annika Morgan

Senior
Joel Barlow High School, Redding

ISEF Category- Biochemistry



I am very excited to be going to ISEF this year and to be a finalist in the Women of Innovation. This is my first year doing research, and my first ever science fair, so I am very honored to have been given such a wonderful opportunity. Outside of doing research I am a volunteer EMT and have over 2,500 hours of service responding to 911 calls on the ambulance and treating patients. One of my biggest passions is providing service to others so I am also a driver in my town's safe rides program to reduce accidents due to drinking and drug use, and am a founding member of our Youth Mental Health First Aid organization. I am a captain of my school's science bowl team and a competitor on the varsity math team. Outside of school, I enjoy art and fashion design, obtaining Scholastic Gold Keys at the state level in ceramics and portfolio this year as well as the Fine Arts Award. I will be attending Dartmouth College next year as a biomedical engineering major and am looking forward to engaging in more research opportunities and exploring more science disciplines.

The effect of Deuterium oxide (D_2O) on the viability of Coliphage bacteriophages under Low temperatures as a model for stability in live attenuated viral vaccines

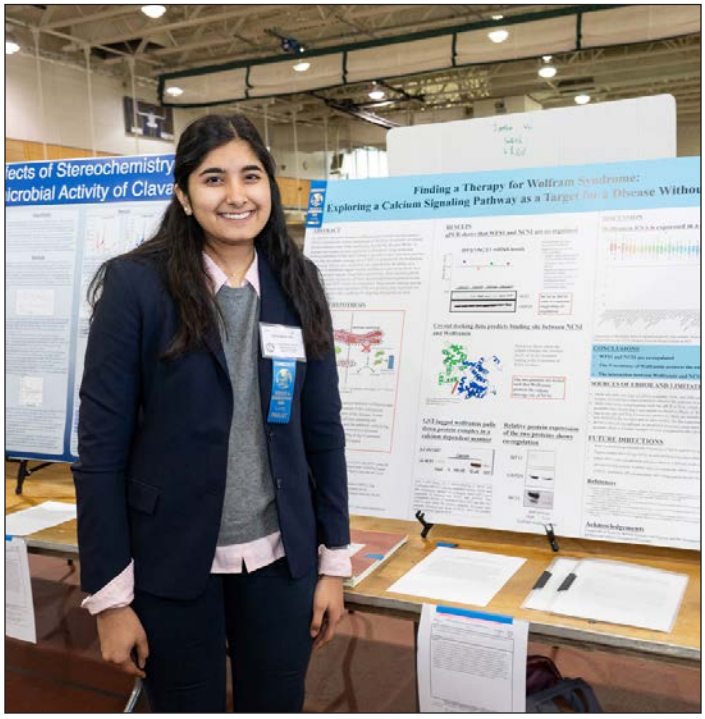
Viral particles used in vaccines and viral therapies are often damaged due to the molecular movement of their storage solution and require storage at low temperatures to reduce the velocity of the water molecules. Deuterium oxide (D_2O) is made with an isotope of hydrogen that increases the density of water to 1.11 g/mL; when viral particles are stored in D_2O the increased weight reduces the molecular speed of the solution, reducing trauma to the particles, increasing the temperature in which samples can be stored. A T4 bacteriophage was used to test how a viral particle would react to its environment and deteriorate over time while stored in D_2O and deionized water. A sample of Coliphage bacteriophages stored in D_2O was compared to a sample stored in deionized water at 16°C to determine the infectivity titer of the samples over time using plaque assays. The sample stored in D_2Oshowed significantly less deterioration over time and slowed the rate of degradation to 6% that of deionized water. D_2O proved to be a more advantageous solution than deionized water in supporting the health of the phages and is a promising storage additive for viral samples. This solution has application for use to increase the storage temperature of live attenuated viral vaccines, such as the Ebola vaccine, rVSV EBOV that often require storage at very low temperatures during transport and storage to remain effective and viable for administration to patients.

Saira Munshani

Junior

Hopkins School

ISEF Category- Biomedical and Health Sciences



Saira Munshani is a junior at Hopkins School in New Haven, CT. At the 2019 Connecticut Science and Engineering Fair, she was awarded third place in The Jackson Laboratory Life Sciences category, and given an award from the Society for In-Vitro Biology. Saira is interested in the interaction between two proteins involved and their role in Wolfram Syndrome, a rare disease. She hopes to target this pathway underlying the disease to create novel therapeutics. Saira was one of sixteen students selected from her grade to be in the "Hopkins Authentic Research Program" at school, participates in the Science Olympiad team and is a section editor in the school newspaper. Saira is a co-founder of "Hopkins STEM Journal," a science publication that features student written articles about new discoveries in STEM fields. Along with science, Saira is passionate about the arts. She has played the cello for thirteen years, and played with the Norwalk Youth Symphony for the last seven years. In her spare time, she creates and sells art through her non-profit, "Creation for a Change." The proceeds go to organizations that support victims of human trafficking. Saira hopes to continue her science research, and combine it with a career in medicine.

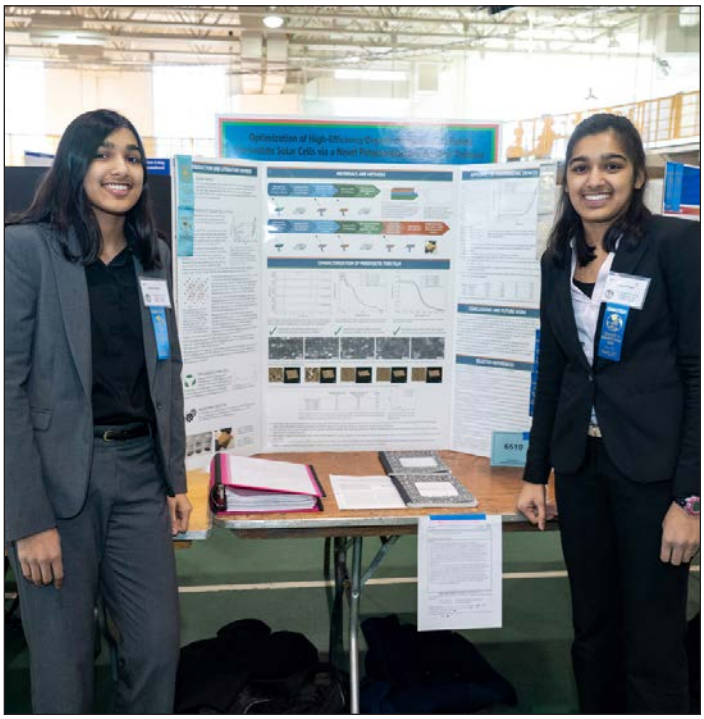
Finding a therapy for Wolfram Syndrome: Exploring a calcium signaling pathway as a target for a disease without a cure

An aberrant interaction between wolframin and neuronal calcium sensor 1 (NCS1) explains the clinical implications of Wolfram Syndrome, an orphan disease without a cure. Wolfram Syndrome is an autosomal recessive genetic disorder that is caused by endoplasmic reticulum dysfunction, with typical symptoms being diabetes mellitus, optic nerve atrophy, hearing loss, and neurodegeneration. Patients typically die between the ages of 25-49 with some form of brain stem failure and respiratory complications. NCS1 is important in regulating calcium signaling and maintaining calcium homeostasis within the cell. When wolframin, encoded by the gene WFS1, is mutated, this protein-protein interaction between wolfram and NCS1 is disrupted. Using molecular docking platforms (PyMol and PyDock) I am able to show that these proteins nest so that the calpain cleavage site of NCS1 is protected by the N-terminus of wolframin. When calpain, a calcium dependent protein, cleaves NCS1, NCS1 is dysfunctional which causes reduced calcium signaling throughout the cell. This in silico prediction was supported by the ability of a glutathione S-transferase tagged version wolframin to pull down NCS1 in a calcium dependent manner. Quantitative polymerase chain reaction (qPCR) with hepatocellular carcinoma cell lines demonstrated that expression levels of wolframin and NCS1 levels are coregulated. These results indicate that the functional expression and interaction of the two proteins plays a pivotal role in cell health and provides a pathway for targeting therapeutics to treat Wolfram Syndrome.

Anisa & Sirina Prasad

Seniors
Staples High School, Westport

ISEF Category- Energy: Physical



Anisa and Sirina Prasad are twins and seniors at Staples High School in Westport, CT. They conducted their research last summer at the Garcia Center for Polymers at Engineered Interfaces at Stony Brook University. Their research focuses on enhancing on perovskite solar cells through the use of polymer additives. In addition to competing at CSEF, Anisa and Sirina have presented this research at MIT's Undergraduate Research and Technology Conference, the Materials Research Society, the International Science Youth Forum in Singapore, and the CT Junior Science and Humanities Symposium.

They have always been interested in STEM subjects: they compete on the Staples High School Math Team and Science Olympiad Team in addition to spending many hours volunteering at elementary and middle school STEM events. They have worked in multiple labs, including Columbia University, Harbor Watch at Earthplace, and Quinnipiac University; they will be interning at a Yale University lab in May and June. In their free time, they love to bake, knit, watch movies, read, and play video games. Anisa and Sirina will be attending Harvard University this fall.

Optimization of High-Efficiency Organic-Inorganic Lead Halide Perovskite Solar Cells via a Novel Polycaprolactone Additive Pathway

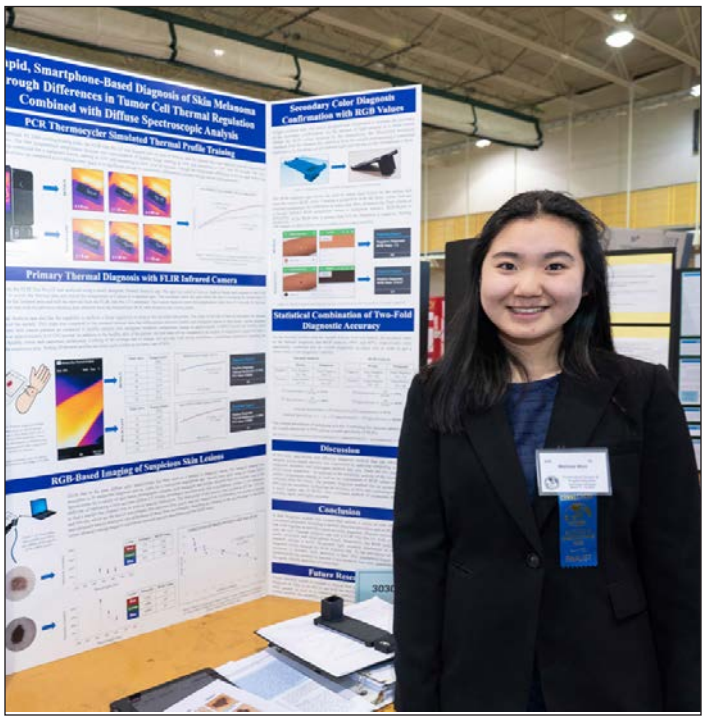
The recent global energy crisis has resulted in a push for the development and commercialization of renewable energy sources, most notably solar cells. In 2009, Kojima et. al. revolutionized the field of photovoltaics by synthesizing the first perovskite-based solar cell (PSC). Perovskites are semiconducting materials with the crystal structure ABX3, whose unique optoelectronic properties make them very suitable as the light-absorbing layer in photovoltaic devices. Techniques used to fabricate these devices, however, often result in poor surface morphology. The goal of this study was to manufacture perovskite layers with fewer defects, resulting in solar cells with higher power conversion efficiencies (PCEs). We investigated the effect of a biodegradable, environmentally-friendly polycaprolactone (PCL) additive on the film quality and photovoltaic performance of methylammonium lead iodide PSCs.

The devices were fabricated using spin-coating techniques. Perovskite films were characterized using various imaging and composition tests; PCE quantified overall cell efficiency. The results indicate that PCL additives passivate grain boundary defects and enlarge grain size by controlling perovskite crystallization rate during film formation. The resulting films were smoother and thus exhibited extended charge carrier diffusion length and suppressed charge recombination. The optimal doping concentration, 0.6 mg/mL, increased the efficiency of the device by 39.7% to a PCE of 13.2%. These high efficiency devices fabricated with the novel, biodegradable, and easily-processable PCL dopant suggest its viability as a promising component of commercial, high-efficiency PSCs.

Melissa Woo

Junior
Greenwich High School, Greenwich

ISEF Category- Biomedical Engineering



Melissa is a junior at Greenwich High School in Greenwich, CT. At the 2019 Connecticut Science and Engineering Fair, she was awarded first and second place in the Alexion Biotechnology and the Collins Aerospace Engineering categories respectively for her research in smartphone-based quantitative detection of melanoma based on thermal regeneration and spectral analyses. From a young age, Melissa has always loved her STEM classes in school and, upon discovering the positive impacts of science research at a summer internship at Memorial Sloan Kettering Cancer Center, hopes to continue combining technology with medical needs to improve the health sciences field. In her free time, Melissa enjoys figure skating, reading, and spending time outdoors. She i s dedicated to helping others, be it volunteering at local elementary schools to teach computer programming through the nonprofit she founded, STEM For All, or working in public service at Congressman Himes' office. At Greenwich High School, she is the co-president of Girls Who Code, Science National Honor Society, and the Economics Club. She is motivated to pursue her passions and make a mark on the global community.

Rapid, Smartphone-Based Diagnosis of Skin Melanoma through Differences in Tumor Cell Thermal Regulation Combined with Diffuse Spectroscopic Analysis

Although melanoma is treatable with early detection, it accounts for nearly 80% of all skin cancer-related deaths. Diagnosis is limited to time-consuming and expensive biopsies, leading to late detection. Recent research suggests that increased metabolic activity of skin cancer cells causes more pronounced heating after external cooling relative to normal cells (15-25°C in 50sec for melanoma versus 15-21°C for normal cells); additionally, slight color differences distinguish between malignant and benign lesions. This research focuses on the development of a smartphone-based app to easily diagnose a suspicious lesion through analysis of surface temperature change and the simplified diffuse reflectance spectrum. First, a suspicious lesion was artificially cooled to 15°C and thermal images were obtained for 1min using an infrared smartphone camera (with a PCR-thermocycler being adapted to mimic thermal profiles). A new smartphone app converts the thermal metadata for comparative analysis against data from skin cancer patients, diagnosing the lesion in seconds with ~96%. This diagnosis is reinforced by the supporting detection/analysis, where a traditional smartphone image of the same lesion, taken through a newly designed-3D printed analysis accessory, is converted to a predictive ratio based on red, green, and blue color proportions. This value is compared to internal/standard data for normal and melanoma lesions to produce a unique diagnosis with 85% accuracy. As complementary techniques, a dual lesion diagnosis is provided by the smartphone app in only 5 minutes with a combined sensitivity of 94% and a specificity of 97%, yielding an overall accuracy of ~98.8%.

Meet the Chaperones

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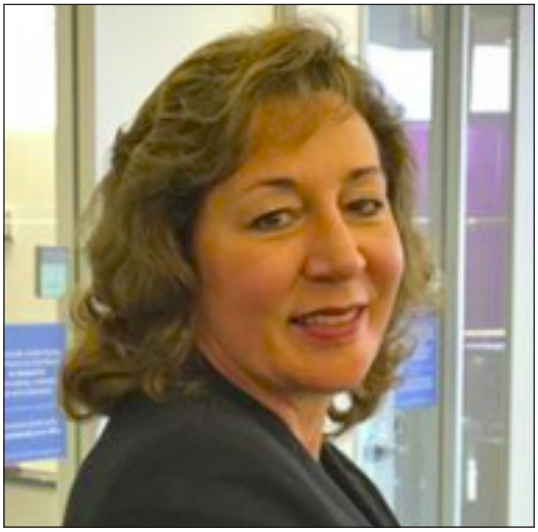
Ann Frattalone – ISEF Week Coordinator • CSEF Board

Ann Frattalone retired after 31 years of teaching Special Education, the last 20 years in the Connecticut Technical High School System. An alumnus of Greenwich High School, Ann received a Bachelor's degree from Western Connecticut State University and completed her Master program in Vocational Special Education at UConn, Storrs. She has been the Regular Awards Chair of the Connecticut Science Fair for the past 27 years and is the ISEF Week Coordinator.

Ann is active in her community where for the last 18 years she has been a member of the Bridgewater Volunteer Fire Department Women's Auxiliary and currently serves as its Vice-President. Ann volunteers at the Senior Center and coordinates the town van that transports seniors to their appointments and activities. In her spare time she is a substitute teacher at their local elementary school and plays a little golf.



Dr. Susan DeCorte – ISEF Week Assoc. Coodinator • CSEF Chief Judge

Susan DeCorte has been involved in the Connecticut Science and Engineering Fair for several years and is currently the Chief Judge for the entire fair. Her career spans several years in the health care sector, including leading teams in the successful development and approval of novel products in the oncology, cardiovascular, reproductive health, metabolic and endocrine areas. Dr. DeCorte is a pharmacist and lawyer, and additionally holds an MBA. She has over 30 years of experience in the pharmaceutical industry including positions with the US Food and Drug Administration, Sanofi, and Pfizer, has served as an Adjunct Professor at Temple University and chaired the Regulatory Affairs Certification Board. She is a strong advocate for women in science and an ardent supporter of STEM careers for aspiring students.

Bob Wisner – Fair Director/Chairman of the Board of Directors

Bob began his association with the Connecticut Science Fair as a 7th grader from Hartford's Kennelly School. He competed in high school making it to the National Science Fair in 1958 and 1959. In 1960 as a result of his science project work Bob was offered an internship at United Technologies Research Center. After receiving his electrical engineering degree from UConn, Bob became a full-time research engineer doing research in high-energy lasers, adaptive optics, and power electronics resulting in 15 patents. His proudest career accomplishment was leading a research team in the development of an automated clinical gait analysis system used to evaluate children with cerebral palsy. After 35 years at UT Research Center and 5 at Oits Elevator Bob retired in 1999. His science fair volunteer days began in the early seventies when his 7th grade science teacher asked him to become involved. Bob became chairman of the Fair's board in 1974 and Fair Director in 1989. Bob and his wife, Sue, have three children and five grandchildren. Bob enjoys sailing and his electronics hobby.

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Dr. Frank LaBanca – Fair Director • CSEF Board

Dr. Frank LaBanca is a teacher, educational researcher, and change agent. He currently serves as the Fair Director for the Connecticut Science and Engineering Fair. Bridging the research-practice nexus, he is the Founding Principal of Danbury's Westside Middle School Academy magnet and the Executive Director of the National Center for Inquiry Learning. Formerly he was the Director of the Center for 21st Century Skills at EDUCATION CONNECTION, where he directed and managed the implementation and research of innovative Science, Technology, Engineering, and Math programs in 50+ middle and high schools across Connecticut. In this capacity he was the project director and principal investigator of numerous National Science Foundation Advanced Technological Education and Innovative Technology Experiences for Students and Teachers Grants. He also project managed a US Department of Education Investing in Innovation program. He was the principal investigator of two Nellie Mae Education Foundation Research Grants. During his career in the classroom, Dr. LaBanca taught Biology and Applied Science Research at Stamford, Newtown, and Oxford High Schools. His work has been featured in numerous educational research and practice journals and he often presents his work at the American Educational Research Association Annual Meeting. Dr. LaBanca is a Society for Science and the Public Advocate and just completed a Students-at-the-Center Distinguished Fellowship. He was also recognized as a Fellow from the Connecticut Academy for Education. Dr. LaBanca adjuncts at Western Connecticut State University, teaching Quantitative and Qualitative Analysis for Educational Research and also supervises dissertation research. He holds a BS in Biology, an MS in Science Education, and an EdD in Instructional Leadership.