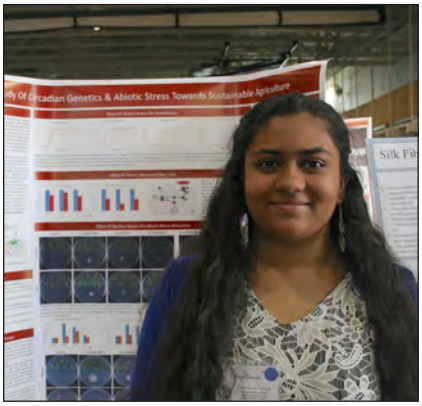
CONNECTICUT SCIENCE & ENGINEERING FAIR **www.ctsciencefair.org**
at the
INTEL INTERNATIONAL SCIENCE & ENGINEERING FAIR
Los Angeles, California, May 14 - 19, 2017

Meet our 2017 ISEF Competitors

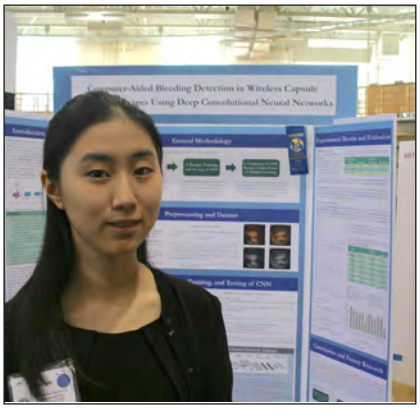
Connecticut Science & Engineering Fair ISEF Competition Participation Winners– l-to-r: Maya Geradi, Ethan Novek, Luca Barcelo, and Rahul Subrmanian, and Sophie Edelstein (missing is Michelle Xiong)

Luca Barcelo, Junior
Greenwich High School
4th Place - Pfizer Life Sciences

Sophie Edelstein, Sophomore
Wilbur Cross High School, New Haven
1st Place UT Aersopace Systems Engineering

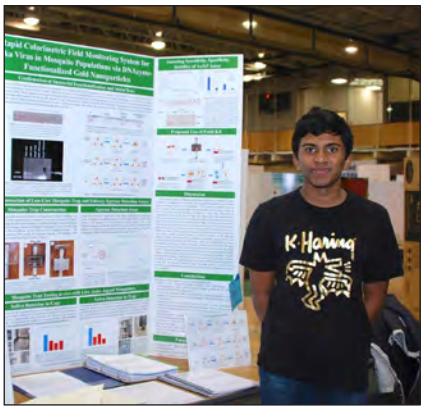


Maya Geradi, Junior
Wilbur Cross High School, New Haven
1st -CASE/Aetna/IBM Urban School Challlenge

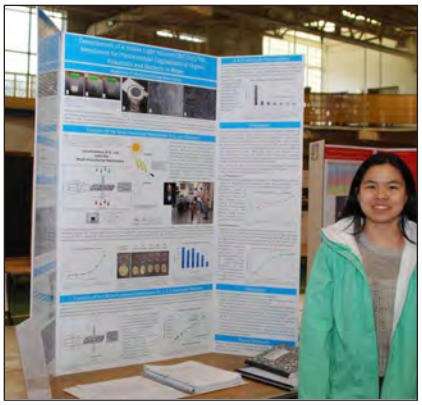


Eunji Lee, Junior
Sacred Heart Academy, Hamden
2nd Place- PepisCoPhysical Sciences

Ethan Novek, Senior
Greenwich High School
1st Place - Pepsico Physical Sciences



Rahul Subramanian, Sophomore
Greenwich High School
5th Place - Pfizer Life Sciences



Michelle Xiong, Junior
Greenwich High School
1st Place - Alexion Biotechnology

Meet the Chaperones

CONNECTICUT SCIENCE & ENGINEERING FAIR
at the
INTEL INTERNATIONAL SCIENCE & ENGINEERING FAIR
Los Angeles, California, May 14 - 19, 2017

Ann Frattalone – ISEF Week Coordinator

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.

Kirk Shadle – ISEF Week Assocate Coodinator

Kirk Shadle has been a teacher at the Bridgeport Regional Aquaculture Science and Technology Education Center for twenty-one years. During that time he has had the opportunity to teach courses ranging from aquaculture design, biology, and environmental science to advanced drone piloting. Currently, he teaches the "Bridgeport Aquaculture College Alliance" program which combines University of Connecticut course work with a science research component. He is also an adjunct professor with the University of Connecticut, a licensed United States Coast Guard Captain and serves on the Town of Hamden Inland Wetland Commission.

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.

An Explanation of How Some of Students Earned Their ISEF Participation

An interesting outcome in the Life Sciences Senior High category came about as a result the students winning

- 1st Place Shobhita Sundaram has already won a trip to the International Science and Engineering Fair from the CT-STEM Fair.

- 2nd Place Sophie Edelstein has already won a trip to ISEF as 1st Place winner of our Fair's Engineering category.

- 3rd Place Maya Geradi has already won a trip to ISEF as 1st Place winner of our Fair's Urban School Challenge category.

Therefore, representing Life Sciences at the ISEF are:

- 4th Place- Luca Barcelo, Greenwich High School
- 5th Place- Rahul Subramaniam, Greenwich High School

Physical Sciences Senior High Category

- 1st Place- Ethan Novek, Greenwich High School
- 2nd Place- Eunji Lee, Sacred Heart Academy, Hamden

Urban School Challenge

- 1st Place High School- Maya Geradi, Wilbur Cross High School, New Haven
- 1st Place Middle School- Madison Lee, Sport and Medical Sciences Academy, Hartford

Luca Barcelo

Junior

Greenwich High School, Greenwich

Competing in "Environmental Engineering"

Luca Barcelo is a junior at Greenwich High School in Greenwich, Connecticut. Luca's engagements with his project entitled Crowd Sourced Detection and Mapping of Nitrate Water Pollutants via a Mobile Web-Based Image Analysis System, won him a fourth-place award in the life science category at the Connecticut Science and Engineering Fair, an award from the American Society for Quality, an honorable mention at the NCC science fair, was selected to represent Connecticut at the National Stockholm Junior Water Prize, and admittance into the Intel Science and Engineering Fair. Apart from these science-based activities, Luca is an avid participant in Model United Nations, where he won a verbal commendation at University of Pennsylvania's Conference. He is also a varsity debater for his school and a community participant that has engaged with a non-profit organization aimed at raising the educational standard for disadvantaged Hispanics in Harlem, New York, by providing a schooling system where they may attain their GEDs. Ever since a young age, Luca's interests ranged outside of science, and into literature and history. As such, Luca was selected as the second-place winner of UCONN's Martin Luther King award and placed as a semi-finalist in Yale University's Bassett Award competition for diversity and inclusion. Luca is fluent in Italian and Spanish and is interested in linguistics and learning to be a polyglot. Due to his interests in water-based activities, Luca also rowed for Greenwich Crew for roughly three years and competed at the Head of the Fish, Charles, and Saratoga.

Crowd-Sourced Detection and Mapping of Nitrate Water Pollutants via a Mobile Web-Based Image Analysis System

Countle ss fertilizers and plant-conditioning products utilize nitrates, which when presented into an ecosystem with surrounding bodies of water, catalyze the dangerous process of eutrophication. Eutrophication is both a rapid process and difficult to detect due to the volatility of nitrate influx into bodies of water. During the day phytoplankton populations grow exponentially where nitrates are present in abundance, while at night most die off, which results in a serious drop in dissolved oxygen levels during the night because of decomposers. To combat this drop in dissolved oxygen levels effectively, a crowd-sourcing detection method is essential in order to accurately, efficiently, and rapidly tag problematic zones. Furthermore, by introducing both a Sulphanilamide coupled with N-(1- naphthyl)-ethylenediamine dihydrochloride compound, and zinc powder into the water sample, and by measuring the color emitted from the solution, through image analysis and supervised machine learning—once both compounds are added to the water sample—the mobile platform will be able to measure the quantity of nitrates that are present in the given water source. The mobile image analysis system uses a picture's RGB values to correlate color intensity to nitrate concentration through an R-based shiny web-based application. Through the implementation of colorimetric analysis of given solutions by the utilization of the user's phone camera, one may attain information on nitrate concentration levels in the tested body of water, which will be uploaded to a database that all contributors may access, thus allowing for the general population to acquire knowledge about their surrounding aqueous environments.

Sophie Edelstein

Sophomore

Wilbur Cross High School, New Haven

Competing in "Biomedical Engineering"

Sophie Edelstein is a sophomore at Wilbur Cross High School in New Haven. After developing a 3D printed implant to treat internal snapping hip syndrome in female adolescents and being awarded 4th place at Intel ISEF in 2016, she decided to continue with similar research. Edelstein's interest in orthopedics comes from her own personal experiences. As an adolescent, Edelstein was diagnosed with both dysplastic hips and snapping hip syndrome, and has has several labral tears over the last 2 years. The culmination of her research this year describes a bovine gelatin based, instead of collagen due to its high cost, crosslinked scaffold for potential human tissue applications as a cost-effective, patient specific, alternative treatment of acetabular labral tears of the hip. Inspired by her surgeons' launch of the Bridge-Enhanced ACL Repair program at Boston Children's Hospital, she too was curious as to why, like the ACL, the acetabular labrum doesn't heal naturally. The scaffold Edelstein has engineered promotes natural healing by implementing the scaffold in position of the acetabular labrum or the torn fragment, drawing blood from the patient, injecting it into the surgical site, and then forming a stable clot that stimulates cell ingrowth, proliferation, and tissue healing. Sophie hopes to pursue a BA in biomedical engineering and then go on to receive her MD in orthopedic surgery with a speciality in pediatrics so she can help adolescents just like herself. Aside from her research Sophie is a member of Mu Alpha Theta (Math Honor Society), Yale Model UN Program, and Yale Pathways to Science. She is also a math tutor and science fair mentor at a local middle school, plays the flute, and is a rower for the Great River Rowing Club.

Formulation of a Bovine Gelatin Cross-Linked Scaffold for Potential Human Tissue Applications: A Patient Specific, Cost-Effective Alternative Treatment of Acetabular Labral Tears of the Hip

Acetabu lar labral tears comprise 22% of reported groin pain. Repairs involve suturing torn tissue to the bone via anchors, or removing inflamed tissue. Both prevent the body from healing naturally. The Bridge-Enhanced ACL Repair piloted by Boston Children's Hospital, a collagen-based scaffold, reduces pain, recovery time, and osteoarthritis by letting ACL heal naturally. This research seeks to design a gelatin-based scaffold for the hip labrum composed of hyaluronic acid, a Glycosaminoglycan, cross-linked with glutaraldehyde and glyceraldehyde producing similar results. A 2% gelatin was chosen and mixed with .5% (w/v) hyaluronic acid. Six gels were cross-linked with glutaraldehyde and D-L glyceraldehyde at concentrations of .1%, 1%, and 10% (w/v). Young's Modulus for each scaffold was recorded via ball bearing apparatus, ImageJ, and equation (Ju & Liu 2001). With a general Young's Modulus (E) of various tissue and acetabular labrums between 42-44 MPa, candidate gel was 2% bovine gelatin/hyaluronic acid blend cross-linked with 10% glutaraldehyde solution, having the closest properties to the given E of an actual acetabular labrum, 41.21 MPa. As cells prefer firm growing conditions, an interface was produced by making a gel with a thin 10% gelatin outer layer for bone adherence, and another layer with the candidate 2% gel. The layers were cross-linked with the 10% glutaraldehyde solution. CT scan data of the human hip joint was 3D printed. The scaffold described was set in acetabulum making scaffold patient-specific. Molded device was frozen/lyophilized to determine preservability. Gelatin-based scaffold, rather than collagen, is less expensive, making device cost-effective at $22 per unit.

Maya Geradi

Junior
Wilbur Cross High School, New Haven

Competing in "Plant Sciences"

Maya Geradi, a junior at Wilbur Cross High School, New Haven, has been competing at CSEF for 5 years and was an Intel ISEF finalist last year. She was a recipient of the H. Joseph Gerber Medal of Excellence, recognized by the New Haven ACS chapter and a gold medalist at the 2016 I-SWEEEP Science Olympiad. Maya is very interested in environmental engineering and biology.

This year, her research focuses on exploring circadian genetics in conjunction with beneficial bacteria and a method for improving plant growth under various abiotic stress. The method her project explores has implication for sustainability as it shows promise for engineering salt tolerant crops and the development of viable biofertilizers in the future. Maya aspires to be an environmental engineer, focusing on improving agricultural efficiency and waste management.

Maya is also interested in the history of environmental awareness. She has participated in history day competitions for 4 years, competing at nationals. Maya is an avid musician. She plays flute and is part of the leadership team for the WCHS wind ensemble and mentored younger musicians in a greater youth band. She is also a museum interpreter at the Yale Peabody Museum, teaching kids and visitors about science. Maya pursues her passion for STEM outreach by volunteering at local science outreach events, organizing and speaking at a math event for middle school students and peer tutoring for mathematics. She enjoys spending her free time kayaking and reading novels.

A Study of Circadian Genetics and Abiotic Stress towards Sustainable Agriculture

Food security and agriculturally unfavorable climates are prevalent sustainability concerns. Irrigation, a vital agricultural process, results in salinization of arable land. Saline soil diminishes crop growth and yield. Circadian genes regulate plant response to abiotic stress and can be utilized to improve understanding. Furthermore, plant growth promoting rhizobacteria can be used in increasing yield under stress.

This project aims to study circadian genetics and the effect of beneficial Bacillus strains to develop methods to alleviate saline and osmotic stress. Towards this goal, wildtype Arabidopsis thaliana and 3 circadian plant lines, gi-2, FKF1 and CCA1 OX, were studied. Plant development and germination were studiedin 8 v.s. 16 hour chambers under ranging salt and mannitol concentrations (0-200mM). Stress mitigation and growth promotion by 2 Bacillus species were studied by spotting suspended cells onto agar plates with plants. Partition plates were used to study effect of microbial volatile compounds. Plant growth was evaluated by examining biomass, rosette surface area and hypocotyl length.

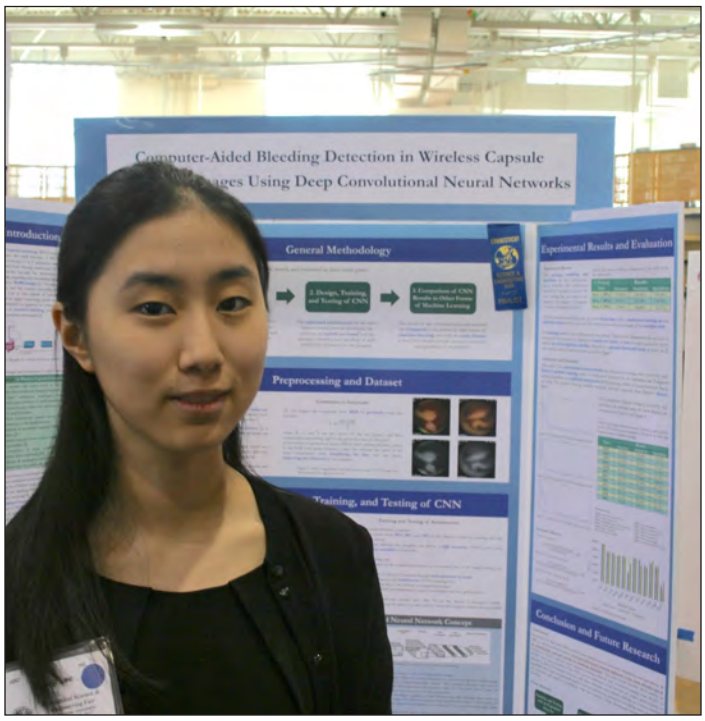
B. subtilis GB03 and B. subtilis Bsn5 significantly improved plant yield and induced different responses in the 3 circadian genetic backgrounds and wildtype. Both strains increased biomass by 250% – 500% in plants grown under saline and osmotic stress. The FKF1 mutant has increased germination efficiency under salt and osmotic stress, compared to wildtype. Larger trichomes and higher trichome density was observed in the FKF1 and gi-2 mutants, during early development. These results show promise for engineering salt tolerant crops and identifying viable biofertilizers for improving agricultural productivity in the future.

Eunji Lee

Junior

Sacred Heart Academy

Competing in "Robotics and Intelligent Machines"



Eunji Lee is a junior at Sacred Heart Academy in Hamden, Connecticut, and lives in Trumbull, Connecticut. She has participated in the Connecticut Science and Engineering Fair for two years, and became interested in STEM fields, especially computer science, through classes in school and opportunities out of school, especially through her internship the past summer of 2016. She chose to focus on deep learning and neural networks for her project this year due to their widespread potential applications, especially in image processing and biomedical data. In the future, she hopes to continue learning more about computer science and its applications in college. At Sacred Heart Academy, Eunji is an officer of the Math Honors Society, Math League, and Mock Trial clubs, and is the concertmaster for the school orchestra. Outside of school, she enjoys playing the violin, and has participated in the Connecticut All-State orchestra, and volunteers for the KEYS music program.

Computer-Aided Bleeding Detection in Wireless Capsule Endoscopy Images Using Deep Convolutional Neural Networks

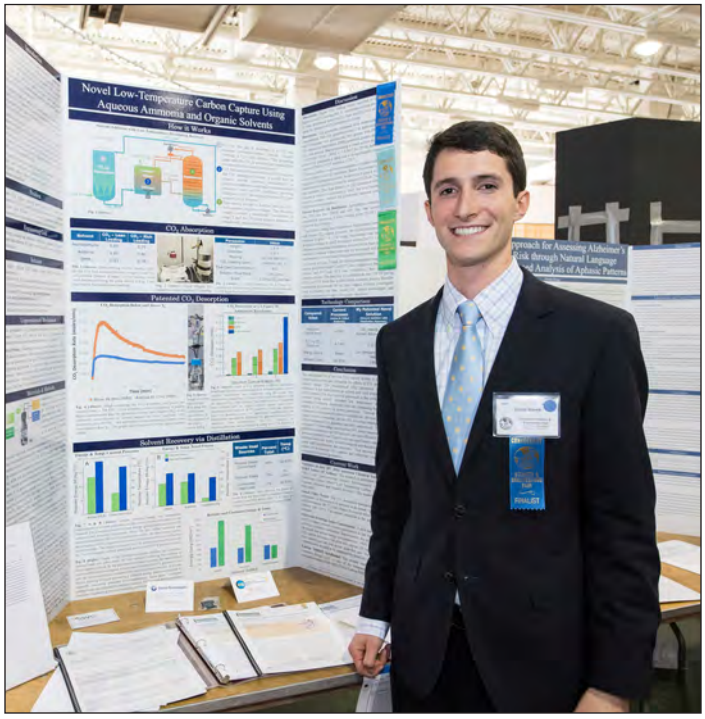
Wireles s capsule endoscopy (WCE) is a minimally invasive alternative to traditional endoscopy focusing on the small intestine; however, it is costly due to physician labor costs for manual analysis. Existing solutions for bleeding detection in WCE images have low accuracy and utilize complicated preprocessing. In this project, a deep convolutional neural network (CNN) approach is employed to address these problems. For the CNNs, Google's TensorFlow is utilized with Python code. First, a simplified preprocessing procedure is proposed by converting color images to normalized greyscale. For training of CNNs, three different sizes are selected, i.e., 70%, 80%, and 90% of the dataset accordingly, while the remainder is used for testing. Then, the number of convolutional layers and sizes of filters are optimized for each training size. After training and testing for the three architectures, the CNNs' results are evaluated through comparison with ten other machine learning methods from Python's sklearn library. The average accuracy for the three architectures is 97.78%, the average sensitivity is 98.15%, and the average specificity is 97.22%. However, the accuracies of Python's sklearn methods range from 40% to 86.70% with large discrepancies between sensitivities and specificities. The results show that the proposed CNN approach can provide an accuracy up to almost 2.5 times higher than common machine learning methods. In addition, the CNN approach uses less training data and simpler preprocessing, which demonstrates efficiency. Future research includestesting full-length WCE videos with unbalanced datasets and classifying bleeding by severity.

Ethan Novek

Senior

Greenwich High School

Competing in "Environmental Engineering"



Ethan Novek developed and holds an issued utility patent (US 9,624,111) for an entirely new technology for capturing CO_2 emissions. His novel carbon capture process desorbs high-purity CO_2 by adding an organic solvent to a CO_2-rich aqueous ammonia solution. He recovers the organic solvent with low temperature distillation. The remaining CO_2-lean solution is recirculated. Ethan's process requires 75 percent less energy than present CO_2 capture processes and is the first CO_2 capture process capable of being powered entirely by abundant low temperature waste heat. Ethan holds seven patents related to his research and is first author of a peer-reviewed paper describing this work in the American Chemical Society journal Environmental Science & Technology Letters. Ethan is a semi-finalist in the $20 million Carbon XPRIZE competition with his startup company, Innovator Energy. He is currently constructing a large scale prototype (200 kilograms of CO_2 captured per day) of his CO_2 capture process in Texas. He has won numerous awards, including first place at Intel ISEF and is the first student from Connecticut to win at the Science Talent Search (STS). Ethan will be attending Yale University this Fall.

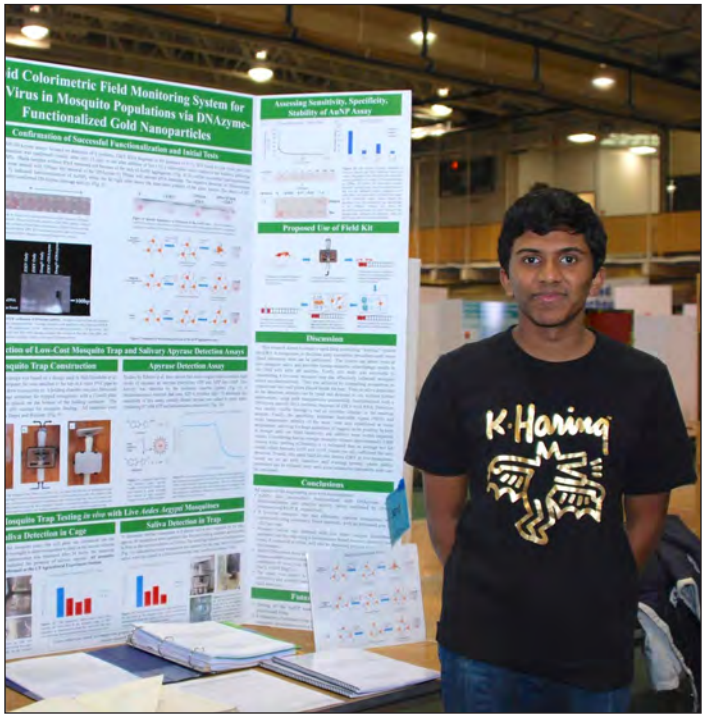
Novel Low-Temperature Carbon Capture Using Aqueous Ammonia and OrganicSolvents

Current post-combustion CO2 capture technologies are energy intensive, require high temperature heat sources, and dramatically increase the cost of power generation. This work introduces a new carbon capture process requiring significantly lower temperatures and less energy, creating further impetus to reduce CO2 emissions from power generation. In this process, high-purity CO2 is generated through the addition of an organic solvent (acetone, dimethoxymethane, or acetaldehyde) to a CO2 rich, aqueous ammonia/carbon dioxide solution under room-temperature and -pressure conditions. The organic solvent and CO2-absorbing solution are then regenerated using lowtemperature heat. When acetone, dimethoxymethane, or acetaldehyde was added at a concentration of 16.7% (v/v) to 2 M aqueous ammonium bicarbonate, 39.8, 48.6, or 86.5%, respectively, of the aqueous CO2 species transformed into high-purity CO2 gas over 3 h. Thermal energy and temperature requirements for recovering acetaldehyde, the best performing organic solvent investigated, and the CO2-absorbing solution were 1.39 MJ/kg of CO2 generated and 68 °C, respectively, 75% less energy than the amount used in a pilot chilled ammonia process and a temperature 53 °C lower. The findings exhibit the promise of economically viable carbon capture powered entirely by abundant low temperature waste heat.

Rahul Subramaniam

Sophomore
Greenwich High School

Competing in "Microbiology"



I'm Rahul Subramaniam, and I'm a 10th grader at Greenwich High School in Greenwich, CT. I've been interested in science for as long as I can remember, often watching Bill Nye videos in my free time as a kid. I took part in my first science fair when I was only in 1st grade, at my elementary school in Florida and actually won the first prize. My project topic: "Does Ice Melt Faster in Air or Water?" A simple project, but I still found it thrilling to be a "sitist" - how I spelled "scientist" when I was 6 - and I credit this with solidifying my interest in science.

Fast-forward to 8th grade and my return to more serious science research. My project, about the harmful effects medicines on gut bacteria, eventually became a 2-year project that I continued in 9th grade in Mr. Bramante's research class. The same year was my first entry into CSEF and I was a finalist for the Alexion Biotech Award. With the outbreaks of SARS, H1N1, Ebola and Zika, I was fascinated with how a "non-living" entity - a package of genetic material, like malicious computer code - could overrun the human body. This led to my current project, and a continued interest in viral diseases.

My hobbies include playing the cello, building construction puzzles and reading science fiction novels. In the future, I would like to pursue a career in medicine and emerging infectious diseases.

An Early Warning System For Zika Virus in Mosquito Populations Based On Real-Time Field Detection of Viral RNA In Mosquito Saliva

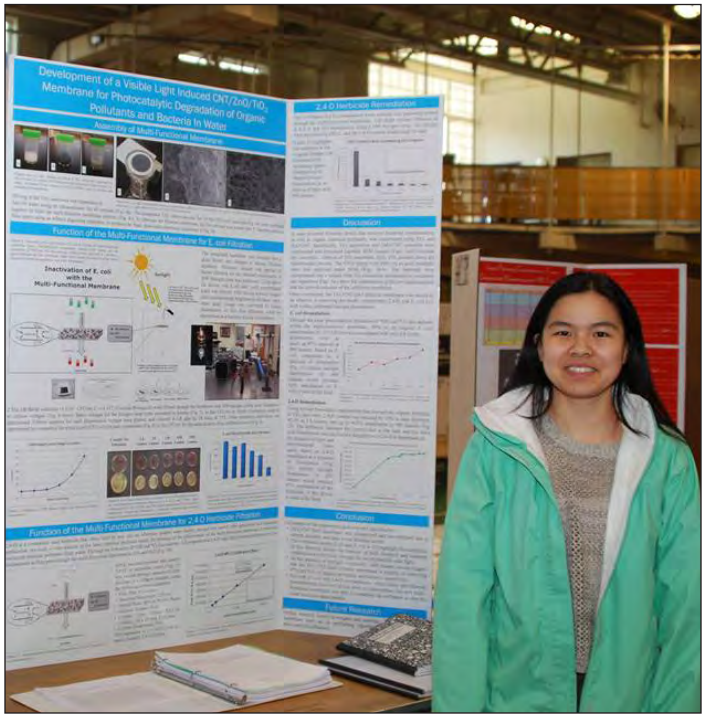
The Zik a virus (ZIKV) epidemic is an urgent global health crisis. While RT-PCR is the gold standard for detecting ZIKV, a lengthy turnaround time (2-4 weeks) and laboratory data analysis can lead to infection of additional individuals, especially in areas with limited infrastructure. This study describes development of an early warning system for ZIKV in mosquito populations via real-time detection of the virus in mosquito saliva without further lab analysis, allowing quarantine measures while PCR tests are run. Designed as an all-in-one unit, a low-cost mosquito trap was constructed that effectively collects mosquito saliva and used to demonstrate that virus would be deposited into the trap in a field scenario. Saliva from live mosquitoes deposited into a 10% sucrose foodsource was detected using bioluminescence to follow activity of apyrase, an enzyme in mosquito saliva. To detect ZIKV in the trap without human interaction, a colorimetric gold nanoparticle (AuNP) assay specific to ZIKV was devised and incorporated in the foodsource. Aggregation of these DNAzyme-functionalized AuNPs is only observed in the presence of ZIKV RNA and is temperature-independent. At ZIKV RNA concentrations 10 times less than that contained in mosquito saliva, positive virus detection is easily discernible, even by non-experts, as a red-to-colorless change in situ within 15 minutes. As an early warning system (trap-AuNP assay combined) placed in the field, the rapid detection of ZIKV-infected mosquitoes allows immediate quarantining of the vicinity until further tests are conducted, thus preventing the spread of virus to local residents.

Michelle Xiong

Junior

Greenwich High School

Competing in "Environmental Engineering"



Michelle is a junior at Greenwich High School. In addition to doing research, she is on the debate team and writes for the Greenwich Free Press. She also serves on the Student Advisory Board at She's the First, a non-profit organization that gives scholarships to girls who will be the first to graduate in their family. She is a mentor to middle school girls in the Positively More program at the Junior League of Greenwich and is also on the Jv swimming and Varsity sailing team at school.

Development of a CNT/ZnO/TiO2 Membrane for Visible-Light Induced Photocatalytic Filtration of Water-Borne Organic and Bacterial Pollutants

With 780 million people without access to a potable water source, the development of a simple, self powered, and point-of-use water system is desirable to remove waterborne bacteria, and chemical pollutants. This research designed an inexpensive solar powered filtration device, that removed bacterial contamination, as well as organic chemical pollutants, such as 2,4-Dichlorophenoxyacetic acid (2,4D), a herbicide that is often found in agricultural water runoff. Recently, semiconductors have shown promise as nanomaterials that can help clean water through photocatalysis. TiO2 nanowires and ZnO/CNT nanorods were incorporated into a unique membrane for concurrent photocatalytic oxidation and separation. The structure of CNT/TiO2 composite is advantageous, as CNTs add strength and chemical stability to the filter membrane, while providing necessary heterojunctions at the CNT/TiO2 interface for efficient translation of sunlight for photocatalytic decomposition under visible light. Because contaminants are degraded at the surface, the membrane exhibits low fouling potential. TiO2 nanowires were synthesized via hydrothermal process and CNTs were doped with ZNO with an acid treatment. The materials were layered on 3 in. filter paper to form the CNT/ZnO/TiO2 composite membrane, that was then installed in a hand-held, solar-powered filtration system. At 3lumens illumination, the system removed as much as 85.3% 2,4D; removal was dramatically increased to 99.7% at 990 lumens. The system's disinfectant abilities were studied with E-coli k12. The membrane removed 90% of bacteria at 3 lumens and 97% of bacteria at 990 lumens. With typical sunlight at 377bvlumens, the filter will have 97% and 91% remediation for organic pollutants and bacteria respectively.