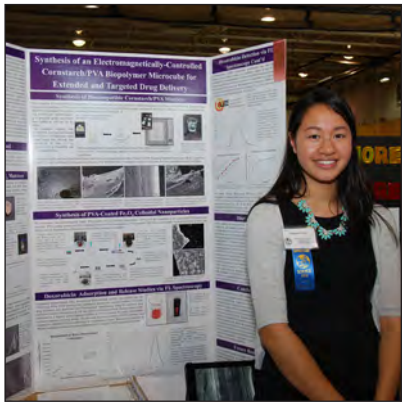
CONNECTICUT SCIENCE & ENGINEERING FAIR
at the
INTEL INTERNATIONAL SCIENCE & ENGINEERING FAIR
Pittsburgh, Pennsylvania, May 10 - 15, 2015

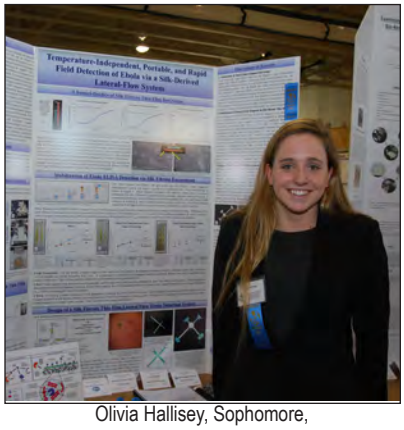
www.ctsciencefair.org

Meet the Winners

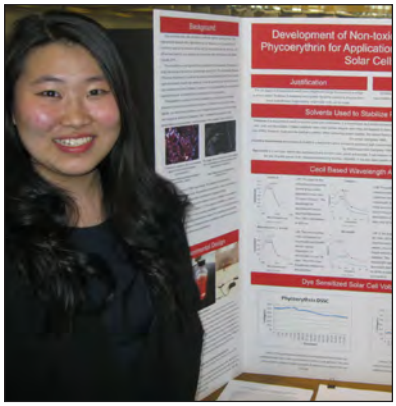
Connecticut Science & Engineering Fair ISEF Winners– l-to-r:Eunsun Hong, Ethan Novek, Margaret Cirino, William Yin, and Olivia Hallisey (not present: Reid Radolovacki)



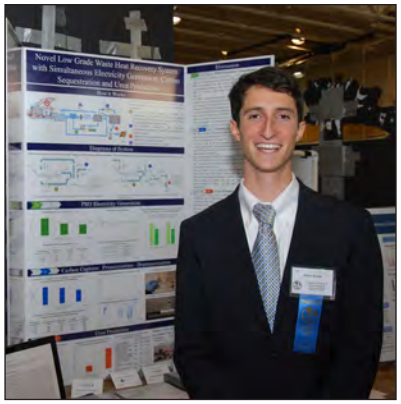
Margaret Cirino, Sophomore
Greenwich High School
2nd Place -Physical Sciences



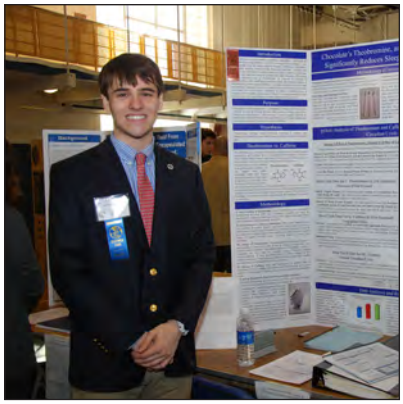
Olivia Hallisey, Sophomore,
Greenwich High School
1st Place - Alexion Biotechnology
1st Place Pfizer Life Sciences



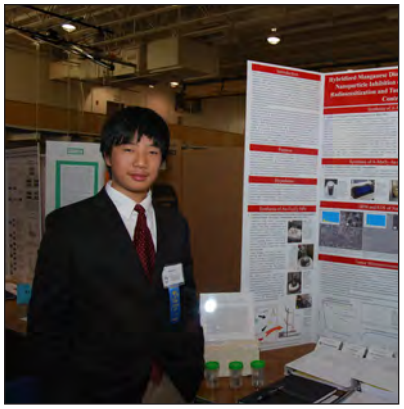
Eunsun Hong, Senior
Bridgeport Regional Aquaculture School
1st Place - Urban School Challlenge



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



Reid Radolovacki, Junior,
Greenwich High School
2nd Place - Pfizer Life Sciences



William Yin, Sophomore
Greenwich High School
3rd Place - Pfizer Life Sciences

Meet the Chaperones

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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 26 years and is the ISEF Week Coordinator.

Ann is active in her community where for the last 17 years she has been a member of the Bridgewater Volunteer Fire Department Women's Auxiliary and currently is its 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.

Andy Bramante – Greenwich High School

Andy Bramante is the Independent Science Research teacher, mentor, and research program director for more than 50 participating students at Greenwich High School, in Greenwich, CT. Prior to arriving at the high school 9 years ago, Andy enjoyed a 15-year career as an applications scientist and design specialist for various analytical instrumentation companies, including Foxboro, Hitachi, and more recently, PerkinElmer. His expertise lies in the various life & material science application of these analytical technologies, based on the many publications he has authored, most notably at PerkinElmer. Andy is also an Adjunct Lecturer at Sacred Heart University in Fairfield, CT, during the evenings, and was recently named a Distinguished Teacher of the Year for the Town of Greenwich, for 2011-2012. Andy is a native of New York City, and completed his undergraduate and graduate degrees in chemistry at Fordham University, at Rose Hill. He is a seasoned veteran of ISEF, and looks forward to an exciting and educational trip for all.

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Michel Leask – Fields Memorial School

Michel Leask is the Technology Director at Fields Memorial School in Bozrah, CT. As a certified teacher of secondary mathematics, she also serves as a STEM coach and technology teacher. Michel has mentored Bozrah students who participate in the CT Science and Engineering Fair for 17 years. She began her career in education in 1999 as a Technology Specialist/Trainer at LEARN in Old Lyme, CT.

Michel was previously employed by the Naval Undersea Warfare Center in New London, CT for 20 years as an electronic engineer in the area of software development for submarine sonar systems. She is an alumnus of Waterford High School, completed her undergraduate Engineering and Computer Science degree at UCONN and her graduate degree in Engineering at RPI.

Michel has a passion for introducing young students to Computer Science Education. She teaches coding classes, offers an after school computer programming club to middle school students and is the leader of a Robotics 4H club. Michel is an active community member. She is co-chair of the PTO, a member of the Board of Finance and has served as Registrar of Voters and Board of Education member. Michel is excited about her first trip to ISEF.

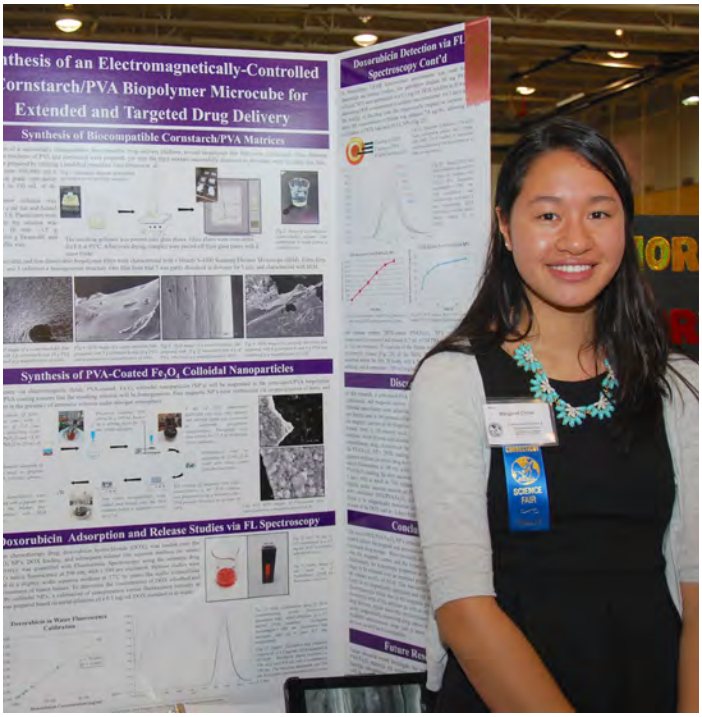
Bob Wisner – Fair Director/Chairman of the Board of Directors

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.

2014 CSEF Competitors
Intel ISEF, Los Angeles

Margaret Cirino

Sophomore
Greenwich High School



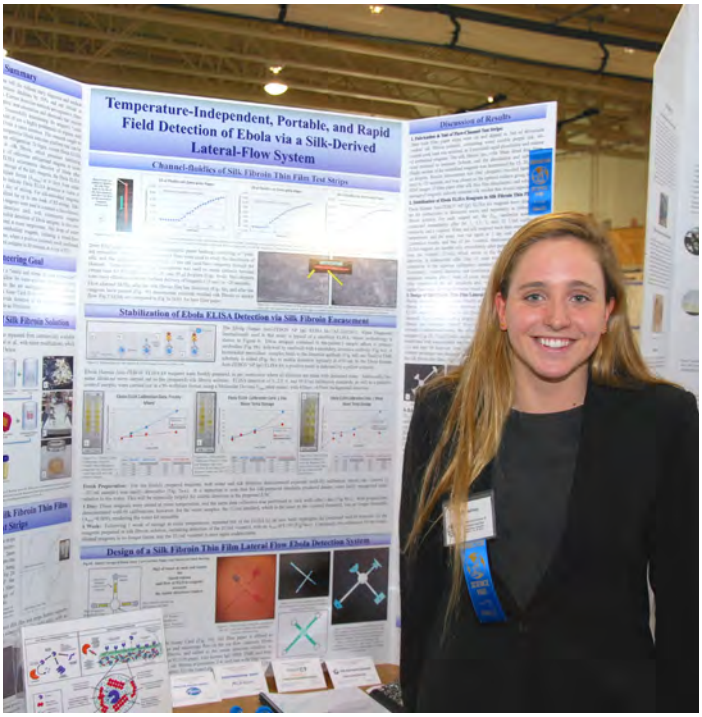
Margaret is a sophomore at Greenwich High School. She is a three-time medalist at CSEF, a participant in the 2015 JSHS, and a silver medalist at the 2014 I-SWEEEP Science Olympiad. This year, she has been conducting research on the synthesis of an iron-polymer matrix for targeted and extended-release drug delivery. Margaret is inspired to pursue STEM by her parents and teachers, who have helped to focus her research. Margaret also enjoys providing the same research opportunities she was given to other young children. She is President and founder of the Science Research Club, which encourages middle schoolers to conduct STEM research under the tutelage of high school mentors. She is also the Vice President and co-founder of Science Outreach Club, an outreach program that fosters a love of science in young children through interactive science lessons and experiments. Over the summer, Margaret plans to continue research on iron nanoparticles for drug delivery at the Mount Sinai Medical Center. Additionally, Margaret is a three-year volunteer at the Mianus River Fishway and an avid tennis player, playing with her school's team for the past two years. She is a passionate writer and has won a number of awards for academic essays, including the 2nd Place Lillian Butler Davey Award for Academic Essays. Margaret hopes to pursue STEM in college.

Synthesis of an Electromagnetically-Controlled Corn-Starch/PVA Biopolymer Microcube for Extended and Targeted Drug Delivery

There has been recent focus on water-soluble polymer matrices with integrated protein or starch bases to increase mechanical characteristics of extended-release drug delivery devices. Unfortunately, a biocompatible, dissolvable micro-carrier that can be maneuvered throughout the body has rarely been researched despite its potential for extended-release and targeted drug delivery. This research proposes the novel synthesis of a water-soluble cornstarch/PVA biopolymer matrix embedded with microclusters of iron colloidal spheres for subcutaneous maneuverability via external electromagnetic fields. Biopolymer films were synthesized with a 2:3 ratio of PVA (Mw-100,000) to cornstarch, using modified methods from Othman et. al. Fe3O4 magnetic nanoparticles (NPs) were prepared by co-precipitation of ferric and ferrous ions in an aqueous ammonia solution under N2-atmosphere. Resultant NPs were then coated with PVA to ensure homogeneous mixing of colloidal spheres with the biopolymer, which was molded using a printed three-dimensional template. Coating of the biopolymer matrices were supported by FTIR/SEM analyses. Anticancer chemotherapy drug, doxorubicin hydrochloride (DOX), was loaded onto the PVA/Fe3O4 NPs. DOX loading, and subsequent release into aqueous medium (to mimic drug delivery), was quantified using the drugs native fluorescence at 553/590nm, with a 230nm excitation. 1.2g DOX/mg PVA/Fe3O4 loading was achieved in as little as 5days, with as much as 75% release of the drug in only 50hours, into slightly acidic aqueous medium at 37°C. 100mm3 cornstarch/PVA films with embedded DOX/PVA/Fe3O4 colloidal-NPs were constructed, and found to be magnetically motorized and water soluble over 7hours, for release of the DOX load in ~1day from mimicked tumor-site localization.

Olivia Hallisey

Sophomore
Greenwich High School



Olivia Hallisey is a sophomore at Greenwich High School in Connecticut. Her decision to focus her project on the development of a temperature-independent, rapid and inexpensive diagnostic assay for the detection of the highly infectious and often fatal Ebola virus was prompted by the devastating loss of life in Africa during the most recent 2014 Ebola outbreak. The consequences will be far-reaching, as the concentration of fatalities in stricken areas has left many children orphaned and the socioeconomic fabric of entire villages destroyed.

The Ebola Assay Card she has developed "breaks the cold chain", encasing reagents in stabilizing silk fibroin and no longer requiring the unbroken chain of refrigeration from manufacture to use that is impossible in many parts of the world. Her research identified challenges in the current detection and treatment process, making it possible to diagnose individuals while they are still asymptomatic, and has applicability as a diagnostic tool for other diseases as well.

Olivia hopes to be a doctor like her grandfather was when she is older, and work for a global health organization. Outside of school she volunteers as a middle school tutor, swim instructor and with community outreach. Olivia is a competitive swimmer with the Chelsea Piers Aquatic Team, and plans to swim in college.

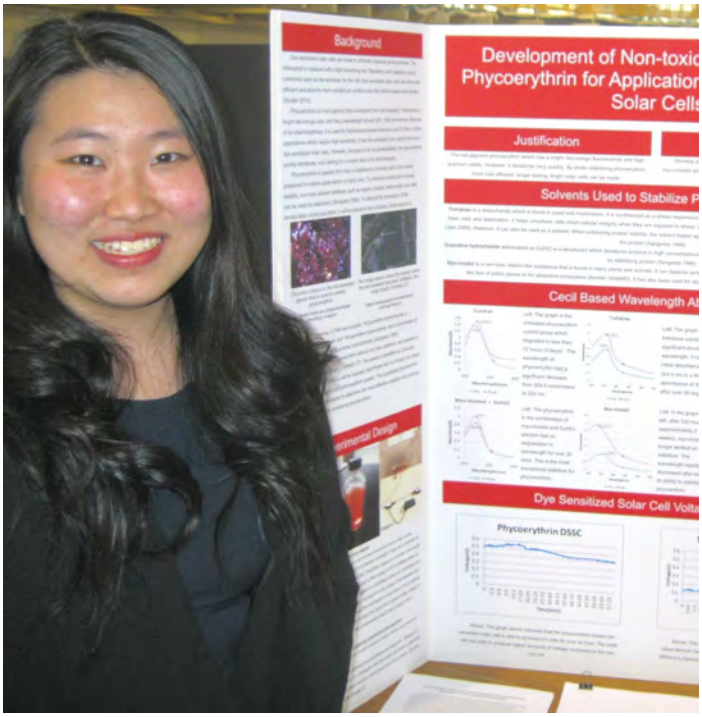
Temperature-Independent, Portable, and Rapid Field Detection of Ebola via a Silk-Derived Lateral-Flow System

Up to 90% of Ebola victims will die without early diagnosis and medical intervention, which can reduce fatalities by 50% and are critical to preventing future epidemics. Current detection methods are expensive, time-consuming and utilize complex instrumentation and chemicals that require uninterrupted refrigeration. Successfully maintaining the reagents cold-chain from laboratory to point of use is highly problematic in regions with poor infrastructure, where Ebola is most common. This research sought to devise a rapid, simple and inexpensive Ebola detection platform that can be stored and transported without refrigeration. To begin, current Ebola ELISA reagents were embedded in silk fibroin, which possesses stabilizing properties, allowing storage of otherwise refrigerated reagents at room temperature. To confirm ELISA colorimetric detection of Ebola after prolonged, non-refrigerated storage of the kits reagents, the Ebola ELISA was conducted in a 96-wellplate format (A450nm) at 0-7days from initial mixing and dilutions. Results indicate Ebola ELISA detection is viable in water dilutions only on the day of mixing. For silk-embedded reagents, successful detection was realized for up to one week of RoomTemp-storage. Silk-film embedded Ebola ELISA reagents were used to construct a four-channel, paper-based, fluidic detection card, with colorimetric reagents positioned to create timed, visible detection of Ebola antigens. In this new device, that is stable and stored at room temperature, 30l drops of water were used to dissolve silk-embedded reagents, initiating a timed-flow towards a center detection zone, where a positive (colored) result confirmed the presence of 500pg/ml Ebola(+)control antigens in 30min, at a cost of $25.

Eunsun Hong

Senior

Bridgeport Regional Aquaculture Science and Technology Education Center



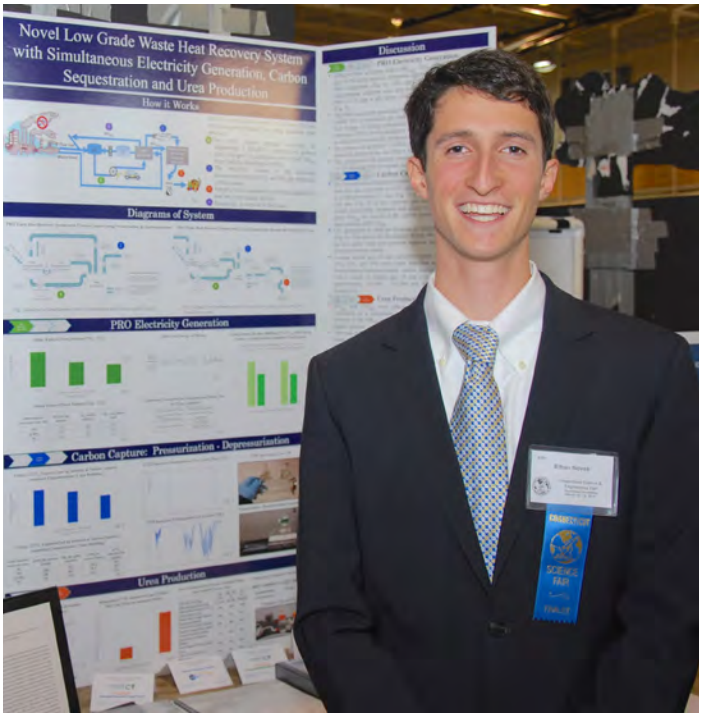
Eunsun Hong is a senior at the Bridgeport Regional Aquaculture School and this was her first time competing at the Connecticut Science and Engineering Fair. For her research project she has successfully photostabilized phycoerythrin, a red light harvesting protein extracted from seaweed, to develop a dye sensitized solar cell using phycoerythrin as the sensitizer to develop a more cost efficient, longer lasting cell. Last year, Eunsun's team at the Connecticut Student Innovation Expo won first place in the Innovation Expo Science Challenge category with their project Water from Air. She enjoys learning new languages and is fluent in English and Korean. She is currently studying Italian and Japanese, as well. Eunsun is also a member of the Women's Federation for World Peace (WFWP), a non-profit organization that works with the United Nations in order to promote friendly relations among multiple religions around the world. She will be attending Fairfield University in the fall and enrolling in a Pre-med program.

Development of Non-toxic Photostabilized Phycoerythrin for Application in Dye Sensitized Solar Cells

Phycoerythrin is a light harvesting phycobilin protein extracted from the red seaweed species Chondrus crispus. Phycoerythrin has the potential to be used as the sensitizer in dye sensitized solar cells (DSSC). DSSC's are cost efficient and absorb more sunlight per surface area than silicon-based solar cells. However, phycoerythrin which is currently sold in the market is photo stabilized with highly toxic sodium azide and rapidly denatures within 72 hours, without stabilization, when exposed to light. To eliminate the toxicity and increase photostability, five solutions were employed with trehalose, myoinositol, guanidine hydrochloride, a solution of trehalose and guanidine hydrochlorideand a solution of myo-inositol and guanidine hydrochloride to prevent denaturation. The solutions were placed underneath ambient light ~210 (lumens). The maximum absorption of the untreated phycoerythrin control group decreased indicating degradation after 72 hours, when compared to the phycoerythrin in the solution of myoinositol and guanidine hydrochloride maintained photostability beyond 30 days (720 hours). When incorporated to the DSSC, the phycoerythrin generated 1.2 milliwatts while the industry standard technique titanium based control cell generated 0.4 milliwatts. The phycoerythrin based DSSC produced 60% more electrical output than the titanium based control cell. The results indicate that phycoerythrin can be stabilized with non-toxic additives and can be applied as the sensitizer for DSSC. With further research, phycoerythrin could be applied in food dye and ink or other materials that require a non-toxic natural red pigment

Ethan Novek

Sophomore
Greenwich High School



Ethan is a sophomore at Greenwich High School. He has competed at CSEF and has been a 1st Place category award winner for the past three years. Ethan's focus is harnessing untapped renewable energy resources and converting emissions into valuable byproducts. In 2014, Ethan developed a novel system to generate electricity from water seepage from tides, addressing many of the environmental and economic issues with current tidal power systems. Ethan's current invention generates electricity from CO2 emissions, while capturing and sequestering this CO2 using low grade waste heat into the valuable byproduct of Urea. Ethan's invention is the first system to eliminate CO2 emissions while increasing profitability and efficiency of a Power Plant. Ethan's 2015 project invention has a provisional patent and there is an issued utility patent for his 2014 tidal power invention. He has won several awards in the past few years including 1st Place in Applied Technology (2014), 1st Place in Energy (2014), 3rd Place at National JSHS 2015 in Maryland ($4,000 scholarship), and was recognized as one of nine students in the U.S. to be a Popular Mechanics "Future Breakthrough Award Winner" for 2014. Due to Ethan's patented invention, Yale University has asked Ethan to publish a paper with them in a leading science journal over this summer.

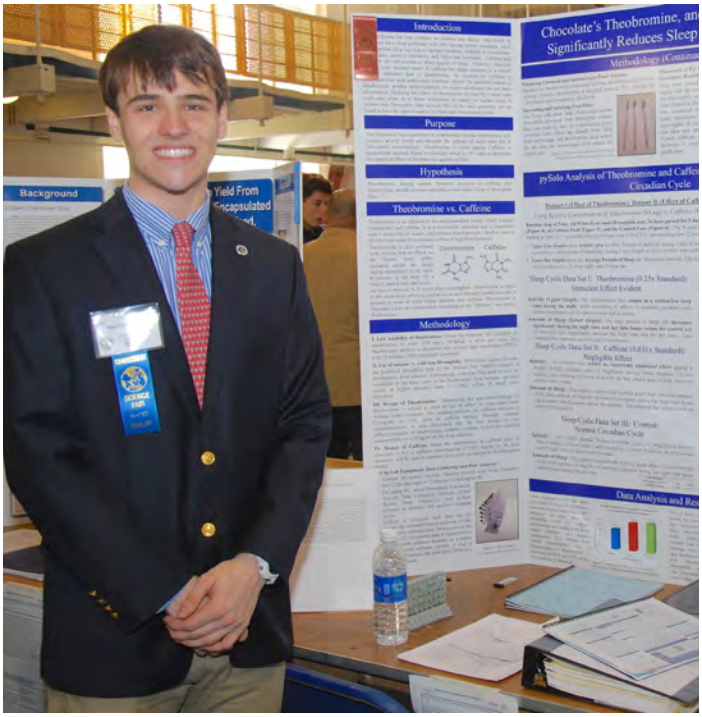
Novel Low Grade Waste Heat Recovery System with Simultaneous Electricity Generation, Carbon Sequestration and Urea Production

Over 60% of energy generated during electricity production is discarded as low-grade waste heat. Concurrently, modern power plants are reluctant to capture and sequester flue-gas CO2, due to high cost and significant efficiency reductions. The novel system invented in this research converts untapped low grade waste heat into valuable byproducts including electricity, captured CO2, and Urea. The system generates electricity by engineering a concentration gradient using CO2 emissions and recycled NH3(aq) in an Osmotic Heat Engine. An NH4HCO3 solution then selectively decomposes into pure CO2 and NH3 gas streams for carbon capture and Urea production. The performance of each component was separately evaluated, and integrated to determine viability of the complete process. In electricity generation, a high concentration solution was created through NH3(g) (recycled) and CO2(g) absorption with pH 8.6 and NH3:CO2 1.3:1, parameters exceeding draw solution requirements. 14.4Wh electricity was produced per kg CO2 scrubbed, translating to 180 MWh per day from a 500 MW power plant. The Pressurization-Depressurization CO2(g) capture at 45oC produced 98% NH3(g), 1.02atm; 99% CO2(g), 2.1atm and was 85.5% more efficient than current carbon-capture systems. Ammonium Carbamate/Urea production achieved conversion efficiencies of up to 99% and was carbon negative, net sequestering 770 kg CO2/ton Urea. Based on the CO2 emissions of 500MW coal power plant, the system will produce 335 metric tons of Urea/hour respectively. The proposed integrated system dramatically lowers the cost of carbon capture/sequestration and converts otherwise waste products into valuable Urea, while simultaneously improving the efficiency of power plants and industrial facilities.

Reid Radulovacki

Junior

Greenwich High School



Reid Radulovacki is a junior at Greenwich High School in Greenwich, CT. At Greenwich HS, Reid was a founding member of the American History Club, inspired by family trips to historic sites in the southern US States. He was recognized for academic excellence by the Spanish and Math Departments, receiving a Certificate of Excellence Award for Spanish in 10th grade, and the Distinguished Student Award in Algebra, also in 10th grade. Reid has been part of the Independent Science Research program for the last two years, testing the impact of theobromine on the sleep-wake cycle of drosophila melanogaster (fruit flies).

Reid has logged over 120 hours on community service projects on a local level and nationally. In Greenwich, Reid volunteered as an assistant physical therapist at the Nathaniel Witherell Nursing Home. He also worked on a number volunteer projects in New Orleans, Louisiana,

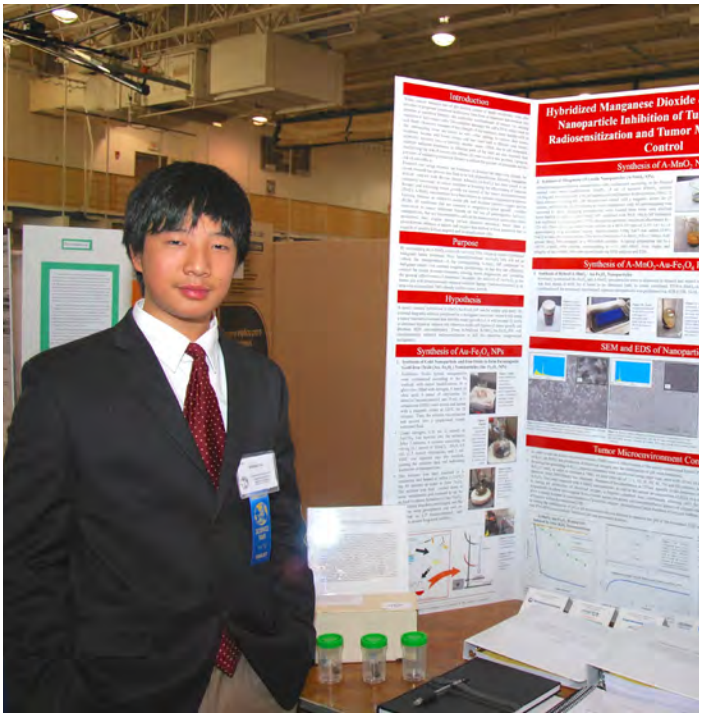
Reid has also been active in athletics, rowing on the Greenwich Crew team for 5 years. He was captain of the freshman team and was also voted the most valuable rower. He has won medals in numerous regional regattas and has competed in the prestigious Head of the Charles regatta.

Chocolates Theobromine, and not Caffeine, Significantly Reduces Sleep in Drosophila

Chocolate and caffeine are well-known to affect the quality of sleep. Chocolate, however,contains only minimal traces of caffeine but larger amounts of theobromine, a related alkaloid stimulant, whose effect on sleep has not been documented. Studying the effect of theobromine on the sleep/wake cycle of Drosophila melanogaster, whose circadian cycles are the same as humans, may allow us to better understand its impact on human sleep. This research investigates whether theobromine increases wakefulness and reduces sleep for D. melanogaster, relative to caffeine, a known stimulant. Theobromine and caffeine were separately administered to the Sucrose/Agar food supply of white-eyed adult D. melanogaster at relative concentrations of 8:1 (respectively) typically found in chocolate. For each alkaloid added, the Circadian sleep pattern (24-hour fly activity) for single test subjects was monitored for five days using a Trikinetics Sleep Chamber and Drosophila Activity Monitor (DAM). Sleep and wake times were collected, and later processed using pySolo. Analysis of circadian sleep cycle data in D. melanogaster, for relative amounts of theobromine to caffeine (8:1 ratio) found in chocolate, suggests that theobromine disrupts sleep, while caffeine plays only a limited role. Theobromine-fed flies register 30% less total sleep at night versus the control group, while for caffeine-fed flies, only a 4% reduction in sleep is observed. Moreover, theobromine-fed flies demonstrate a 90% increase in activity during the daytime vs. both caffeine-fed and control flies. These results suggest that theobromine, and not caffeine, may be the dominant chemical in chocolate that affects the human sleep/wake cycle.

William Yin

Sophomore
Greenwich High School



William Yin is a sophomore at Greenwich High School, and a member of the Science Research program; this is his first year competing at the Connecticut Science and Engineering Fair. His passion for disease treatment has led him to investigate the use of hybridized, biocompatible manganese-dioxide and gold-iron oxide nanoparticles as a novel method for enhancing radiation therapy while simultaneously modulating the tumor microenvironment. William was an intern at the Genomics laboratory at the Albert Einstein College of Medicine, and was also an intern abroad at the Hongkou Shanghai First People's Hospital. He currently works as a teacher at Zaniac Greenwich, a K-8 campus for STEM education. William is also an avid musician, and has performed solo performances at Carnegie Hall and Steinway Hall. This summer, he will be performing in an international tour at Lisbon, Portugal. In his free time, William enjoys playing tennis, and currently plays on the school Junior Varsity team. In the future, William hopes to pursue studies in medicine and biology

Hybridized Manganese Dioxide & Gold-Iron Oxide Nanoparticle Inhibition of Tumor Growth via Radiosensitization and Tumor Microenvironment Control

While controlled bombardment of cancer cells via ionizing radiation remains the leading form of cancer treatment, its effectiveness is often limited by damage caused to neighboring healthy tissue. Recent innovation in cancer treatment focuses on the use of paramagnetic Au-Fe3O4 nanoparticles that, once positioned, display strong surface plasmon resonance, which leads to thermal ablation, a natural and oxygen-free method of heat generation that quickly kills targeted and localized cancer cells. Separately, A-MnO2 nanoparticles have been shown to regulate cancer tumor microenvironments through simultaneously limiting hypoxia and acidosis to enhance radiation response by preventing tumor aggressiveness. This research investigates novel synthesis of biocompatible hybrid A-MnO2-Au-Fe3O4 nanoparticles, so that both therapies can be realized concurrently, once the magnetically-responsive hybrid NPs are accurately positioned. 15nm A-MnO2 nanoparticles were synthesized via a modified Prassad method, while 2-14nm Au-Fe3O4 NPs were synthesized via a modified Yu method, all of which were supported by SEM/EDS. Hybrid A-MnO2-Au-Fe3O4 were then formed by the combination of A-MnO2:Au-Fe3O4 (1:3M) via 60oC sonication in 0.2% PVA. SEM/EDS analyses confirm the creation of PVA coated hybrid nanoclusters (PVA-HNC; ~20nm), that remain magnetically responsive. In a simulated tumor environment, these PVA-HNCs would limit hypoxia, or slow tumor aggressiveness, as 45M quenched 94% of 1.1mM H2O2 in 40min. Additionally, surface plasmon resonance of the PVA-HNCs was achieved. Irradiation of 100M PVA-HNC demonstrated increased radiation signature versus a PVA-Fe3O4 colloidalsuspension of equal scattering concentration. Overall, PVA-HNCs performed markedly better than the individual parts.