CONNECTICUT SCIENCE & ENGINEERING FAIR
at the
INTEL INTERNATIONAL SCIENCE & ENGINEERING FAIR
Pittsburgh, Pennsylvania, May 13 - 18, 2018

Meet our 2018 ISEF Competitors


Raina Jain, Sophomore
Greenwich High School
2nd Place - Lockheed Martin Physical Sciences

Maya Geradi, Senior
Wilbur Cross High School, New Haven
1st Place Lockheed Martin Physical Sciences

Shobhita Sundaram, Senior
Greenwich High School
1st Place - Alexion Biotechnology

Emily Philippides, Senior
Greenwich High School
1st Place - Pfizer Life Sciences

Keshav Vedula, Senior
CREC Academy of Aerospace and Engineering, Windsor
1st Place - UT Aerospace Engineering

Srikar Godilla and Cristian Rodrigues, Juniors
CREC Academy of Aerospace and Engineering, Windsor
1st Place CASE • PepsiCo • IBM
Urban School Challenge
Maya Geradi, a senior at Wilbur Cross High School, New Haven, has been competing at CSEF for 6 years. She is a 3-time finalist and 4th place grand award recipient at Intel ISEF and will become a 3-time recipient of the H. Joseph Gerber Medal of Excellence this May. She has also been recognized by the New Haven ACS chapter and was a gold medalist at the 2016 I-SWEEEP Science Olympiad.

This year, her research focuses on developing a radiotracer that can be used in PET scans for the research and diagnostics of Alzheimer’s disease, epilepsy and other neurodegenerative diseases. She worked on modifying the chemical synthesis of a radiotracer targeting the protein SV2A, with the aim of its increasing practicality and accessibility to multiple PET centers.

Maya also has an interest in medical and environmental history. She has participated in History Day competitions for 6 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 a member of 4 honor societies, one of which she initiated. 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 and speaking at local science and math outreach events and peer tutoring for mathematics. She enjoys spending her free time kayaking and reading novels. Maya will be attending Yale University this fall.

**Synthesis and Separation of Chiral Compounds in the Preparation of a PET Radiotracer Targeting Synaptic Vesicle Glycoprotein 2A**

Positron emission tomography (PET) is a promising technology that utilizes radiotracers for producing detailed, 3D images of the body. The radiotracer studied in this project targets the SV2A receptor in the brain, which is a marker of synaptic density and hence can be used to study Alzheimer’s disease and epilepsy. This project aims to synthesize an enantiopure compound in preparation of a chiral PET radiotracer. The racemic compound was synthesized at -20C and purified using a silica gel column. Reaction progress was monitored by thin layer chromatography and structure was confirmed utilizing NMR. Conditions required for separation using the HPLC system were optimized by testing varying combinations of organic solvents (0–100%), in conjunction with different chiral columns and flow rates (0.1 –2mL/min). Three chiral catalysts were tested under varying reaction conditions for synthesizing an enantiopure compound. The racemic compound was successfully synthesized and separated using the HPLC system. Full separation was achieved by using ethanol and hexane in a 25%/75% combination, 0.1% TEA, 1.0mL/min flow rate and the CHIRALCEL OJ-H column. The quinidine catalyst preliminarily yielded a successful 90/10 enantiomeric ratio on a tested compound. The other 2 catalysts produced a racemic compound. The quinidine catalyst is being tested under new conditions to further improve the enantiomeric ratio. Using chiral catalysts to optimize the synthesis of the radiotracer could increase product yield and lower the synthesis time and cost. This increases the viability of this PET radiotracer for diagnostics and research of Alzheimer’s disease, epilepsy and other neurodegenerative diseases.
Srikar Godilla & Cristian Rodriguez
Juniors
CREC Academy of Aerospace and Engineering, Windsor

Competing in “Materials Science”

Srikar Godilla is a junior at Academy of Aerospace & Engineering in Windsor, CT. Srikar and his teammate Cristian's research project has won them 1st place - Urban school challenge award, 1st place - H. Joseph Gerber Award, 2nd place - Lockheed Martin Awards, Arthur Mensing award and others at Connecticut Science and Engineering Fair, and they also gained admittance to Intel Science and Engineering Fair. Srikar is also passionate about Robotics. He is proud to have led his team to State Finals this year as the Team Captain. He is also Vice president of his school's varsity debate team. He has won Novice First place speaker award at the Farmington, CT debate tournament as a sophomore. He was also accepted into the Yale Young Global scholars program in the summer of sophomore year. Srikar is devoted to introducing Robotics to elementary and middle school students and has organized numerous demonstrations. He likes to volunteer in the Department of Defense's STARBASE STEM program, which aims to inspire disadvantaged kids in fields of science and technology. He also takes pride in mentoring members of his Robotics team in CAD, programming and Engineering design. He likes to relax by playing flute.

Cristian Rodriguez is a junior at CREC Academy of Aerospace and Engineering in Windsor, Connecticut. Cristian and his teammate Srikar Godilla’s research project “Effect of Experimental Parameters on Forming Prince Rupert’s Drops for Maximum Strength and Toughness” has won them first place in the CASE PepsiCo Urban school challenge award with IBM. Through this they were selected to represent Connecticut at the Intel 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, Vice president of Student council, and chair of the fundraising committee in the National Honor Society. Apart from the sciences he is very interested in music and the arts such as dancing. He regularly performs and enjoys painting as a stress reliever.

Effect of Experimental Parameters on Forming Prince Rupert’s Drops for Maximum Strength and Toughness

The history of modern glass starts 400 years ago with the creation of the world’s first Prince Rupert’s Drop a thermally shocked glass bulb. It is created by dropping molten glass into distilled water causing the glass drop to cool rapidly, forming compressive stresses on the exterior of the drop. The inside of the drop cools at a slower rate forming internal tensile stress. The combination of compression and tension make the drop very difficult to break. This research seeks to enhance the strength of the drop by varying the concentrations of contaminants in solution. Poly vinyl acetate (PVA) as a contaminant suggested the largest increase in strength and was chosen as the principle variable to test. Specimens were prepared with varied concentrations of PVA (2-70%) at constant temperature and solvent composition. Drops were tested and measured under compression revealing the maximum strength, Young’s Modulus, and toughness. As the concentration of PVA increased from 2% to 50%, there was an increase in maximum compressive strength and toughness; however, concentrations greater than 50% resulted in a decrease in mechanical performance. High-speed video analysis during compression testing showed that fracture occurs internally towards the end of the tail, suggesting the air gap has a great effect on the drops strength. Initial results from finite element analysis (FEA) indicate that the air bubble plays an important role in the fracture of the material.
Hiba Hussain
Sophomore
Greenwich High School, Greenwich

ISEF Category: “Biomedical Engineering”

Hiba Hussain is a sophomore at Greenwich High School in Greenwich, CT. With her research entitled a Non-Invasive, Low-Cost Diagnosis of Chronic Obstructive Pulmonary Disease (COPD) she aims to make her diagnostic test accessible & affordable compared to the current cost, which is around $1000. Her research, utilizing NFC technology and breath biomarkers, is able to detect COPD in as little as four minutes and for a fraction of the current cost. For her work, she was awarded second-place in the life science category, including awards from the Barnes Aerospace and UTC Aerospace Systems, and was selected to represent Connecticut at the Intel Science and Engineering Fair. She became interested in the STEM fields and medicine through classes in school, and later her involvement with the Greenwich Emergency Medical Services Explorer Post. Through her engagement with this organization, Hiba volunteers to educate the community about emergency medicine through various public outreach events and aspires to become an EMT herself in the next couple of years. Hiba is also part of her school’s science team, which will be attending the National Science Bowl, as well as her school’s debate team. In the future, Hiba hopes to continue her passion for medical research and wishes to pursue a career in medicine.

Non-Invasive, Low-Cost Detection of Chronic Obstructive Pulmonary Disease (COPD) via Smartphone Breath Analysis

Chronic Obstructive Pulmonary disease (COPD) is expected to become the third largest killer worldwide by 2030. Current diagnosis mechanisms are time-consuming and costly, highlighting the need for a more accessible and rapid diagnosis so that the disease can be treated at its earliest stage. In this research, a rapid and simple smartphone-based detection of COPD was created. Single-walled carbon nanotubes (SWCNTs) were combined 2-hydroxy-1,1,1,3,3,3- hexafluoropropyl)-1-naphthol (HFIPN) in a 2:1 mass ratio, to create a COPD-breath gas specific PENCIL powder. When integrated into a Texas Instruments NFC Tag, and exposed to COPD breath gases isoprene, octadecane, hexanal, and undecane, conformational change in the PENCIL-HFIPN selector was realized by an increase in the material’s resistivity. Exposure of the PENCIL-on-NFC tag to 1ppb and 1 ppm COPD breath gases caused an increase in PENCIL resistance from 13-13.7k and 12.7-27k, respectively. Change in PENCIL-on-NFC tag resistivity produces changes in current usage drawn from a Smartphone, when read by the device, and acts as the basis for COPD detection. After 1 minute of exposure to typical 1ppb concentration of COPD breath gases for an afflicted patient, Smartphone read of the PENCILon- NFC tag drew only 1.5mA of current, which is 3.5mA less than current used under normal, ambient conditions. Increase in PENCIL resistance, and subsequent Smartphone current reduction was found to be COPD gas specific and was used to train a new Smartphone application to provide a 4-minute diagnosis for COPD, based on calibration of the circuit’s current usage, and its effect on the phone’s battery usage.
Raina Jain  
Sophomore  
Greenwich High School  

ISEF Category: “Environmental Engineering”

I have always had a strong passion for science. Perhaps it was due to the curious attitude that my parents fostered in me by encouraging my constant bombardment of questions (which I am sure got annoying sometimes) but while others would be busy playing about, I remained fascinated with my collection of science articles. My passion for science was furthered when I started conducting science experiments and saw the properties of nature first hand. I remember doing simple experiments such as connecting a battery to salt water using two pencils and standing in awe when smelling the chlorine in the air. Andrew Bramante, my research mentor at Greenwich High School, further introduced me to the applications of science, and helped me develop a device that can be used to detect arsenic contamination in water using Fe₃O₄ photonic crystals. The device was the first of it’s kind to be able to detect arsenic contamination of 10ppb using a light spectrum. After months of dedication, from the development of the idea to execution of design, I submitted this project to state science fairs and received great recognition. I plan on continuing the improvement and implementation of this design and hope to delve deeper into the subject of chemistry, which I have gained an interest for, and learn more along the way. Although my passion for science research is infinite, I also enjoy other hobbies such as playing the piano, competing in half marathons, and singing (although I am not very good at it). I would like to pursue a career as a science researcher, an interest that was sparked by Mr. Bramante’s science research class.

Magnetically Induced, Visual Detection of Trace Arsenic Contaminants in Water Using Fe₃O₄ Photonic Crystal Structures

Arsenic, a highly toxic metal contaminant commonly found in our drinking water, is responsible for many accidental deaths. Currently, the only visual arsenic-in-water detection system is tedious, and can detect arsenic concentrations of 250ppb or more, well above the EPA 10ppb water-action-level. To combat arsenic drinking water contamination, a sensitive, inexpensive, portable, and easily-visualized detection system is needed, and has been developed in this research. To begin, superparamagnetic, SiO₂-coated, polyacrylic acid-capped Fe₃O₄ colloidal nanocrystals (CNC’s) were synthesized, and their photonic and physical properties characterized via SEM and UV-Visible spectroscopy. Application of 80-140G magnetic field from a portable, 3” magnet altered the refractive indices of the photonic structures, so that long-to-short wavelength, red-to-blue color change is easily visualized from the native brown CNC solution color. Addition of 1ml of 10ppb Arsenic, however, to 2ml of 8mg/ml CNCs causes alteration of the photonic characteristics, so that long-wavelength shift occurs with applied magnetic field (native brown to orange). This new color changing behavior is specific to arsenic contaminant, and attributed to As-O interactions at the surface of the SiO₂-coated CNCs. Other typical metal contaminants did not share this same metal-oxide CNC-coating affinity. For the consumer friendly, rapid Arsenic-in-water assay, a color code was developed to detect/indicate as little as 10ppb As-contaminant, with color change at 10ppb increments. In the field, drops of suspect water are added to the CNC solution at 1:2 (v/v) in a small vial; Arsenic contamination is determined in seconds via color change through the application of a small magnet.
Emily Philippides  
Senior  
Greenwich High School  
ISEF Category: “Translational Medical Science”

Emily is a senior at Greenwich High School in Greenwich, CT. At the 2018 Connecticut Science and Engineering Fair, she was awarded first and second place in the Pfizer Life Sciences and Alexion Biotechnology categories respectively for her research involving “donut-shaped” hydrogels that deliver localized, time-released treatment of ovarian anticancer drugs. She was also awarded the H. Joseph Gerber Award of Excellence. From a young age, Emily realized her strengths and passions lie in the sciences, and hopes to pursue a STEM-related career. She became interested in cancer therapy after her grandfather was diagnosed with prostate cancer several years ago, and the mother of a close friend was diagnosed with brain cancer just last year. In her free time, Emily enjoys spending time outdoors, staying active, and reading dystopian science fiction books. She has participated in several clubs at her high school, including the Debate Team and the Environmental Action Club, and is also a competitive runner. Emily will be attending Princeton University this Fall.

Controlled-Release Delivery of Ovarian Anticancer Paclitaxel via Vortex Ring, Donut-Shaped Hydrogels

Ovarian cancer affects countless women worldwide. Unfortunately, systemic chemotherapy for treatment of ovarian cancer necessitates one-time super dosing, leading to the onset of severe side effects, and like radiation therapy, causes the destruction of neighboring, healthy cells. A method where chemotherapy is temporarily implanted at the cancer and subsequently time-released would be preferred, to adhere the drug to the tumor, and minimize side effects associated with immediate overdosing. Here, such a device is engineered, via donut-shaped hydrogel vortex rings that are formed and loaded with a chemotherapy agent. Specifically, 750g of paclitaxel (PAC) is dissolved in 1ml aqueous 2% sodium alginate, a droplet of which is then injected into a 5mM CaCl2 and 95mM MgCl2 buffer to create a 1mm vortex ring hydrogel, with a 7.5g drug load. Under simulated ovarian conditions, each sticky, PAC-loaded vortex ring steadily releases its chemotherapy, so that 50% is released in 4hours, with up to 5.4g delivered in a maximum of 20hours (72% release), post-application. Simulation of pointed placement of the PL-VRH donuts, their adherence to a cancerous tumor in the ovarian cavity, resistance to movement due to aqueous conditions, and subsequent release of the paclitaxel, was carried out using a porcine intestine membrane model. For delivery of a localized PAC dosage that concurs current IP-injection (342g for a typical 57cm2 ovary), it was determined that ~60 hydrogel vortex rings can be directly delivered to the ovarian site via 600l injection of medicated precursor, ensuring direct and extended interaction of the chemotherapy and cancer.
Alzheimer’s disease (AD) is a neurodegenerative, fatal brain disease characterized by impairments in memory, language, reasoning, and cognition. Identifying AD in its earliest stages of Mild Cognitive Impairment (MCI) allows patients access to the best possible treatments, and time to make crucial caregiving and financial decisions. Currently, no accurate diagnostic tests exist for early-stage AD; internationally just one in four patients are diagnosed. In this study, the development of a machine learning tool to accurately diagnose AD and identify high-risk MCI patients is proposed, using neuropsychological and blood proteomic profiles. A novel two-layer hierarchical framework was designed: The first layer diagnoses patients as healthy, MCI, or AD, and the second layer analyzes healthy/MCI patient profiles to predict future AD onset. The online Alzheimer’s Neuroimaging Initiative database of 560 patients was used to build the first model. A subset of 368 patients was used for the second model, using multiple observations per patient across a 12-month timespan. For each classification layer, a multi-pronged approach was developed to extract the most relevant biomarker data from patient profiles, integrating univariate and multivariate methods. Upon evaluation, the first model diagnosed patients with a 91% accuracy, based on linear components extracted from proteomic profiles. The second model predicted future AD onset for current MCI patients with a 92% ROC accuracy within a 6-48-month timeframe, using biomarkers selected from both proteomic and neuropsychological profiles. These results far outperform prior research and indicate that this tool will provide a low-cost, minimally invasive method of detecting early-onset AD.
Keshav Vedula is a senior at the Academy of Aerospace and Engineering in Windsor, Connecticut. Keshav’s research on biomimetic airfoil design and its applications won him first-place in the engineering category at the Connecticut Science and Engineering Fair, along with other special awards. Keshav plans on continuing his research and presenting his final conclusions at an AIAA conference in Atlanta, Georgia this summer. Aside from his research, Keshav actively competes in mathematics and physics competitions at the regional, national, and international levels. He ranked 15th place internationally in the AAPT Physics Bowl as a junior, and has qualified as a USA Physics Olympiad Semifinalist this year. As a mathematics and physics enthusiast, Keshav thoroughly enjoys reading books by prominent figures in each field and taking courses in these subjects at local universities. Keshav also competes in coding competitions across the Northeast, and has won third place at the Quinnipiac University Coding Competition and second place in the Lockheed Martin Code Quest. When he’s not studying, you can find him on the basketball court. Keshav has played on his high school varsity basketball team for the past three years, during which time his passion for the game has only risen. His team made it the Connecticut State Final Four during his junior season, and he was proud to have been named the team captain as a senior. Off the court, Keshav strives to support his teammates and peers academically by organizing tutoring sessions as President of the National Honor Society.

Undulated Leading-Edge Airfoils in Low to Medium Reynolds Number Regime

Biologically inspired airfoil designs have recently become of increasing interest to the aerospace industry for their aerodynamic versatility. One approach involves mimicking the undulating leading-edge of humpback whale fins. Such airfoils have been shown to improve stall characteristics in specific airflow regimes depending on the relative turbulence of the flow. This research project explored the validity of these biomimetic airfoils in the transitional Reynolds number regime (Re=120,000–500,000). The study featured two NACA 2415 airfoils: a traditional design, and an experimental design with a sinusoidal leading-edge that mimics the tubercle protuberances on the leading-edge of humpback whale fins. Wind tunnel testing was conducted in the transitional regime with 3D-printed prototypes; the coefficients of lift and drag were calculated for both airfoils at varying angles of attack. A numerical study using Computational Fluid Dynamics was also executed under the same conditions to provide flow visualization and a secondary set of data. Experimental data verified numerical predictions that the tubercle airfoil would stall more gently and consistently compared to the control airfoil. However, the wind tunnel testing revealed that the gain in stability came with a slight loss in efficiency in the transitional regime (Re~400,000). Flow visualization highlighted that the troughs in the leading edge acted as streamwise vortex generators, accelerating channels of air and inducing a low-pressure region inside the troughs. This explains the biomimetic airfoil’s stable performance in the post-stall regime compared to the control airfoil, suggesting its potential aviation applications for low-altitude subsonic aircraft.
Meet the Chaperones

CONNECTICUT SCIENCE & ENGINEERING FAIR
at the
INTEL INTERNATIONAL SCIENCE & ENGINEERING FAIR
Pittsburgh, Pennsylvania, May 13 - 18, 2018

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.

Jacqueline DiNuccio – ISEF Week Assoc. Coordinator • CSEF Board
Jacqueline DiNuccio holds the position of Sr. Operations Manager. In this position, Jacqueline has overall responsibility for the successful execution of multiple helicopter programs, including coordination of program activities to realize cost, schedule, financial performance, and delivery targets. Jacqueline joined Sikorsky in 1993 and has held several diverse positions with increasing responsibilities. Most recently, she was the regional sales manager for Europe. In this capacity she developed the strategy for Sikorsky entry into Eastern Europe including initiation of the PZL Mielec acquisition. She also served as Business Acquisition Manager for sales campaigns and as team leader for coordinating the two-week UH-60M BLACK HAWK helicopter tour and demonstration in Poland earlier this year.

Jacqueline holds a Master of Science degree in System Design and Business from MIT, a Master of Science degree in Electrical Engineering from Boston University and a Bachelor of Science degree in Chemistry from Framingham State College.

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 Otis 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.