Meet Our Winners

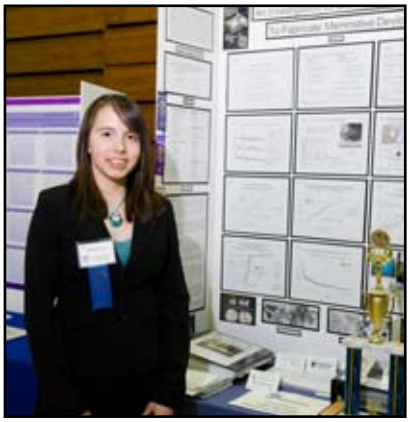
CONNECTICUT SCIENCE FAIR & SCIENCE HORIZONS at the INTEL INTERNATIONAL SCIENCE & ENGINEERING FAIR San Jose, California, May 9 - 14

l-to-r: Wynn Müller, CSF Registration & ISEF Coordinator; Madeleine Skaller & Jacob Ness, Science Horizons Winners; William Newberry, Amooyla Narayanan & Heather Leask, CSF Winners. (absent is Jason Gandelman, CSF Winner.)

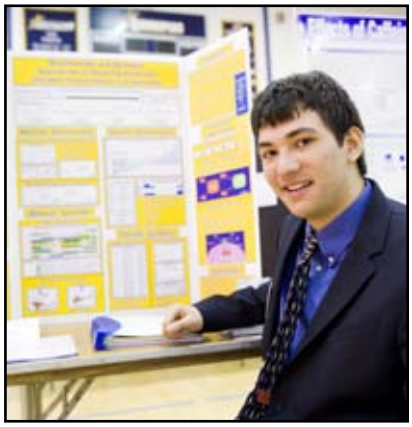
William Newberry, Senior, Greenwich HS

Amooyla Narayanan, Junior, Glastonbury HS

Madeleine Skaller, Junior, Brewster HS



Heather Leask, Senior, Norwich Free Academy



Jason Gandelman, Senior, Staples HS

Jacob Ness, Senior, New Milford HS

Representing the Connecticut Science Fair at the 2010 Intel International Science & Engineering Fair

www.ctsciencefair.org

William C. Newberry, Grade 12

Greenwich High School, Greenwich, CT

Diatom-CdS Nanostructures as a Method to Enhance the Efficiency of a Dye-Sensitized Solar Cell

Connecticut Science Fair Awards

- Dominion's Millstone Power Station Physical Science Awards --- 1st Place - Physical Science Senior High Individual - $500 & trophy, and trip to compete at Intel ISEF
- CT Clean Energy Fund Alternative/Renewable Energy Awards --- 3rd Place High School - $200 Cash and Trophy
- Goodrich Awards for Excellence In Engineering --- 3rd Place- Engineering High - $200 & trophy
- United Technologies Corporation Awards --- $500 in UTC Common Stock, Plaque, Backpack and Annual Report
- H. Joseph Gerber Medal of Excellence, an award of the Connecticut Academy of Science and Engineering in partnership with CCAT --- Physical Sciences Senior - $1,000 cash, Solid Silver Medal of Excellence and
- Dominion Scholarship --- $5000 Scholarship
- MIT Club of Hartford --- For excellence in energy related research, high school, $150 cash award
- The Coherent, Inc. Richard Hart Award for Excellence in Photonics --- $300 cash, plaque, invitation to lunch and tour Coherent factory

Abstract

The Dye-Sensitized Solar Cell (DSSC) provides an inexpensive alternative to standard solar cells. This type of solar cell is greatly inefficient in its production of electricity, as most cells reflect over 70% of the incident light. The integration of light-trapping materials into a DSSC may decrease the amount of light reflected and allow for increased efficiency. Certain algae known as diatoms are characterized by the presence of an internal matrix nanostructure used to trap light for photosynthesis. These structures, biosilica frustules, are composed of naturally produced SiO2 and contain nanoscale complexities not replicable by synthetic preparation. Literature has indicated that it is possible by complex methods to extract these frustules from the interior of a diatom and preserve their structure in a salt. The current study isolated biosilica frustules from the algae Pinnularia sp. and developed a simple method to coat them with a thin layer of the semiconductor, Cadmium sulfide, by a chemical bath deposition process. Characterization of these coated frustules using scanning electron microscopy (SEM) and energy dispersive spectroscopy (EDS) indicated that such methods were successful. Isolated frustules were coated with semiconducting material to allow for their integration into a DSSC without losing the matrix nanostructure necessary for light capture. UV-Vis analysis of CdS coated frustules in comparison to an equivalent CdS coating without frustule incorporation demonstrated that these frustules trap up to an additional 5% of incident light and decrease the reflective nature of a surface very similar to a DSSC. These results strongly suggest that the integration of CdS coated diatom frustules into a DSSC will decrease the amount of light reflected and increase the solar conversion efficiency of the cell.

Biography

William Newberry is a senior at Greenwich High School whose most recent science research project focuses on utilizing the light-trapping capabilities of certain species of algae to enhance the efficiency of a Dye-Sensitized Solar Cell. This project has the capability to increase the efficiency and practicality of this relatively inexpensive alternative energy source. In college, William plans to pursue a degree in chemistry and continue scientific research in this field. He will also study some economics. He hopes to apply these skills and passions in a career that blends science and business. William is also an active member of the Greenwich High School community, serving this year as the captain of the Varsity cross-country running, alpine skiing, and tennis teams. He is also the Student Body President.

Representing the Connecticut Science Fair at the 2010 Intel International Science & Engineering Fair

www.ctsciencefair.org

Heather N. Leask, Grade 12

Norwich Free Academy, Norwich, CT

The use of sol-gels for the fabrication of a Memristive Device

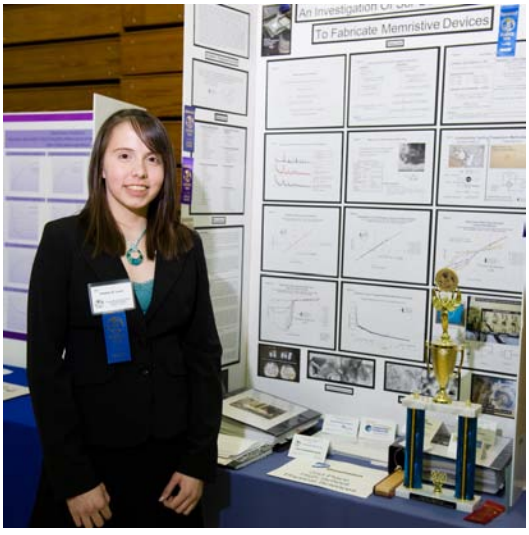
Connecticut Science Fair Awards

- Dominion's Millstone Power Station Physical Science Awards --- 2nd Place- Physical Science Senior High Individual - $300 & trophy, and trip to compete at Intel ISEF
- Goodrich Awards for Excellence In Engineering --- 1st Place - Engineering Senior High - $500 & trophy
- U.S. Metric Association --- Certificate & membership to CT Science Center given by CSF
- Mu Alpha Theta --- Certificate, membership to CT Science Center given by CSF
- IEEE, Connecticut Section --- $100 Honorable Mention
- The John B. Trevor, Jr. Award for Electrical or Electronic Projects --- 1st Place - $500 cash award

Abstract

In 1971, Leon Chua hypothesized the memristor as the fourth passive circuit element based on a "missing" relationship between charge and flux. In 2008, Hewlett Packard fabricated a device with memristive characteristics. Memristor circuits can potentially be used for computer memories, to simulate brain functions by recreating associative memory in electronic devices, as well as increasing memory chip density by an order of magnitude. The fabrication of memristive devices was investigated using three sol-gel methods to create titanium oxide powders including: an acid reflux, a chelating agent (precipitation technique), and a metal alkoxide technique. The molarity and procedure were modified to create the correct nano-particle size of the titanium dioxide to emphasize memristive effects. Samples of titanium oxide were characterized using X-ray Diffraction to find the method that created the smallest nano-particles. The products of the sol-gels, titanium oxide powders, were pressed into pellets to create memristive devices. Conductivity testing was performed via the four-point probe test on selected samples to determine if memristive effects could be detected. The sample layer's thickness and material were adapted based on the results and the ability of the device to maintain the state of the resistance. Memristor properties, including the pinched hysteresis loop, were found within the devices fabricated from metal alkoxide technique. A Memristor emulation circuit was breadboarded using semiconductor multipliers and operational amplifiers to emulate memristive effects.

Biography



Heather Leask is a senior at Norwich Free Academy. This is her sixth year as a participant and finalist in the Connecticut Science Fair. Her latest research concerns fabricating memristive devices through materials science. As a result of this research, she is co-authoring a paper and two patents are being applied for. Last year, the focus of her project was creating a memristive circuit using existing passive circuit elements. Her project won second place in the Goodrich Engineering category as well as a $5,000 Dominion Power Scholarship.

Heather has been a highest honors student since freshman year and was inducted into the National Honors Society in her junior year. She is involved in outdoors club and is the treasurer for National Honors Society Science Club where she is working with other high school students to create an admiration of science in middle school students. Heather is a varsity member of cross-country, indoor and outdoor track teams. This year she earned all-conference for high jump during indoor track season. Heather is a coordinator for Project Outreach, a community service organization. Heather will be attending Worcester Polytechnic Institute in the fall.

Representing the Connecticut Science Fair at the 2010 Intel International Science & Engineering Fair

www.ctsciencefair.org

Amoolya Narayanan, Grade 11

Glastonbury High School, Glastonbury, CT

Effect of trans-cinnamaldehyde on reducing attachment and invasion of Uropathogenic Escherichia coli in urinary epithelial cells

Connecticut Science Fair Awards

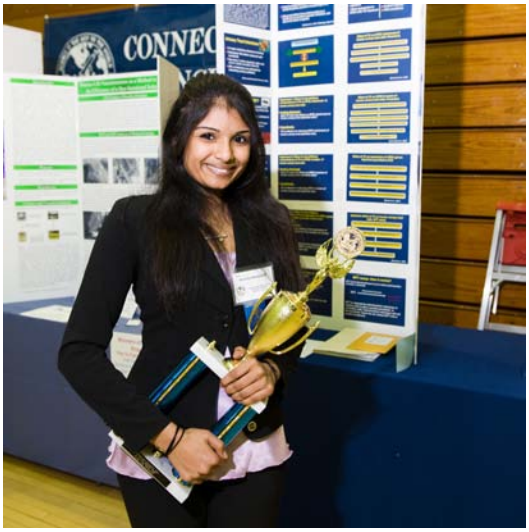
- Pfizer Life Sciences Awards --- 1st Place- Life Sciences Senior High- $500 & trophy, Trip to compete at Intel ISEF
- H. Joseph Gerber Medal of Excellence, an award of the Connecticut Academy of Science and Engineering in partnership with CCAT --- Life Sciences Senior - $1,000 cash, Solid Silver Medal of E xcellenceand Invitation to
- U.S. Army --- certificate and $50 savings bond

Abstract

Urinary tract infection (UTI) is one of the most common infectious diseases in the United States, causing more than 100 million cases and costing over $1 billion annually. Uropathogenic *Escherichia coli* (UPEC) is the primary bacterium causing UTIs in humans. Emerging antibiotic resistance in UPEC is a major concern, highlighting the need for alternate approaches to control the pathogen. Attachment and invasion of urinary tract epithelial cells by UPEC is the first critical step in establishing a successful UTI, which results in pathogen colonization of host tissue, thereby evading host defenses and serving as a reservoir of recurrent infections. UPEC encodes several virulence factors, including *fimA*, *fimH*, *focA*, *sfaA and SfaS* that enable bacterial attachment and invasion of urinary tract. This research investigated the effect of sub-inhibitory concentrations (concentrations not inhibiting bacterial growth) of trans-cinnamaldehyde (0, 350, 550, and 750 μM), an ingredient in cinnamon, on UPEC attachment and invasion of human urinary tract cells. Additionally, the effect of trans-cinnamaldehyde on expression of UPEC genes encoding *fimA*, *fimH*, *focA*, *sfaA and SfaS* was investigated, using real-time, quantitative polymerase chain reaction. Moreover, the cytotoxicity of trans-cinnamaldehyde, if any, on urinary tract epithelial cells was determined. Results indicated that trans-cinnamaldehyde significantly reduced UPEC invasion of uroepithelial cells, and expression of UPEC genes encoding *fimA*, *fimH*, *focA*, *sfaA and SfaS*. Trans-cinnamaldehyde did not exert any deleterious effect on uroepithelial cells. Trans-cinnamaldehyde attenuated UPEC virulence via modulating bacterial gene expression, and justifies follow up *in vivo* studies validating its potential to control UTIs.

Biography

Amoolya Narayanan is a junior at Glastonbury High School. This is her third year of participation in the Connecticut Science and Engineering Fair (CSF). Her this year's project is a continuation of last year's research on uropathogenic Escherichia coli(UPEC), which was a finalist at the 2009 Intel International Science and Engineering Fair held at Reno, Nevada. Her last year's research on controlling UPEC on urinary catheters has been accepted for publication in the Journal of Urology, published by the American Urological Association. In addition to winning first place in the Pfizer Life Sciences category at the 2010 CSF, she also won third place at this year'sConnecticut Junior Science and Humanities Symposium (JSHS). Being a high honors student, Amoolya is also an active member of her school's FIRST Robotics Team, Math Club, India Club, and orchestra. She volunteers her time in various creative, fundraising events by performing Indian dances for community programs, as well as choreographing dances for other children, teenagers, and adults. Apart from her strong passion in dance, Amoolya enjoys swimming and playing tennis and basketball during her free time.



Representing the Connecticut Science Fair at the 2010 Intel International Science & Engineering Fair

www.ctsciencefair.org

Jason Gandelman, Grade 12

Staples High School, Westport, CT

Bioinformatic and Synthetic Approaches to Studying Advanced Glycation End-products in Eukaryotes

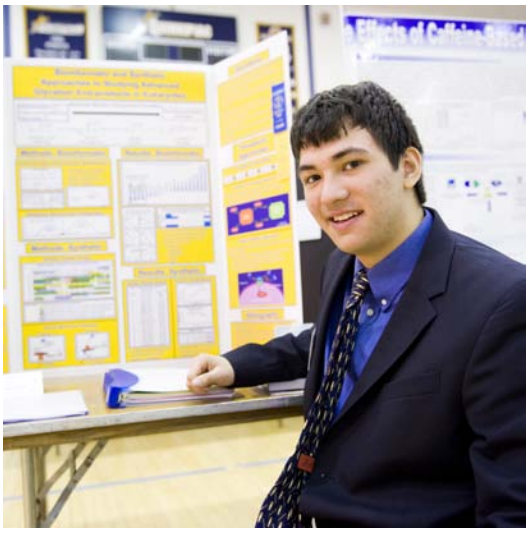
Connecticut Science Fair Awards

- Pfizer Life Sciences Awards --- 2nd Place- Life Sciences Senior High- $300 & trophy, Trip to compete at Intel ISEF
- ATOMIC (Associated Teachers of Mathematics In CT) Mathematics Awards Program- with Xerox --- 1st Place High School- $300 Savings Bond, and Trophy, $500 from Xerox

Abstract

Advanced Glycation End-product (AGE) accumulation has been strongly implicated in the pathology of diabetic complications of the vasculature and kidneys through the activation of the Receptor for AGEs (RAGE). Thus a better understanding of AGE formation and RAGE activation in eukaryotes is highly desirable in the creation of novel treatments for diabetic complications. First, we provide evidence, using comprehensive bioinformatic screening analyses, that in *Saccharomyces cerevisiae* an evolutionary adaptation decreases the susceptibility of its enzymes to AGE formation. From a total of 5883 metabolic enzymes in *S. cerevisiae*, I identified 185 enzymes that catalyze reactions involving metabolic intermediates which contain reactive carbonyl groups. These enzymes are considered the most susceptible to AGE formation due to an enhanced probability of nucleophilic substitution by the reactive carbonyls with nucleophilic amino acids in these enzymes. I subsequently found that these enzymes were significantly under-represented in nucleophilic amino acids compared to the proteome-wide average, providing the first scientific evidence that an evolutionary adaptation can lead to a biochemical mechanism to combat the formation of toxic AGEs. Second, I synthesized biologically important AGE-peptide fragments of glycated human serum albumin. These AGE-peptides are being tested for binding efficiency to RAGE using a unique enzyme-linked immunosorbent assay (ELISA) method. These binding assays may identify an AGE-peptide sequence that binds specifically with high affinity thereby competitively blocking RAGE activation. Thus, this study provides possible novel directions in the development of therapeutics to confer vasculo- and renoprotective effects in diabetic patients.

Biography



Jason A. Gandelman, 17, of **Westport**, investigated toxic compounds called Advanced Glycation End-products (AGEs), which are known to contribute to the long-term health problems associated with diabetes. Jason's study showed that yeast had evolved mechanisms to minimize the formation of toxic AGE compounds. He is now attempting to identify a protein that will block the human body's receptor sites from binding with AGEs. Jason believes his study will lead to new medications to prevent or cure blood vessel and kidney damage associated with diabetes. His research was inspired by his family's long history with the disease. Jason is president of the **Staples High School** engineering team, investment club and debate team, which finished third at the Harvard National Debate Tournament. He counts stock investment as a hobby, and has served on the Westport Youth Commission for four years. A long-time volunteer, he has received recognition for his water quality work with Earthplace. Jason is the son of Mitchell and Kuan Gandelman, is fluent in Mandarin Chinese, and aspires to continue conducting research in biological chemistry in college.

Representing Science Horizons
at the 2010 Intel International Science & Engineering Fair

www.ctsciencefair.org

Jacob D. Ness, Grade 11

New Milford High School, New Milford, CT

The Cross Pollination of an Edible Pumpkin with a Powdery-Mildew Resistant Ornamental Pumpkin to Create an Edible Powdery-Mildew Resistant Pumpkin

Connecticut Science Fair Awards

- Pfizer Life Sciences Awards --- 5th Place- Life Sciences Senior High- trophy
- Audubon Connecticut & Arch Chemicals Environmental Awards --- HS Finalist - Audubon gifts, CSF Medallion; Non-trophied- acrylic award
- Yale Peabody Museum --- Family "six-pack" of free passes to the Yale Peabody Museum
- University Of Connecticut - Plant Science Department --- 1st Place for excellence in Plant Science, $100 cash and certificate, High School
- Connecticut Association of Biology Teachers Awards --- $100 for student and membership in CTABT for teacher
- Milton Fisher Science Fair Award for Innovation and Creativity --- For Excellence in Creativity and Innovation by a High School student, $200 cash

Abstract

The purpose of the experiment is to create an edible powdery mildew resistant pumpkin. This plant would be beneficial to farmers, saving time and money, as the plant is less likely to die from powdery mildew. Chemicals also would not be needed, and the crop could be marketed as "natural" or "organic" if chemicals weren't used. Furthermore, chemicals used to prevent powdery mildew are not introduced into the environment. It was hypothesized that if a powdery mildew resistant "charisma" pumpkin is crossed with an edible "baby bear" pumpkin, then an edible, powdery mildew resistant f1 generation will be created, because the powdery mildew resistance genes and the "edible" genes will be present in the f1 generation. For the procedure, an edible and powdery mildew resistant pumpkin were cross-pollinated, forming an f1 generation. The f1 generation's dried seeds were planted and tested against control pumpkins for susceptibility to powdery mildew. The first trial found the f1 generation to have resistance to powdery mildew, lasting 19 days before contracting the mildew. The second trial found the f1 generation to resist for 21 days. It was also found that the flesh of the f1 generation pumpkin was hard and compact, similar to the edible "baby bear" pumpkin. Based upon the data, the "edible" and powdery mildew resistance genes of the parental generation pumpkins were transferred to the f1 generation. For further experimentation, one could perform a cross using different parental pumpkins to see if different resistance patterns would be present in f1 generations.

Biography

Jacob Ness is presently a junior at New Milford High School whose most recent science project focused on the creation of a powdery-mildew resistant pumpkin that also has edible qualities. This new pumpkin will have various benefits, as it will limit the introduction of chemicals into the environment and allow one to market the crop as "natural" or "organic" if no chemicals are used in the growing process. Jake is currently looking into colleges to apply to this fall, and hopes to pursue a major in business, economics, or engineering. Jacob spends much of his time at the Great Brook Sugarhouse and Sullivan Farm, both located in New Milford, where he participates in the production of maple syrup, bee keeps, black smiths, hays, and grows organic vegetables. At school he is a member of the National Honor Society and Spanish Honor Society. He is also a member of the executive and mock trial club, as well as a member of The Wave Review, the schools newspaper. Jake is a student representative on the New Milford Youth Agency Student Advisory Board. Jake also divides his time between playing air-soft, baseball, and antique collecting.

Representing Science Horizons
at the 2010 Intel International Science & Engineering Fair

www.ctsciencefair.org

Madeleine L. Skaller, Grade 11

Brewster High School, Brewster, NY

Biomimetic insulation: inspired by the eastern tent caterpillar (malocosoma americanum) and the white-tailed deer (odocoileus virginianus)

Connecticut Science Fair Awards

- Dominion's Millstone Power Station Physical Science Awards --- Finalist - Physical Science Senior High - CSF Medallion & Acrylic Award
- Goodrich Awards for Excellence In Engineering --- Finalist - Engineering High School - CSF Medallion & Acrylic Award

Abstract

In the previous stages of this investigation, research was done which proved that caterpillar silk-tent weaving templates prove to be successful in providing a weaving pattern to minimize heat loss. The second part of the investigation sought to determine the ideal bore size of a hollow fiber for maximum thermal efficiency. Various methods were used to model hollow hair fibers with varying inner diameters but constant wall thickness. The main species used as inspiration for this research was the white-tailed deer, whose hairs are hollow. Though no actual deer hairs were handled during experimentation at any point, data proves that a smaller inner diameter of a hollow fiber is the most efficient in preventing heat transfer. Several trials were done to ensure accuracy and tests were conducted under heated and cooled conditions to mock natural environmental temperature fluctuations. This research lays a basis for creating a superior form of insulation to be used in homes based around the principles of biomimicry, innovation inspired by nature.

Biography

Madeleine Skaller is a junior at Brewster High School. This is her first year competing in the Connecticut State Science Fair and her second year competing at Science Horizons. Last year, her project concerning the biomimetic gross morphology of the tents of eastern tent caterpillars was chosen as a finalist at Science Horizons. This year, with her project dealing with biomimetic thermal insulation inspired by the hollow hairs of the white tailed deer, she took first place overall at Science Horizons, was selected as a finalist as CSF and competed at the Junior Science and Humanities Symposium. In addition to being active member of the her community through her school's newspaper, student government, environmental club, math honor society, and prom committee; she is also a high honor roll student and president of her school's science honor society. Madeleine plans to continue this research through her senior year of high school.