

# CONNECTICUT SCIENCE FAIR

[www.ctsciencefair.org](http://www.ctsciencefair.org)

## CSF Trip Winner to the Intel International Science and Engineering Fair, Atlanta, GA, May 11 – 16, 2008 (Student information as of April 2008)

**Fiona W. Wood, Grade 11  
North Haven High School, North Haven, CT**

*Project Title: A Numerical Model of Late-Spiking Neurons*

### Connecticut Science Fair Awards

Pfizer Life Sciences Awards	1 <sup>st</sup> Place, Senior High, \$500 and trophy
ATOMIC Mathematics Award with Webster Bank	High School Medallion
Xerox Computer Science Award	Senior High Finalist – Medallion & Acrylic Award
H. Joseph Gerber Medal of Excellence of the Connecticut Academy of Science & Engineering	Life Sciences Senior - \$1,000 cash, Solid Silver Medal of Excellence & Invitation to CASE's Annual Meeting
Mu Alpha Theta	Certificate, \$50 CSF gift certificate
Meyerand Young Woman Scientist Award	\$300 cash – High School Life Sciences

### Abstract:

Normal brain function depends critically on timing and temporal encoding across a wide range of time intervals. The present study attempts to understand the role of cellular neurophysiology in temporal encoding on time scales ranging from tens of milliseconds to tens of seconds. One approach to this problem is to assume the existence of “reverberatory” circuits. But since typical “regular-spiking” (RS) neurons require only a few milliseconds to fire, a reverberatory circuit is an impractical mechanism for encoding tens of seconds of time because such a circuit would need a huge number of neurons. The recent discovery of “late-spiking” (LS) neurons suggests a potential resolution to this problem. These unusual neurons delay firing for seconds after the onset of a depolarizing stimulus. To investigate the role LS neurons may play in temporal encoding, I created a computational model of an LS neuron using the simulator NEURON. Computer simulations are necessary for solving the system of stiff, non-linear, differential equations that govern the activation and inactivation of the various membrane conductances as a function of time. My model, the first of its kind, demonstrates that the incorporation of a slowly inactivating potassium (“D-type”) current can in fact give rise to firing that is delayed by seconds from the stimulus onset. Furthermore, my model accurately reproduces the detailed firing characteristics of real LS neurons in the cerebral cortex. In future work, I will use the model to construct large-scale circuits of LS and RS neurons



### Biography:

Fiona Wood, a junior at North Haven High School, has strong interests in math and computer science. A member of her school's computer club since 9<sup>th</sup> grade, and president of the club for the past two years, she has been the club's top scorer in its American Computer Science League contests. Fiona has also competed on teams at high school computer programming competitions sponsored by Quinnipiac University and Providence College. In 10<sup>th</sup> grade, Fiona won 2<sup>nd</sup> place at the annual statewide G.E. High School Computer Science Competition, held at G.E. headquarters in Fairfield.

In 9<sup>th</sup> grade, Fiona became the first Connecticut student to win the 1<sup>st</sup> place individual award at the International Future Problem Solving Competition at Colorado State University. Since July 2007, Fiona has been an intern in a neuroscience lab at Yale University, where she uses computational models to investigate the properties of late-spiking neurons. Fiona plans to major in computer science, neuroscience or artificial intelligence.

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**Eliza H. McNitt, Grade 11  
Greenwich High School, Greenwich, CT**

*Project Title: Tracing the Migration of Pesticides Through the Production of Southwestern Connecticut Honey*

### Connecticut Science Fair Awards

Pfizer Life Sciences Awards	2 <sup>nd</sup> Place, Senior High, \$300 and trophy
Audubon Connecticut & Arch Chemicals	1 <sup>st</sup> Place HS - \$500, trophy, Audubon magazine, Bird Feeder, Mini-Carabiner, Medallion and Acrylic award
Environmental Awards	
CURE BioBus Educational Programs	CURE Award for Research Excellence – HS

### Abstract:

Continued use of pesticides and herbicides throughout both the agricultural and private sector has led to concern about the effects of these chemicals on common fruits and vegetables, and whether these often harmful chemicals are still present when the food is consumed. Most research has focused on the growth and retail of typical agricultural products, however little work has been done to identify the presence of residual pesticides in the honey of *Apis mellifera* (the typical honey bee). This investigation seeks to verify the migration of five known pesticides, applied within a 30 acre radius within the Bartlett Arboretum (in Stamford, CT), to the honey product of a controlled bee-hive located within the Arboretum grounds. The five pesticides applied within the Arboretum are Dipel, Neem Oil, Insecticidal Soap, Imidacloprid, and Pyrethrins. Initial experiments based on ultrasonic-solvent extraction of honey, and the analysis of the organic layer against known samples of the five pesticides, with Attenuated Total Reflectance (ATR) Fourier Transform Spectroscopy (FTIR), proved to be non-specific and lacked sufficient sensitivity since all pesticides, and the neat honey samples exhibited an asymmetric C-O stretch at  $1058\text{ cm}^{-1}$ . High Pressure Liquid Chromatography based analysis, with UV detection at 255 nm, indicates that components of Pyrethrins and Imidacloprid are not detectable in the organic honey extract. This same analysis points out, however, that components of BioNeem Oil are present in the final product of the Arboretum 2007 Fall Honey. The Analysis of Commercial Honey of unknown origin also revealed the presence of the Bio Neem Oil components as well as other additional compounds.



### Biography:

Eliza McNitt is a Junior at Greenwich High School (GHS) in Greenwich, CT. In addition to Science, her interests include Theater Arts, Student Government and Community Service. She is currently Vice-President of the GHS Student Government and has appeared in educational videos, national television shows and movies – including the current film “The Life Before Her Eyes” with Uma Thurman.

Eliza is on the Steering Committee of Names Day, a diversity awareness project co-sponsored by the ADL and the YMCA. She is also one of three student members of the GHS School Improvement Team which is tasked with reviewing and establishing school policy. During her Senior year at GHS, Eliza will be studying Environmental Science and continuing her research into the migration of pesticides in the production of honey, as well as looking into the potential relationship between certain pesticides and Colony Collapse Disorder. Eliza would like to attend a major university in New York City or Los Angeles.

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## CSF Trip Winner to the Intel International Science and Engineering Fair, Atlanta, GA, May 11 – 16, 2008 (Student information as of April 2008)

**Theresa A. Oei, Grade 9  
East Catholic High School, Manchester, CT**

*Project Title: Use of Seashells to Detoxify Lead-Contaminated Effluent and Groundwater*

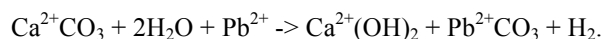
### Connecticut Science Fair Awards

Connecticut Science Center Physical Science Awards with eesmarks/CEEF	1 <sup>st</sup> Place, Senior High, \$500 and trophy
Barnes Aerospace Applied Technology Awards	1 <sup>st</sup> Place High School - \$500 and Trophy
Audubon Connecticut & Arch Chemicals Environmental Award	2 <sup>nd</sup> Place HS - \$200, trophy, Audubon magazine, Bird Feeder, Mini-Carabiner, Medallion and Acrylic award
Future Sustainability Award - eesmarks / CT Energy Efficiency Fund	High School Finalist – Medallion and Acrylic Trophy
H. Joseph Gerber Medal of Excellence of the Connecticut Academy of Science & Engineering	Physical Sciences Senior - \$1,000 cash, Solid Silver Medal of Excellence, Invitation to CASE's Annual Mtg
U.S. Army	\$50 U.S. Savings Bond & Certificate
Water Environment Federation	Certificate, Letter, CSF \$50 Gift Certificate
Long Island Sound Foundation, Inc.	\$1,000 Life Sci./Environmental Sci./Physical Sci.
Society of Women Engineers – Hartford Section	Scientific Calculator

### Abstract:

Lead contamination is a growing problem that affects many regions of the world. It is mainly caused by manufacturing processes and e-waste. Seashells are porous nano-structures composed mostly of calcium- carbonate ( $\text{CaCO}_3$ ).

In this project, the size of the seashells, the settling time, the salinity and the acidity of the water were varied to optimize lead removal. The seashells were effective in eliminating the lead from the contaminated water through the following chemical reaction:



The time required to extract lead from the water varied directly in accordance with the size of the crushed shells. Decreasing the size of the seashell particles has the effect of increasing the surface area and thereby the reaction sites. The pH of the contaminated water also affected the results of the experiment. The high alkaline (high pH) of the water along with carbonate forms calcium hydroxide, also known as scaly lime ( $\text{Ca}^{2+}(\text{OH})_2$ ). This allows the  $\text{Pb}^{2+}\text{CO}_3$  to better adhere to the reaction sites accelerating the extraction of the lead. Scanning Electron Microscope (SEM) at 2000X magnification clearly revealed the lead ions as white crystalline polyyps attached to the seashell.

Based on the results of this experiment a seashell filter was built. Samples analyzed by an independent laboratory showed 100% elimination of lead in the contaminated water. The effectiveness of the seashell filter and its low cost is a viable alternative to more expensive, commercially available units.

### Biography:

Theresa is a freshman honor student at East Catholic High School. This is her third year participating in The Connecticut Science Fair. She has won numerous awards at the Connecticut Science Fair including first place in the Life Sciences as an eighth grader. She was top 40 finalist at the Discovery Channel Young Scientist Challenge where she went on to win the National Parks Award. She is a 2006 recipient of the \$20,000 Quinnipiac University Scholarship and has also won other special awards. Besides science, Theresa also has a love of the arts. She plays the piano and takes ballet and Irish step dancing. She was recently accepted into the American Ballet Theatre Summer Program. Theresa is also a champion Irish step dancer. She is a four-time world qualifier.



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## CSF Trip Winner to the Intel International Science and Engineering Fair, Atlanta, GA, May 11 – 16, 2008 (Student information as of April 2008)

**Dayton T. Horvath, Grade 12  
Newtown High School, Sandy Hook, CT**

*Project Title: In Vitro Enzyme-Catalyzed Conversion of Carbon Dioxide to Methanol*

### Connecticut Science Fair Awards

Connecticut Science Center Physical Science Award with eesmarts/CEEF	2 <sup>nd</sup> Place, Senior High, \$300 and trophy
Dominion Alternative/Renewable Energy Award	1 <sup>st</sup> Place High School - %500 Cash and Trophy
Northeast Utilities: Environmental Management	Senior - \$250 Scholarship, energy conservation and renewable energy sources
Dominion Scholarship	\$5,000 Scholarship

### Abstract:

As nations around the world develop and grow, pollutants levels are increasing in the atmosphere far beyond controllable levels. The emission of carbon dioxide may be causing the warming of Earth's climate. The billions of tons of carbon dioxide produced every year from combusted fuels needs to be captured and controlled. There are multiple methods available to collect newly produced carbon dioxide but no simple way to store or recycle it. Using an in-vitro equilibrium between three enzymes and reduced Nicotinamide Adenine Dinucleotide (NADH), one carbon dioxide molecule can be converted through a series of intermediates into one methanol molecule. A novel procedure was developed from a previously reported sol gel carbon dioxide conversion method and a recent silica-film coated alginate bead setup. Encapsulating each dehydrogenase enzyme into silica-film coated alginate gel beads enhanced the reaction over previously described methods. The NADH functioned as an electron donor and allows for the reactions to take place. The reverse mechanisms of each enzyme were utilized to convert carbon dioxide into methanol, theoretically consuming six molecules of NADH in the process. A fluorimeter was employed to analyze NADH levels over time to ascertain the reaction rate of the system. Gas Chromatography was used to quantify methanol production. The data indicate that enzyme-enhanced alginate beads successfully convert carbon dioxide to methanol. An electric current was applied in an attempt to recycle  $\text{NAD}^+$  electrochemically. This may help the system become a self-contained method of recycling carbon dioxide.



### Biography:

Dayton Horvath is a senior at Newtown High School currently taking challenging courses and participating in the Senior Project Program. He joined the class to showcase his science research project. He was motivated to create a project this year based on his varied interests in physics, chemistry, and independent research. Besides his interest in science, Dayton enjoys playing soccer or hiking when it's warm out. He also participates in the Hungarian community in Fairfield and visits relatives in Hungary every other summer. After high school, he hopes to go into a career in chemistry or physics at Carnegie Mellon University or University of Connecticut.

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## Science Horizons Trip Winner to the Intel International Science and Engineering Fair, Atlanta, GA, May 11 – 16, 2008

(Student information as of April 2008)

**Alexandra L. McIe, Grade 12  
Brewster High School, Brewster, NY**

*Project Title A Novel Extraction of the Pyrrolizidine Alkaloids from Petasites hybridus to Create an Anti-Spasmodic Supplement for Equine COPD*

### Connecticut Science Fair Awards

Pfizer Life Sciences Awards Finalist, Senior High, CSF Medallion & Acrylic Award  
Quinnipiac University Scholarship \$20,000, 4 year scholarship to Quinnipiac University

#### Abstract:

The root of the plant *Petasites hybridus* has shown promise in the medical field through its natural production of petasin and isopetasin, which inhibit the synthesis of lipoxygenase and cyclooxygenase. However, the presence of the naturally occurring pyrrolizidine alkaloids, a hepato-toxin and carcinogen, has hindered the widespread use of *Petasites hybridus*. A successful method for extracting these alkaloids was developed, allowing for the creation of an equine supplement targeted at the prevention of COPD and relief of its symptoms. Soxhlet extractions using ethanol as the solvent removed the alcohol-soluble alkaloids, and electrophoresis confirmed retention of petasin and isopetasin. The results of column chromatography were compared to those of the Soxhlet extraction. The chromatography was enhanced with a novel silica sol-gel column that also successfully removed the pyrrolizidine alkaloids. Compared to the Soxhlet extraction, recovery of petasin and isopetasin was significantly reduced in chromatography, suggesting Soxhlet extraction is a preferred purification process. A nebulizer for administering the supplement in severe cases has also been designed.

#### Biography:

Alexandra McIe is a senior at Brewster High School in New York where she has been working on her independent science research for five years. She is a member of both the Science and National Honor Societies. This is her third time going to ISEF as the overall winner of the Science Horizons fair in 2005, 2007, and now in 2008. Last year she received a fourth place award in the animal sciences category. In addition to her heavy involvement in the sciences, Alex is principal flutist for her high school wind ensemble, and high school musicals. She is trombone section leader for the marching band and a member of the high school jazz band. She plays piccolo in the Putnam County Symphony Orchestra. In 2006 Alex toured Europe with the Sound of America honor band. Alex is a chief in the BHS NJROTC, and served as Color Guard Commander in 2007. Alex also teaches Hebrew to a class of fifth graders at Temple Beth Elohim in Brewster. Alex was captain of the Brewster High School ski team for two years and is an accomplished equestrian. She is in the process of deciding where she will go to college and plans to double major in neuroscience and music with the hope of going to medical school after receiving her undergraduate degree.

