CONNECTICUT SCIENCE & ENGINEERING FAIR

www.ctsciencefair.org

Top Winners in the
2013 Connecticut Science & Engineering Fair

(Student information as of April 2013)

Aakshi Agarwal, Grade 8

Hamden Middle School, Hamden, CT

TACE Inhibitors As Non-Biological Drugs For Treating Rheumatoid Arthritis

Connecticut Science & Engineering Fair Awards

- Pfizer Life Sciences Awards --- 5th Place- Life Sciences 8th grade- trophy and Invite to Compete Broadcom MASTERS
- Office of Naval Research- U.S. Navy / U.S. Marine Corps --- Middle School- Certificate, $50 gift card to Amazon given by CSF

Abstract

The etiology of Rheumatoid Arthritis is unknown. However, increased amounts of TNF-α (Tumor necrosis factor-alpha) in the joints of RA patients led to the belief that it is an autoimmune disorder. An RA patient's body mistakenly assumes that bone and cartilage are foreign substances and attacks them by releasing cytokines and chemokines. These chemicals cause irreversible joint destruction, intense pain, progressive disability, and significant morbidity. Currently available anti-RA medications help only 50% of the patients and that too, only partially. I aimed to design orally available, non-biological anti-RA medications. I designed inhibitors of TNF-α converting enzyme (TACE), an enzyme responsible for converting inactive precursor of TNF-α into the active TNF-α. If appropriate drugs are designed then they will bind strongly with TACE, because drugs will optimally occupy the catalytic site of TACE. Next, pep:MMs:MIMIC was used and non-biological TACE inhibitors were designed by using TIMP-3 as template in the 3D structure of TACE bound with TIMP-3 (another protein). Subsequently, Schrodinger Suite of Software was used for calculating MMGBSA binding energy (dG) and top ranking twenty inhibitors were selected by the calculated dG. I found that calculated dG of top twenty TACE inhibitors was in the range of -77.89 to -106.25 kcal/mol. This result suggested significant reduction of TNF-α by these inhibitors. My project was successful in designing non-biological TACE inhibitors. Synthesis and testing of these inhibitors will potentially identify more effective RA medications possessing fewer side effects and that will help greater than 50% of patients for a longer period.

Biography

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Margaret Cirino, Grade 8

Central Middle School, Greenwich, CT

Bird Song Variation and Genetic Drift in Common Yellowthroats

Connecticut Science & Engineering Fair Awards

- Alexion Biotechnology Awards --- 3rd Place- Biotechnology 8th grade- $100 & trophy and Invitation Compete in Broadcom MASTERS
- Yale Peabody Museum --- Family "six-pack" of free passes to the Yale Peabody Museum
- Lola Lampe Müller Award --- $150 cash for a middle or high school project

Abstract

Current ornithology research has included genetic drift quantification of bird subspecies, as well as genetic correlation between subspecies. Connections have been made across several bird subspecies. For this project, birdsong was tested to see if it could reliably predict a correlation between subspecies. In order to see if birdsong could correctly relate two subspecies based on geographic distance, the most common sign of differentiating genetic code, thirteen sound recordings spanning seven distinct subspecies of Pygmy Wren-Babbler (Pnoepyga pusilla) were analyzed as spectrographs and were sorted based on several features of each recording, including the frequency of each note, the number of notes, and the time between notes. Then, each of these features were measured against the distance separating the Pygmy Wren-Babbler subspecies (annamensis, everetti, harterti, lepida, pusilla, rufa, and timorensis). It was found that the variable with the largest correlation to geographic location was the average frequency of each sound recording, with a correlation coefficient of 0.6623. Possible extensions of this research project could include verifying this correlation with other bird subspecies, or using this correlation to quantify the genetic drift of bird subspecies.

Biography

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Top Winners in the 2013 Connecticut Science & Engineering Fair

(Student information as of April 2013)

Martha Haddad, Grade 8

St. Joseph School, Danbury, CT

Converting Waste to Electricity using Efficient Microbial Fuel Cell

Connecticut Science & Engineering Fair Awards

- Dominion Millstone Power Station Physical Sciences Awards --- 4th Place- Physical Sciences 8th Grade Ind. - trophy, invite to compete Broadcom MASTERS
- EnergizeCT/eesmarts Alternative/Renewable Energy Awards --- 2nd Place Middle School - $200 Cash and Trophy
- EnergizeCT/eesmarts Sustainable Resources and Practices Awards --- 1st Place Middle School - $500 Cash and Trophy
- UTC Aerospace Systems Awards for Excellence in Engineering --- $1,000 cash and plaque for excellence in engineering
- Alexion Biotechnology Awards --- 1st Place- Biotechnology 8th grade- $300 & trophy and Invitation Compete in Broadcom MASTERS
- Talcott Mountain Science Center --- Founder's Award - $450 Saturday Mentorship Course at TMSC - Middle School Phys Science
- Society of Women Engineers - Hartford Section --- Scientific Calculator
- MIT Club of Hartford K-12 Initiative --- For excellence in energy related research, middle school, $150 cash award

Abstract

Microbial fuel cells (MFCs) provide an ecologically friendly and cost-effective energy source. Different variables such as sugar, yogurt, yeast, and compost were tested as additives to MFCs to mimic the effect of organic waste from the food industry waste stream, on the performance and sustainability of MFC. Seven different MFCs were tested and compared. The energy production of each cell was measured once every twenty-four hours in millivolts/2.5 inch of anode. The compost soil (rich with organic material) provided the most efficient cell; it produced 737 mV at its peak, which translates to 182.9 V/m2. As hypothesized, the addition of yogurt and sugar to MFCs demonstrated increase in the energy production of the cells, providing proof of concept for possible usage of food industry waste stream in combination with MFCs as an alternative energy source. A new concept, multiple-anode microbial fuel cell, was devised and tested. This concept consists of a stepwise buildup of the cell by adding soil and another anode on top of the cathode which inverts to a new anode with the last added cathode on top (repeated 3 times). The results indicated that all anodes were equally effective. This allows for applications in compost buildup and new compact MFC activated by consuming food industry waste stream. Multiple-anode MFC plants are compact and would take advantage of the high energy production equal to that of several separate MFCs, they could be built near food industry plants as energy source that treats their own waste stream.

Biography

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Top Winners in the
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(Student information as of April 2013)

Grace Herrick, Grade 8

St. Rose of Lima School, Newtown, CT

Evaluating the Performance of a Model Solar Updraft Tower Power Plant

Connecticut Science & Engineering Fair Awards

- Dominion Millstone Power Station Physical Sciences Awards --- 3rd Place- Physical Sciences 8th Grade Ind, - $100 & trophy, invite to compete Broadcom MASTERS
- People's United Bank Mathematics Awards - with ATOMIC --- Middle School Finalist - Medallion & Arcylic Award
- Barnes Aerospace Applied Technology Awards --- 1st Place Middle School - $300 and Trophy, Medallion
- Environmental Sciences Awards with CACIWC --- 3rd Place MS- $100, Trophy, CACIWC gifts
- EnergizeCT/eesmarts Alternative/Renewable Energy Awards --- 1st Place Middle School - $300 Cash and Trophy
- EnergizeCT/eesmarts Sustainable Resources and Practices Awards --- 3rd Place Middle School - $200 Cash and Trophy
- Society of Women Engineers - Hartford Section --- Scientific Calculator
- Spirit of Invention Award --- $100 Cash and Plaque for Inventive Concepts

Abstract

Hot air always rises and it is possible to convert this rising hot air into a draft channeled into a chimney. The draft can be made to mechanically rotate the blades of a turbine. The turbine's mechanical energy derived from its rotation is used to convert it into electrical energy in the generator on the basis of Faraday's Laws. The efficiency of conversion is dependent on the design and size of the containment area and design of the generator. A system based on these principles was built to illustrate the value of this alternative method of power generation. It was predicted that the Solar Updraft Tower would generate electricity. A muffin fan was used to convert the kinetic energy into power/electricity. The outdoor temperature, containment temperature and humidity, wind speed at base of tower and the sun's irradiance were all measured. The following mathematical equation was used to calculate the power (watts) produced: P=2/3 (□t □coll)(g/(cpTo)(h Acoll G) Where: □t is the turbine efficiency and □coll is the collector efficiency, Acoll is the collector area, cp is the specific heat of air, To is the inlet air temperature, g the acceleration due to gravity, h the height of the tower, and G the solar constant. The system did produce electrical power and illustrated the strength of simple and elegant engineering models to prove valuable engineering concepts in cost effective ways. A large scale solar updraft power system with a gigantic tower and thirty two turbines is being built in Arizona.

Biography