

## TRSEF Finalists: Abstracts

### 2006 - EN139

#### **DEVELOPMENT AND DESIGN OF AN ALL TERRAIN, OMNIDIRECTIONAL PLATFORM WITH OBSTACLE CLIMBING CAPABILITIES.**

*Christopher Jon Olsen*

*Valley Central High School Montgomery, NY, USA*

Many people throughout the world have physical handicaps that confine them to wheelchairs. Although these mobile platforms allow their users to achieve a basic level of freedom, no one wants their independence to be controlled by the limits of a mechanical device. Unfortunately, even the most advanced wheelchairs can be stopped by a curb or small obstacle, and their maneuverability in tight spaces is severely restricted by their physical configuration. These limitations not only affect the freedom of the user but also make it impossible for the chair to function in an intuitive manner. As a result, this study was an attempt to develop a wheelchair that can function in all environments, and provide the natural movement patterns that we take for granted, so that the people who are forced to rely on them as their only means of mobility can focus their energy on where they're going and not how they're getting there. The unique articulated wheel system that was developed not only allows for true omnidirectional motion, but through a system of rotary and linear actuators, allows the wheel pairs to act in a coordinated stepping action when presented with curbs and other obstacles. A scaled prototype of the system was built and tested on a variety of simulated terrain types. The new device proved able to negotiate irregular surfaces, climb curbs and steps, and move in any direction at will, providing the basis for an assistive platform that more closely approaches the natural capabilities that non-disabled people enjoy.

#### ***Awards won at the 2006 ISEF***

Patent attorney services not to exceed \$10,000 - Woodard, Emhardt, Moriarty, McNett & Henry

### 2006 - BE051

#### **THE CAPACITY FOR EMPATHIZING AND SYSTEMIZING IN CHILDREN WITH WILLIAMS SYNDROME: IDENTIFYING A COGNITIVE PHENOTYPE**

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*Valley Central High School, Montgomery, NY USA*

The capacity for empathizing and systemizing was investigated in children with Williams Syndrome (WS) and typically developing (TD) controls, with all participants of a mental age between 6-11 years. The experiment tested the hypothesis that the cognitive phenotype of WS correlates with the extreme female brain, which is characterized by superior ability to empathize and inferior ability to systemize when compared to TD controls. Parents of the aforesaid populations completed the Cambridge Child Personality Questionnaire in reference to their child. Results showed that subjects with WS scored significantly lower on the systemizing questions ( $\alpha = .05$ ;  $p = .0049$ ;  $t = -2.67$ ) than TD controls, while no significant difference for scores on the empathizing questions was indicated between the groups.

Despite this lack of statistical significance, a trend within the WS group revealed that each subject with WS mirrored the “individual” extreme female brain profile: a personally higher aptitude to empathize than systemize. This result, paired with the “typical” ability to empathize in children with WS, challenges previous conclusions that individuals with WS cannot understand second-order belief tasks. Although they test for empathy, second-order belief tasks are often presented to participants in a sequenced or systematic format; however, as this study indicates, individuals with WS cannot understand such a format due to an incapacity for systemizing. This lack of processing encourages guessing on task questions, which implies lack of theory of mind, a key component of empathizing.

#### **2007 - CB025**

##### **FORMATION OF REACTIVE OXYGEN SPECIES IN BEAS-2B CELLS DURING IN VITRO EXPOSURE TO AMBIENT PARTICULATE MATTER**

*Song Qu*

*Monroe-Woodbury High School, Central Valley, NY, USA*

Particulate matter (PM) in ambient air is a widespread environmental pollutant and has been associated with increased mortality and morbidity of pulmonary and cardiovascular diseases among urban residents. The present study aims to test the hypothesis that generation of reactive oxygen species (ROS) may be responsible for the adverse effects of PM exposure on pulmonary and cardiovascular systems. To assess ROS formation, Beas-2B cells were incubated in a Costar 96-well plate with various particles, including fine and ultrafine PM collected from ambient air. Hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) and phosphate buffer solution (PBS) were used as the positive and negative controls, respectively. Formation of ROS was monitored with dichlorofluorescein (DCF) at excitation and emission wavelengths of 485 nm and 530 nm, respectively. Compared with PBS treatment, the fluorescence intensities elevated significantly in cells incubated with H<sub>2</sub>O<sub>2</sub>, but showed no change in cells exposed to TiO<sub>2</sub>, the inert particle. Exposures to both fine and ultrafine PM also induced significant dose-dependent increases of fluorescence. On the other hand, the incubation of all tested particles did not generate any fluorescence in cells without DCF, indicating that the particles were not auto-fluorescent and, therefore, any observed fluorescence increase was ROS-related. Future studies will focus on identifying what specific forms of ROS are generated in cells incubated with PM.

#### **2007 - AS048**

##### **EFFECTS OF DIFFERENT TREATMENT MODALITIES ON SPINAL MECHANICAL NOCICEPTIVE THRESHOLDS IN HORSES**

*Kayleigh Anne Sullivan*

*Valley Central High School, Montgomery, New York, United States*

Back pain severely limits competition horses. Owners turn to alternative therapies to treat their horses, because Phenylbutazone (PBZ), a non-steroidal anti-inflammatory drug (NSAID), is illegal during competition. Chiropractic and massage are two prevalent alternative therapies, but controlled scientific research is limited. The objective of this study was to measure spinal mechanical nociceptive thresholds (MNTs) and evaluate the therapeutic effects of treatment compared with two different exercise-control

groups. Thirty-eight adult horses were used to assess baseline mechanical nociceptive thresholds, which were measured at seven bilateral thoracolumbar sites in asymptomatic horses. The horses were assigned to three treatment groups consisting of instrument-assisted chiropractic treatment, massage, and PBZ. Two control groups consisted of either maintained ridden exercise without any treatment or routine paddock turnout without any ridden exercise. MNTs were repeated at 1, 3, and 7 days post-treatment. The percent change from baseline values were calculated within each group. At Day 7, the overall MNTs increased 22.9% in the chiropractic, 8.9% in the massage, and 6.5% in the PBZ groups. Minimal changes in MNTs were seen in the active and inactive control groups across days. Chiropractic treatment and massage therapy were more effective than PBZ at increasing spinal MNTs in asymptomatic, actively ridden horses.

#### **2009 - MI040**

##### **THE GENETIC CODE OF ANAEROMYXOBACTER DEHALOGENANS**

*Jimmitti Teysir*

*City Honors School, Buffalo, NY*

Anaeromyxobacter dehalogenans (Adhal) is a species of bacteria whose genome contains 4,346 protein sequences. The GC content of the third base position of all codons used in Adhal is 97%, indicating that it primarily uses the 32 codons ending in GC. Certain codons ending in A or T are not used in the most reliably identified proteins in Adhal (i.e.: ribosomal proteins), suggesting that AT-ending codons were nonsense when Adhal came into existence. Of the 4,346 proteins, 40% contained a nonsense codon, though all of these proteins could not have been misidentified. If codons with AT-endings only appear near intergenic regions, it would support our contention that they are nonsense. The genomic data for 50 random Adhal proteins containing one nonsense codon each, was analyzed. Approximately 65% of the time, the nonsense codon was located at either end of the protein, and the excised sequence deleted by the nonsense codon had a higher than typical concentration of the amino acids G, A, R, and P, a composition which usually does not form functional proteins. The nonsense codon, either acting as a defacto stop or preceding the true start codon, excised GARP-rich nonsense segments of the proteins, still leaving a viable open reading frame. From these data, we extrapolated that over 1000 postulated Adhal proteins are in fact nonsense. The results support our hypothesis that it is possible to trace the evolution of the genetic code and use this information to correct errors in genome annotation.

##### ***Awards won at the 2009 ISEF***

Tuition Scholarship ranging from \$6,000 to \$9,000 per year for four, five or six years, depending upon the degree program - University of the Sciences in Philadelphia

#### **2009 - MA037**

##### **GRAPH CROSSINGS AND CYCLIC PERMUTATIONS: TOWARDS A PROOF OF ZARANKIEWICZ'S CONJECTURE**

*Joshua Vekhter*

*Williamsville East High School, East Amherst, NY*

It is known that the general problem of finding graphs with the fewest number of crossings is computationally hard, and tight bounds on crossing numbers do not exist for even the most basic families of graphs. There is a long standing open conjecture by Zarankiewicz which suggests a lower bound on the minimum number of crossings in a complete bipartite graph. This research approached this conjecture by using rotation systems to define particular drawings of graphs as sets of cyclic permutations. The research defined structures that govern which flips, or pairwise interchanges between elements, need to be performed in order to make two cyclic permutations equivalent. Within these structures, operations to generate equivalent sequences of flips were defined. These operations formed the basis of a polynomial time reduction algorithm that finds the shortest sequence of flips between any two cyclic permutations. Bounds on the lengths of minimal flip sequences were also established. These bounds were then used to develop an approach to Zarankiewicz's conjecture. The structures developed in this project pertain to graph crossing numbers and are applicable to computer chip layout problems.

***Awards won at the 2009 ISEF***

First Award of \$1,000 - American Mathematical Society

Fourth Award of \$500 - Mathematical Sciences - Presented by Intel