



**CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY**

Name(s) Savannah A. Benz	Project Number S0601
Project Title Purifying Water Using the Thermoelectric Effect	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals My objective was to see if the Peltier cell could be used in an apparatus to effectively purify water using the electrical energy equivalent of a small to medium-sized solar panel.</p> <p>Methods/Materials Materials used in the testing of apparatus: Peltier cell, 6V and 12V batteries, battery charger, measuring cup, funnel, water, infrared thermometer, styrofoam insulation, thermal grease</p> <p>I designed and created an apparatus that could efficiently heat and evaporate water then transfer the vapor to the other side of the cell to condense into purified liquid water. I first measured how the amount of water in contact with the hot side of the cell affected the temperature difference between the hot and cold sides of the cell at various power levels and the equilibrium temperatures.</p> <p>Testing methods: - 80-minute trials - Poured designated volume of water into apparatus - Attached cell to battery - Checked surface temperatures on cold side (1 area) and hot side (3 areas) to measure temperature difference between cold and hot sides - Measure volume of purified water collected -calculated total energy input and energy output</p> <p>Results After 30 minutes of running the apparatus, the water on the hot side of the cell began to boil, at which point the water vapor rose, and a steady flow of water droplets began condensing into the cold side of the cell. The cool, condensed water helped to maintain the temperature gradient between the hot and cold sides of the cell, perpetuating the process. Since the Peltier cell has both a hot and cold side, my apparatus used the cold side as the condenser and the hot side as the evaporator, serving as a near perfect energy recycler.</p> <p>Conclusions/Discussion The Peltier water purification apparatus effectively purifies water at a relatively high efficiency. Better insulation and solar thermal preheating of the water could improve the efficacy of the device. Ideally the battery would be replaced by a solar panel, so the electricity input would come solely from the sun.</p>	
Summary Statement I created an apparatus incorporating a Peltier cell to purify water via evaporation and condensation.	
Help Received Dad helped saw aluminum cooling fins, cut glass, and answered questions about design/experimental flaws.	



CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s) Seung Hye Choi	Project Number S0602
Project Title Electronic Tongue: Tastes of Toxic Metal Ions in Water	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The main objectives of my project are: (1) to develop a simple, cost-effective electrochemical sensor (electronic tongue) that can simultaneously detect Cd(II), Hg(II), Pb(II), and As(III), and (2) to seek its reusability.</p> <p>Methods/Materials Gold nanoparticles were synthesized, and their surfaces were functionalized with four different types of crown ethers that can selectively produce complexes with Cd(II), Hg(II), Pb(II), and As(III). These functionalized gold nanoparticles were individually drop-casted on four interdigitated array (IDA) electrodes, and these four IDA electrodes were integrated to construct an electronic tongue. The concentrations of toxic metal ions were quantitatively determined by measuring the conductance and junction potential of gold nanoparticle films. For the reusability test, my sensor was washed with a solution of 0.1 M ethylenediaminetetraacetic acid (EDTA).</p> <p>Results Each IDA electrode showed a linear response with a specific metal ion when it was measured with conductance and junction potential. The response from junction potential was more linear than that from conductance. However, measurements of As³⁺ were not as accurate as the other three ions. Selectivity was quantitatively studied by determining selectivity coefficients with six interfering ions. The reusability test revealed that about 99% of metal ions trapped in the film were removed by EDTA for next use.</p> <p>Conclusions/Discussion My electronic tongue simultaneously responds all metal ions except for As(III) with high sensitivity and selectivity. The use of gold nanoparticles resulted in high sensitivity. Also, the different design of crown ethers drives high selectivity. The detection limits of Cd(II), Hg(II), and Pb(II) were better than those reported by other scientists. The reusability was accomplished by cleaning a used electronic tongue with EDTA.</p>	
Summary Statement I have developed the reusable electrochemical sensor (electronic tongue) that can detect toxic metal ions (Cd(II), Hg(II), Pb(II), and As(III)) simultaneously.	
Help Received All experiments were conducted in the department of chemistry, California State University, Fresno, under the guidance of Drs. Attar and Choi.	



**CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY**

Name(s) Hyelim Chun; Prabhjot Grewal	Project Number S0603
Project Title An Analysis of the Effects of Carbon Dioxide on the Dissolution of Calcium Carbonate in Marine Organisms	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals Ocean acidification is when carbon dioxide (CO₂) is absorbed by seawater and chemical reactions occur, which reduce seawater pH, due to a higher concentration of hydrogen ions and therefore increases the carbonate ion concentration. This process is detrimental to the environment because many organisms are relying on the stable pH and a change would result in many organisms' inability to adapt to rapidly changing environment. Different sections of the ocean experience varying levels of temperature, subsequently varying levels of pH. If there is a constant rate of carbon dioxide dissolution that acidifies the solution, then the higher the temperature would result in a higher pH and lower calcium carbonate dissolution.</p> <p>Methods/Materials In the experiment, the masses of shells before and after being introduced to the acidic conditions were compared with each beaker experiencing the same rate of carbon dioxide dissolution. Temperature was the independent variable, as tropical, polar, and room conditions were measured, and the mass loss was the dependent variable. Surface of the shells were also observed to indicate other consequences of ocean acidification. Materials: Carbon dioxide tank, Aquarium mix, Beakers, Distilled water, Shells, Electronic Scale, Microscope, Dry bath, Water bath, pH meter, Stock pH solution (4.0 pH and 7.0 pH), Rod/ scrapper, Gloves, Rubber stoppers, Eye goggles</p> <p>Results The beakers that experienced a temperature of 22 degrees Celsius had a pH of 6.0, the beakers that experienced a temperature of 30 degrees Celsius had a pH of 6.45, and the beakers that experienced room temperature (25 C) had a pH of 6.3.</p> <p>Conclusions/Discussion As a result, the shells from the higher temperature underwent a lower amount of dissolution because the water molecules contain a higher amount of energy, through the form of heat, which creates an environment that is difficult for the carbon dioxide to dissolve into. Another factor that contributes to the effects of ocean acidification is the surface area to mass ratio, where the smaller the shell (the has a larger surface area) would lose the most mass because more of the shell is being exposed to the acidic water.</p>	
Summary Statement Carbonic acid creates a higher ocean pH, leading into ocean acidification, and our project analyzes the effects of ocean acidification on shells. which affect microscopic organisms that are the basis of the marine food web.	
Help Received Mrs. Jennings allowed us to use the dry and water bath in her classroom.	



**CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY**

Name(s) Delayna C. Corts	Project Number S0604
Project Title Chemistry of Baking: Can You Make Your Own Baking Powder?	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals My objective is to see if you can make your own baking powder using baking soda and cream of tartar.</p> <p>Methods/Materials Materials used are muffin pans, measuring cups, timer, kitchen scale, ruler, and muffin ingredients. This includes cornmeal, water, baking powder for control, baking soda and cream of tartar. I made a "control" batch of muffins using baking powder and four batches using different amounts of baking soda and cream of tartar. I want to see which amount of each comes closest to the control batch.</p> <p>Results The third recipe with 1.5 tsp. baking soda and .75 tsp. baking soda was the test batch most similar to the control batch.</p> <p>Conclusions/Discussion Baking powder is a blend of baking soda and cream of tartar. When water is added to the mixture, a reaction causes CO₂ to be trapped in the muffin forming air-pockets which causes the muffin to be less dense. This is an example of acid/base chemistry.</p>	
Summary Statement Baking powder can be made with baking soda and cream of tartar.	
Help Received My mother and science teacher helped me proofread.	



**CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY**

Name(s) Sophia Federico; Elle Froistad	Project Number S0605
Project Title Efficiency of Homemade Desalination Stills	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals For our science fair project, we will be testing two homemade desalination stills to see which one will produce water with the least amount of salt in the least amount of time while also using the least amount of resources. One still will be thermal powered and one will be solar powered. We will test the salinity of the water using Aquacheck strips and time the processes while also taking into account the number of materials used to build each still.</p> <p>Methods/Materials The materials needed for our project were Aquacheck strips, seawater, a teapot, copper pipe, a cork, two 2 liter bottles black paint, a U-Fizz, sunlight, and a stove. For the thermal still boil sea water in teapot and allow steam to cool while rising through the copper tubing. Cool the tube with ice water. For the solar still paint one 2 liter bottle black and fill with sea water. Attach it to the other empty bottle with the U-Fizz. The U-Fizz is a tube that screws onto both bottle tops connecting them. Place the bottles in the sun.</p> <p>Results The thermal still produced 47 milliliters of water. The solar still only produced 1 milliliter. The lines indicate that the thermal still is more time efficient in producing volume of water. The solar still used less resources but did not produce as much water. We tested the resulting water from each still with the Aquacheck strips for the level of salt. The thermal still produced salt free water. The solar still had residual salt in it.</p> <p>Conclusions/Discussion We accept our conclusion that the thermal still is more efficient than the solar still. In the end the results conclusively showed that the thermal still is more time productive and better at removing salt. Although the solar still used fewer resources that did not make up for its lack in time production. The thermal still produced 46 more milliliters of salt free water. This is reasonable evidence to say that our hypothesis was correct for what we were testing. After trial and error with the design for the thermal still we finally came up with something that worked. If we were ever to experiment further we would do more tests on the solar still in different temperatures and different levels of direct sunlight.</p>	
Summary Statement We tested which homemade desalination still worked more efficiently to our standards.	
Help Received Father helped troubleshoot design.	



**CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY**

Name(s) Gino R. Gasbarro	Project Number S0606
Project Title Detoxifying the Atmosphere	
Abstract Objectives/Goals Human-induced climate change is a severe detrimental stress, particularly on ecological and socio-economic systems that are already affected by pollution. Carbon dioxide (CO ₂), a greenhouse gas is the key pollutant responsible for global warming. This project hypothesizes that if the fumes from motor vehicle exhausts are passed through aqueous ammonia (aq NH ₃), then the amount of emitted carbon dioxide pollutant will decrease. Methods/Materials First create a muffler device that will allow car exhaust fumes to flow through aqueous ammonia. Next use a carbon dioxide sensor to test its concentration in the fumes flowing through air, water, and ammonia. Conduct a lime water test to see if a carbonate or bicarbonate exists in the solution. Conduct a phenolphthalein test to see if ammonium bicarbonate exists in the solution. Results Hypothesis is accepted for this experiment. The amount of carbon dioxide emitted as a pollutant from the car exhaust did decrease when the fumes were passed through aqueous ammonia. The products formed upon the reaction of CO ₂ and aq NH ₃ contains ammonium bicarbonate (NH ₄) ₂ CO ₃ . A positive result from the lime water test confirms the presence of either a bicarbonate or carbonate. Lighter pink color with phenolphthalein indicator confirms the presence of a bicarbonate. Ammonium bicarbonate is a very effective and commonly used nitrogen fertilizer. Conclusions/Discussion Thus, this investigation outlines a simple, yet effective method of reducing the CO ₂ emission into the atmosphere with the simultaneous production of a useful by-product. The product formed from this reaction, ammonium bicarbonate, has already been proven and is currently being used as an effective nitrogen fertilizer internationally.	
Summary Statement This project tests to see if aqueous ammonia can filter out carbon dioxide in car exhausts fumes, which creates ammonium bicarbonate used in nitrogen fertilizer.	
Help Received Used high school chemistry lab to perform chemical tests.	



CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s) Akshay R. Hampapur	Project Number S0607
Project Title Generating TMSOCF₃ from TMSCF₃: A Synthetic Attempt	
Abstract Objectives/Goals If TMSCF ₃ transfers the trifluoromethyl anion to carbonyls in presence of trimethyl-N-oxide, which was proposed to proceed through a pentavalent silicon intermediate, then it should be possible for the trimethyl anion to do a 1-2 shift from Si to O in order to form TMSOCF ₃ . Methods/Materials In a typical procedure, trimethyl-N-oxide and initiator were weighed in a microwave vial under an Argon atmosphere, and then tightly sealed with a stir vane. Solvent and TMSCF ₃ were added to the vial and stirred at room temperature. Then, TMSCF ₃ was added and the reaction mixture was allowed to come to room temperature. All the reactions were analyzed by ¹⁹ F NMR, using trifluorotoluene as an internal standard. Results The first experimental method developed was to add the N-oxide and TMSCF ₃ with various solvents and temperatures to set a baseline for our understanding of the reaction. Considering lower solubility, Trimethylamine-N-oxide forms a pentavalent intermediate where the geometry of the sigma orbital of the O-N bond is not in place for the trimethyl anion to undergo a 1, 2 shift (not antiperiplanar geometry), we decided to alter this geometry by adding more silophilic species such as F ⁻ in the form of TBAT or TMAF. In these reactions, we were expecting to see a signal between -70 to -75 ppm(s) in ¹⁹ F NMR, which was based on other OCF ₃ signals in the literature. We observed 20% with respect to internal standard, a signal around -73 ppm in ¹⁹ F NMR. After screening several conditions, we saw that none of the reactions improved the signal at -73 ppm significantly. However, ample amounts of CF ₃ H were created in the process. Given that each experiment had some amount of CF ₃ H remaining in the mixture, this was considered a product of a side reaction. Our understanding was that the CF ₃ was cleaved off, as it was supposed to be, but abstracted a proton from a variety of sources, such as a solvent. This potentially explains why we obtained a large amount of CF ₃ H in the reaction mixture. Conclusions/Discussion In summary, we attempted to develop TMSOCF ₃ , a compound that was hypothesized to be stable compared to other trifluoromethoxide transfer reagents. To suppress the formation of CF ₃ H, other non-acidic N-oxide reagents need to be explored. In order to confirm the product formation, different approaches are being studied along with computational calculations of the product's stability (energies) and NMR chemical shifts.	
Summary Statement The OCF ₃ subgroup is believed to bolster the current medication for Alzheimer's Disease to make it more effective, so the project involves the creation of TMSOCF ₃ from a known compound, TMSCF ₃ .	
Help Received Used lab equipment at University of Southern California under the supervision of Dr. G. K. Surya Prakash and Sankarganesh Krishnamoorthy	



**CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY**

Name(s) Jemima Hernandez	Project Number S0608
Project Title Can a Homemade Whitening Treatment Whiten Faster than a Top Ranked Whitening Toothpaste?	
Objectives/Goals My objective was to determine the varying affects of hydrogen peroxide in teeth whitening products.	
Abstract Methods/Materials Before beginning the experiment, the following supplies are needed: two unfinished white tiles, instant coffee, boiling water, whitening toothpaste, two toothbrushes of the same kind, baking soda, hydrogen peroxide, mouth wash, regular toothpaste, a large bowl, notebook, and permanent marker. The instant coffee must be mixed along with the boiling water in a large bowl. Soak white tiles in coffee for twenty-four hours. Remove tiles from large bowl and let dry for another twenty-four hours. To create the homemade teeth whitening mixture, mix a teaspoon of toothpaste and baking soda with an ounce of hydrogen peroxide and mouthwash. Mix continuously until the mixture has reached a paste consistency. More baking soda may be added to make the mixture thicker. With the permanent marker label each tile and toothbrush according to the whitening medium that will be used with it. Take each tile and brush it in circular or vertical motions for a period of thirty seconds for each trial. The experiment requires a minimum of seven trials to portray a one week period. Remove any residue by gently patting down the tiles with a napkin. In a notebook record observations and comparisons.	
Results The homemade whitening product with the higher concentration of hydrogen peroxide whitened faster opposed to the store bought whitening toothpaste. In the end they both had the same whitening effects, but the product with the higher concentration gave quicker results.	
Conclusions/Discussion At the beginning of this experiment I theorized that the whitening toothpaste would whiten quicker and more efficiently than the homemade whitening treatment. However, my hypothesis was quickly debunked because the homemade whitening mixture removed the coffee stain in the first trial, which is attributed to the high concentrartion of hydrogen peroxide. According to research, hydrogen peroxide was used during the early centuries as an agent for removing teeth stains, intrinsic stains, and was very successful. Even though the whitening toothpaste contains an amount of hydrogen peroxide, it is very minimal. Therefore, the outcome of this experiment is very logical.	
Summary Statement The purpose of this experiement is to determine the affects of varying concentrations of hydrogen peroxide in whitening products.	
Help Received	



**CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY**

Name(s) Charley Huang; Jed McGuigan	Project Number S0609
Project Title Gold and Palladium Nanoparticles as Catalysts for Nitrite Reduction in Drinking Water and Local Water Sources	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals Nitrite contamination, which can cause birth defects, is a growing dilemma facing the global population today, especially in agricultural communities due to the increased use of nitrate rich fertilizers which can contaminate local water supplies. We tested Gold, Palladium, and Pd-on-Au Nanoparticles' effectiveness as catalysts for nitrite reduction. We also detected of the concentration of nitrites in drinking water or sources of drinking water via High Performance Liquid Chromatography.</p> <p>Methods/Materials Gold, Palladium, and Palladium on Gold Nanoparticles were synthesized from Chloroauric(III) Acid, Tannic Acid, Potassium Carbonate, Trisodium Citrate, Palladium(II) Chloride and Hydrochloric Acid. Hydrogen and Carbon Dioxide gas were bubbled into each nanoparticle catalyst and sodium nitrite solution to induce a reduction reaction. Reduction efficiency as well as water sample nitrite concentrations were analyzed via HPLC (Column: Agilent AN1 Anion Exchange Column; Sample Size: 20 uL; Flow Rate: 1mL/sec; Detection: UV, 210; Solvent: 1.7 mM NaHCO₃ Solution; Temperature: 35 degrees C; Run Time: 20 minutes, 2 minute cooldown)</p> <p>Results We determined that 30% sc Pd-on-Au NPs were the most effective in the reduction of nitrite to nitrogen gas, decreasing nitrite concentrations to 88% of its original value ($p < 0.05$). 100% sc Pd-on-Au NPs and pure Au NPs decreased nitrite concentration by 11% and 16% respectively ($p < 0.05$). However, both 300% sc Pd-on-Au and pure Pd NPs failed to produce any significant results. In detecting nitrite concentrations in common water sources, only tap water produced trace amounts of nitrite contamination (0.04356 ppm).</p> <p>Conclusions/Discussion The most effective nanoparticle catalyst was the 30% surface coverage Pd-on-Au nanoparticle, with a bell shaped curve for effectiveness around the 30% sc nanoparticle. Furthermore, HPLC detection proved that no nitrite ions were present in detectable concentrations in bottled water and local area water. However, trace amounts of nitrites were detected in tap water, although much lower than the WHO standard of 0.91 mg/L.</p>	
Summary Statement Tested Pd, Au, and Pd-on-Au Nanoparticles of various surface coverages to catalyze nitrite reduction as well as used HPLC to determine nitrite concentrations in different water sources.	
Help Received Dr. Malhotra allowed use of TOHS lab and HPLC machines; Dr. Cauchon mentored us in HPLC techniques; Dr. Tannaci donated chemicals and supplies; Dr. Quinlan supervised work in CLU Laboratory; Karen Kearsley donated HPLC Column	



CALIFORNIA STATE SCIENCE FAIR 2014 PROJECT SUMMARY

Name(s) Michael L. Janner	Project Number S0610
Project Title Magnetic Field Modulation for Assembly and Manipulation of Responsive Nanoscale Optical Systems	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals In recent years, nanoscale materials have proven useful as building blocks for systems which utilize constructive interference in the visible spectrum to create brilliant optical effects. In order for these systems to be implemented in real-world applications, though, there must exist a mechanism by which their structure, and effectively their structural color, can be finely tuned. The objective of this experiment is to investigate magnetic field modulation by polymer templates as a means to assemble arbitrary building blocks into nanoscale systems that exhibit visible structural color and possess unique, highly controllable arrangements.</p> <p>Methods/Materials Highly uniform nonmagnetic beads were fabricated through emulsion polymerization and subsequently used as building blocks for photonic crystals by placing them in a ferrofluid, created in a hydrolysis reaction, so that they could be magnetically arranged into periodic structures. Patterned polyurethane templates were fabricated and used as a substrate for the photonic crystal assembly. Subsequently, the ferrofluid was used as a building block for the optical system itself, by allowing sufficient time to pass for the ferrofluid to arrange into thin films on top of the polyurethane.</p> <p>Results By surrounding the polymer templates and structural building blocks with ferrofluid, optical nanoscale assemblies were fabricated from a wide variety of materials which would previously not have been suitable for such responsive systems. Additionally, the use of patterned templates allowed for a much higher degree of control over the shape and size of the resultant structures. The photonic crystals exhibited tunability across the visible spectrum, and the thin films displayed visible color dependent on their thickness and the viewing angle.</p> <p>Conclusions/Discussion The ability to build responsive optical systems from nearly any uniform nanoscale material, and to assemble them into a variety of structures through the use of polymer templates, marks a development which can be readily generalized to create highly unique optical systems for niche applications. In particular, this method of fabrication allows for increased accessibility to building blocks of various properties, which will play an increasingly important role as these structures begin to find use in applications such as color-based sensors and anti-counterfeiting devices.</p>	
Summary Statement A general self-assembly procedure involving polymer templates and ferrofluids was investigated with the purpose of building responsive optical systems out of a wide variety of starting materials and with a high degree of structural control.	
Help Received Used lab equipment at the University of California at Riverside under the supervision of Dr. Yadong Yin and Dr. Le He.	



**CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY**

Name(s) Yousef Joseph; Nicholas Mah	Project Number S0611
Project Title Modeling a Blood Glucose Determination Using Surface Conductivity	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The objective of our project is to determine if it is possible to determine a person's blood sugar levels through surface conductivity. The purpose of this project is to model a noninvasive method for blood glucose level determination.</p> <p>Methods/Materials The method for measuring blood glucose levels through noninvasive means is to use dialysis tubing as a model for the skin. Five bags of dialysis tubing would be filled with varying concentrations of glucose and water for the control and the experimental. The dialysis tubing would be submerged in beakers filled with distilled water. Before the dialysis tubing is inserted, the conductivity of each beaker would be measured. The main difference between the control and experimental groups is that the experimental group contains a .3M solution of NaCl in the beaker that the dialysis tubing is submerged in. After approximately 20 minutes, the conductivity of the beakers would be measured and compared to each other and their original conductivity to see if there was a change caused by the diffusion of the dialysis tubing.</p> <p>Results Analysis revealed that the control was relatively static with fluctuations. In terms of the experimental, results showed a decrease in conductivity that was measured by a voltmeter. These results pertain to our objective in that the data obtained showed that a method for measuring blood glucose level could possibly act as a model for topical measurement.</p> <p>Conclusions/Discussion The results supported our initial hypothesis in that the experiment showed how surface conductivity could act as a possible method for determining blood glucose levels. The possibility of a topical method of measuring blood glucose levels would have a great impact in the medical industry.</p>	
Summary Statement This project aims to propose an alternate method of measuring blood-sugar levels.	
Help Received Mother helped make board	



CALIFORNIA STATE SCIENCE FAIR 2014 PROJECT SUMMARY

Name(s) Anjini Karthik	Project Number S0612
Project Title Developing a Novel Method for the Detection of Pathogens on Surfaces Using Cell Imprinted Polymers	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals Each year, 1 in 6 Americans suffers from food-borne illnesses; worldwide, the death toll from consumption of contaminated food and beverages approaches 2 million annually. Methods currently in place to control the spread of food-borne pathogens are cumbersome and inefficient--the USDA reports a ~7-day time period to confirm safety of food products against bacteria. Thus, there is a huge need for simple, effective, and rapid onsite detection of pathogenic microorganisms on surfaces like food. This project developed a novel method to detect pathogens on surfaces using cell imprinted polymers (CIPs) and investigated varying pH, cell density, and centrifugal force levels to optimize their production. It was hypothesized that varying these parameters would affect the CIP's cell count and surface coverage, important factors in assessing the polymer's quality.</p> <p>Methods/Materials Separate CIPs were produced using stamp fabrication for E. coli and S. enterica. PDMS served as the base for the CIP and the thin film for imprinting. Bacterial smears on templates were analyzed with an optical microscope, and CIPs were characterized using AFM. Independent variables were pHs (5, 7, 9), cell densities (OD 2, 3, 4), and centrifugal force levels (radius 5, 10, 15, 20, and 25mm); dependent variables were the characteristics of the CIP produced, measured by cell count and surface coverage.</p> <p>Results Optimal conditions for production of an effective CIP were pH 5, OD 3 for E. coli and pH 7, OD 3 for S. enterica. Varying centrifugal force levels had little effect. AFM images reveal the presence of cavities complementary to the cells in shape and highlight that the cells imprinted were close to a monolayer, optimal for a CIP.</p> <p>Conclusions/Discussion Hypotheses were partially supported. An important finding is that pH 5 displayed the best results for CIP production using E. coli since a lower pH increases surface charge on cells due to protonation of amine groups, increasing the cells' electrostatic interactions and affinity to surfaces. The novel approach investigated and optimized in this project yields a disposable, amplification-free, simple-to-use biosensing wipe for point-of-care detection of pathogens on surfaces like food. This innovation can usher in a new paradigm for food safety management to prevent microbial outbreaks before they occur and significantly minimize the instances of foodborne diseases throughout the world.</p>	
Summary Statement I developed and optimized the production of cell imprinted polymers (CIPs) as biosensing wipes for the simple, effective, and rapid onsite detection of pathogenic microorganisms on surfaces like food.	
Help Received I acknowledge my family and science teacher for their constant support; Dr. Ren and Dr. Zare from Stanford University for giving me the opportunity to use their lab and to present my research at Stanford.	



**CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY**

Name(s) Ryan D. Kmet	Project Number S0613
Project Title Copper Corrosion Solutions	
Abstract Objectives/Goals The purpose of the experiment was to determine effects of orthophosphate, polyphosphate, and blends of the two on copper levels in first-draw tap water. The hypothesis was that addition of polyphosphate to first-draw tap water would increase copper concentration in water secondary to initial sequestration effect and the unpredictability of when reversion to orthophosphate ions would occur to minimize copper release. It was also hypothesized that addition of orthophosphate and polyphosphate together would significantly decrease copper concentration in first-draw tap water. Methods/Materials One control of distilled water and four samples of first-draw tap water were collected and placed in a total of five beakers. Initial copper levels were assessed and recorded in each beaker. Individual and combined orthophosphate and polyphosphate treatments were applied and copper levels were immediately assessed and recorded. This process was repeated nine times, for a total of 50 beakers and 10 sets of samples. The second round of tests utilized the same materials in the same amounts and repeated the same processes, but the copper levels were assessed 24 hours after the addition of the treatments instead of immediately. Results The results supported the hypothesis that addition of polyphosphate to first-draw tap water would increase the copper concentration. Additionally demonstrated was that poly-ortho blends and orthophosphate alone added to first-draw tap water decreased copper concentrations, though orthophosphate alone provided greatest immediate reduction. Conclusions/Discussion Orthophosphates are effective in lowering copper release into water from uniform corrosion, with copper reacting to form low-solubility solids on interiors of pipes. Polyphosphates and poly-ortho blends are also used in treatment of copper corrosion in potable water systems, creating corrosion-control barriers on pipe walls. Polyphosphates first introduced into a water distribution system are in polymeric form and sequester copper. The compounds eventually break into orthophosphate ions, and then copper release is minimized. There is no way to predict when this reversion will occur. Until then, copper ions are sequestered in water and form a bond, so during this waiting period there are likely locations in the water system when customers consume higher metal concentrations.	
Summary Statement The effects of polyphosphate, orthophosphate, and poly-ortho blends are studied to achieve balance between metal sequestration and minimization of copper release in first-draw tap water.	
Help Received Mother purchased materials; CSUB supplied phosphates; Mr. Mark Hartsock advised	



CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s) Rohith C. Kuditipudi	Project Number S0614
Project Title Separating Mirror Molecules: Computational Evaluation and Novel Framework for HPLC Method Development on CD Columns	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals In this study the ability of beta-cyclodextrins (β-CD) to enantioselectively complex omeprazole enantiomers was evaluated, and from this information two equilibrium binding constants were hypothesized and used to effectively predict HPLC peak behavior in columns equipped with cyclodextrin-based stationary phases on which omeprazole is not known to have been analyzed previously. A crucial goal of this project was to produce a general framework for future HPLC method development, a process that is often both expensive and time consuming, by allowing researchers to predict optimal temperatures at which to conduct assays beforehand rather than by trial and error as is often the case.</p> <p>Methods/Materials Complexation resulted from magnetically stirring a bilayer solution consisting of cyclodextrins in water and the drug omeprazole in a non-polar solvent. The complexed omeprazole extracted from the cyclodextrin cavity was injected into SRI International's HPLC, equipped with a Chiral CD-PH column, at 25 degrees Celsius and wavelength 254.0 in a solvent system consisting of 80% methanol and 50 mM ammonium formate pH 4.</p> <p>Results Two relatively large peaks consistently eluted at approximately 10 and 11 minutes respectively. Although omeprazole has been known to degrade significantly in solution in the presence of cyclodextrins, a phenomenon that may have inhibited the use of cyclodextrin columns in the past, degradation was found to be significantly mitigated at higher pH levels approaching 10. The relative amounts of each enantiomer left uncomplexed in solution were obtained via the specific rotation measured by a polarimeter, from which two distinct equilibrium binding constants for each enantiomer were observed and were used to accurately predict differences in elution times between enantiomeric peaks within just 14.33% error. Suitable succinyl-beta cyclodextrin derivates compatible with a CM5 biosensor chip will be processed for the precise validation of determined binding constants.</p> <p>Conclusions/Discussion The remarkably accurate predictions of peak behavior that were achieved in this study using novel, low-cost methods have already laid the foundations for an extendable thermodynamic framework for efficient HPLC method development, and an inexpensive method of separation has been validated for omeprazole enantiomers as a potential means of producing relatively enantiopure drugs. Cheaper, safer drugs may soon follow.</p>	
Summary Statement New cyclodextrin-based methods for the analysis and separation of mirror molecules were developed, both of which may significantly lower the production costs of enantiopure drugs.	
Help Received SRI International provided the HPLC; Dr. Mark Stolowitz of Stanford University provided access to a biosensor; Dr. Smriti Koodanjeri advised the project	



**CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY**

Name(s) Gha Young Lee	Project Number S0615
Project Title Novel Stable Photonic Crystal Polyester Nanosensor Capable of Quick Visual Detection of Chemicals and Biochemicals	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The goal of the project was to create a stable, fast reacting nanosensor from low-cost, easily manufactured cross-linked polyester. To do so a method would be developed to make materials other than silicon have a nanostructure unique to porous silicon called a photonic crystal rugate structure that allows quick and easy visual detection of chemicals and biochemicals.</p> <p>Methods/Materials First, a rugate structure silicon chip was electrochemically etched with a sinusoidally modulating current density. After a bolt with an aluminum foil along its inner radius was placed on the etched silicon chip, a mixture of polyester resin and methyl ethyl ketone peroxide catalyst was inserted into the aluminum-coated bolt. After infiltration and polymerization, the silicon template was removed to result in the freestanding polyester replica. Various parameters were explored such as the etch conditions, polymerization conditions, methods of silicon template dissolution, and other troubleshooting. After each adjustment the reflection graph of the replica was analyzed using a spectrophotometer to check for successful replication. The samples were further characterized by SEM.</p> <p>Results A successful method of replicating the rugate structure was developed. The following is the novelly developed method optimized for polyester: The silicon template is etched with 100-200mA/cm² current density modulation, 5 second period and 200 repeats. Then the silicon is thermally oxidized for 2 hours at 550°C. The bolt and aluminum are placed on the chip and a mixture of 1 drop catalyst and 1mL polyester resin is put in the inner hole of the bolt. The composite is heated at 80°C for 3 hours and after 3-5 days the template is dissolved using 1M KOH. After dissolution, the sample is immediately dried using vacuum.</p> <p>Conclusions/Discussion After many ideas and troubleshooting, the polyester was able to replicate the photonic crystal rugate structure and was stable in air. The resulting replica sensor is much more mechanically and chemically stable than any other containing the rugate structure so far. Furthermore it has practical applications due to its low material cost, quick and simple visual detection of chemicals and biochemicals, portability, ability to control its size and shape, and its possible expansion of the field by making similar sensors with other materials through the developed method.</p>	
Summary Statement A low-cost, easily manufactured, portable chemical sensor with a quick reaction time was developed by imprinting a photonic crystal structure of porous silicon onto cross-linked polyester.	
Help Received Used lab equipment and facilities of the Sailor Lab at University of California, San Diego, under the mentorship of Joanna Wang and overall supervision of Prof. Michael J. Sailor; Participant in the Summer School for Silicon Nanotechnology; Parents helped print and mount the poster;	



**CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY**

Name(s) Hope Lee	Project Number S0616
Project Title Optimization of Enzyme (Bromelain) Recovery Using Polymer-Salt Aqueous Two Phase Systems	
Objectives/Goals The purpose of this study was to determine the optimization conditions of enzyme recovery in polymer-salt aqueous two phase systems (ATPS) by manipulating three factors: polyethylene glycol (PEG) concentration, PEG molecular weight, and phosphate solution concentration.	
Abstract Methods/Materials The equipment used were pipettes, a pipette gun, pipetmen, centrifuge tubes, a tube rack, syringes, filters, a balance, a volumetric flask, nalgene bottles, an UV spectrophotometer, a thermometer, a radiator, and a water bath. Materials used were PEG (three molecular weights), dibasic and monobasic potassium phosphate, bromelain powder, pineapples, L-cystein HCl#H ₂ O, EDTA, NaOH, trichloroacetic acid, sodium acetate, acetic acid, casein, pure L-tyrosine, and water. The study was divided into four phases. For the first phase, standard curves for L-tyrosine and enzymatic activity were created. In phase 2, ATPS partitioning behavior was tested to evaluate the effects of three factors on the ratio of PEG phase volume to total volume. In Phase 3, each factor was tested individually and its effects observed. In Phase 4, two design of experiment (DOE) quadratic models were created to optimize enzyme recovery. Casein Digestion Unit (CDU) analysis was used to test the enzyme reactivity of each sample.	
Results In phase 1, high precision standard curves for L-tyrosine and enzyme concentration were created with R ² values of 0.9986 and 0.9994, respectively. For phase 2, the partitioning ratios ranged from 0 to 0.57. PEG concentration and phosphate buffer concentration were identified as significant factors of partitioning behavior. In phase 3, the extraction percentage increased from 50% to 90% when PEG molecular weight increased, decreased from 43% to 6% when phosphate concentration increased, but showed no consistent trend when PEG concentration increased. In phase 4A (PEG10,000), a maximum of 45.607 mg protein was recovered from pineapple juice. In phase 4B (PEG3350 and 8000), a maximum of 11.416 mg bromelain was recovered.	
Conclusions/Discussion From the phase 4A model, a calculated maximum of 47.7 mg enzyme can be recovered at 166 mg/mL PEG and 1.35 M phosphate. From phase 4B model, a predicted maximum 10.5 mg bromelain can be recovered by using at 183 mg/mL PEG8000 and 2.19 M phosphate. Overall, my hypothesis was partially supported as empirical data contradicted my hypothesis but the calculated optimizations supported it.	
Summary Statement The purpose of this research was to determine the optimization conditions of enzyme recovery in polymer-salt aqueous two phase systems (ATPS) by manipulating three factors.	
Help Received Father helped scan samples with UV spectrophotometer at workplace lab.	



**CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY**

Name(s) Andrew T. Ostrom	Project Number S0617
Project Title Corrosion II: Attack of the Anions	
Abstract Objectives/Goals The purpose of this project was to determine the effect of anions on the corrosion of steel nails and galvanized nails. I hypothesized that nails in the sodium chloride solutions will have the most corrosion because it is similar to seawater. I also hypothesized that the steel nails will corrode more than the galvanized nails due to the protective zinc coating. Methods/Materials One molar solutions of twelve sodium salts were prepared. The pH of each salt solution was measured and split into two glass jars. Two steel nails were pre-weighed and placed in each of the twelve solutions. This was repeated using two galvanized nails. The jars were capped and periodic observations of each jar were made to determine the extent of corrosion. After one month, each pair of nails were dried and weighed to determine any weight change. Results All of the nails tested showed a weight change. Some of the nails had a weight loss and some had a weight gain. The steel nails had a greater percent weight change than the galvanized nails, which confirmed my hypothesis. The solution of sodium bicarbonate had the greatest percent weight change for both the steel and galvanized nails, which did not confirm my hypothesis. Many of the solutions had solids at the bottom of the jars. Some of the nails had corrosion on them, but the solutions were clear. Conclusions/Discussion The nails that showed a weight loss was from rust forming and falling off the nails. The nails that showed a weight gain was from the oxidation of the iron in the nail. Some solutions had a solid in the bottom of the jar, but the nails had a weight gain. This meant that some of the rust fell off, but more of the iron was oxidized on the nail. Zinc cations can combine with some of the anions to form solids. This depends on their solubility and the pH of the solution. This would explain why some galvanized nails showed a weight gain and some showed a weight loss.	
Summary Statement My project determines the effect of anions on the corrosion of steel and galvanized nails.	
Help Received My Mom helped me assemble project board. My Dad supervised the experiments and filled out this form.	



**CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY**

Name(s) Ruchi S. Pandya	Project Number S0618
Project Title The Development of a Electrode Based Biosensor for Cardiac Health Diagnostics	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals Acute myocardial infarction (AMI), or cardiac arrest, accounts for one-third of the deaths in the world. When the heart muscle begins to degenerate, three main proteins are released: Troponin, Myoglobin, and C-reactive protein. Currently, the concentrations of these proteins are determined through a series of multi-step, low sensitivity, time intensive and costly procedures. Electrochemical based biosensors have potential for quick, sensitive, portable, accurate, cost effective detection of a variety of proteins and other biomolecules.</p> <p>Methods/Materials A standard silica wafer electrode etched with lithography is used as a substrate for the biosensor. CNFs are grown using plasma enhanced chemical vapor deposition. A series of surface modification procedures are conducted, including nitric acid soaking, couple linker binding, antibody binding, and antigen binding. At each step of the process, electrochemical characteristics (CV and DPV curves) using the electrochemical workstation are taken. Vertically aligned carbon nanofibers (CNFs) are extremely sensitive detection mechanisms because of their conductivity, biocompatibility, and ease of surface modification. Electrochemical biosensors are 25 times more sensitive than current laboratory techniques, and the CNFs allow for the synthesis of an accurate device with reduced risk of false positive results.</p> <p>Results The change in concentration of Troponin and Myoglobin was mapped using the change in electrical current in the CNF sensor, measured by EIS. Conventional methods can only measure protein concentrations to 5ng/mL sensitivity, and uses laboratory grade equipment with multi-stage processing. The developed biosensor has a sensitivity of .02ng/mL and would only need a very small sample for testing.</p> <p>Conclusions/Discussion By measuring the difference in current between the antibody and antigen curves for each sample, a scale between concentration and current (hence resistance) was calibrated, effectively creating a biosensor for cardiac arrest.</p> <p>This solution provides a cost effective, efficient, highly sensitive, portable, and reliable diagnostic tool for cardiac arrest. It is expected to save the lives of hundreds of thousands of people across the globe, and revolutionize the way we approach cardiac health diagnostics.</p>	
Summary Statement A highly sensitive, cost effective, reliable electrode based biosensor for cardiac arrest diagnostics was developed using plasma enhanced chemically vapor deposited carbon nanofibers.	
Help Received Lab equipment used at NASA Ames Research Center under the supervision of Dr. Jessica Koehne	



CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s) Anshul A. Ramachandran	Project Number S0619
Project Title Determination of Accurate Molecular Models of Polyatomic Ions in Aqueous Solutions by Molecular Dynamics Simulations	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals This research wished to develop a theoretical methodology to determine accurate molecular models of polyatomic ions in aqueous solutions. Currently, accurate models of such ions in aqueous models do not exist, but are required to better understand many important environmental effects and to develop efficient industrial and research procedures.</p> <p>Methods/Materials Quantum mechanical data and experimental results do not exist for polyatomic ions due to complexity involved in applying current approaches. Hence, we aimed to determine accurate models by correlating values of dynamic simulation-calculated properties with experimentally determined macromolecular properties with values that are well known, most notably solubility. This methodology was conducted and is presented in the context of the polyatomic sulfate anion, SO_4^{2-}. Physical parameters of the ion (bond lengths, bond angles, bonds# spring coefficients, partial charges, etc) were varied and multiple dynamic simulation runs were conducted. All simulations were started in equilibrium conditions calculated from experimental studies of macromolecular properties of sodium sulfate. If the chosen values of the parameters in our theoretical model were perfectly accurate, the system started in equilibrium should stay in equilibrium and there should be no deviation in macromolecular properties of the simulation space (such as total energy) over time.</p> <p>Results During each simulation run, the total energy deviation was determined at regular intervals and was analyzed to calculate the unknown optimal values of the parameters. Accuracy of these values was validated by running further simulations that used models incorporating the optimal values. Total energy deviation was once again determined and was found to be low. Statistical tests allowed us to conclude that the low deviation was due to the choice of values of the parameters.</p> <p>Conclusions/Discussion This novel methodology of correlating dynamic-simulation and experiment determined values of macromolecular properties was proven to find a more accurate model of polyatomic ions in aqueous solutions and is broadly applicable.</p>	
Summary Statement This research developed a theoretical methodology to determine accurate molecular models of polyatomic ions in aqueous solutions, which currently do not exist.	
Help Received Ms. Kavita Gupta (mentor) helped proofread my research paper	



CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s) Shreya S. Ramayya	Project Number S0620
Project Title Building a Library of Difluoromethyl- and Trifluoromethyl-Artemisinin: Year Two	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals In recent years fluorine has become increasingly important to the pharmaceutical industry. Coupled with already-potent drugs, fluorine has allowed common therapies to become even more effective in treating many diseases. One disease that could particularly benefit from the development of a more effective treatment method is malaria. For centuries malaria has been treated with artemisinin, but drug resistance has drastically reduced the effectiveness. Recognizing the benefits of adding fluorine to pharmaceuticals, this study focused on developing the methodology required to successfully incorporate fluorine into molecules of biological importance.</p> <p>Methods/Materials In order to improve bioavailability of artemisinin, two types of fluoroalkylation were experimented with. This study focused on successfully trifluoromethylating artemisinin before branching out into the more complex difluoromethylation process. The Ruppert- Prakash Reagent was used to trifluoromethylate artemisinin. The next phase of research consisted of developing a methodology for the difluoromethylation of artemisinin. Methyl- 4- nitrobenzoate was used as a surrogate molecule to model the behavior of artemisinin in the difluoromethylation process. The difluoromethylating reagents used were TMSCF(2)H and TMSCF(2)Br and activating agents were CsF and K(2)CO₃.</p> <p>Results The goal of creating a trifluoroartemisinin analog was achieved, and the difluoromethylation procedures show great promise for further research. Low yields of product are indicative of the potential for a more successful methodology to be developed.</p> <p>Conclusions/Discussion This research successfully synthesized a trifluoromethyl-artemisinin analog, one of the primary goals set for this year of research. In addition, basic difluoromethylation displayed some positive results. Overall, this work has created the necessary platform to create even more analogs of artemisinin that can supplement the existing library of drugs yielding an opportunity for biological testing.</p>	
Summary Statement This project focused on fluoroalkylating artemisinin, an antimalarial drug, to increase its bioavailability and address the issue of drug resistance.	
Help Received Worked at USC Loker Hydrocarbon Research Institute under the supervision of Dr. Surya Prakash.	



**CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY**

Name(s) Amit S. Talreja	Project Number S0621
Project Title Mobile Spectrometer for Environmental and Health Monitoring	
Abstract Objectives/Goals The goal of the project is to create a spectrometer-based chemical analyzer that is portable and comparable in accuracy to lab quality equipment, while minimizing cost. To be considered successful, the spectrometer must have a minimum eighty percent accuracy in identifying differences in known chemicals and concentration of the detected chemicals. It must also be able to identify unknown chemicals by comparing compounds to a database. Methods/Materials After multiple prototypes, a final spectrometer device was constructed using laboratory-grade components and a smartphone to measure and analyze the data. Measurements of water with and without contaminants were taken and then compared to find the differences between the two samples. These differences were then recorded and compared to a publicly available database to identify the contaminants present in the water sample. Results With testing on known chemicals, the device was able to accurately identify the chemical present in the water with a 84.37% accuracy. It was also able to detect the concentration of these chemicals with a 55.4% accuracy. When trying to identify unknown compounds in solution the device achieved an 80.2% accuracy Conclusions/Discussion Current lab-quality spectrometers cost more than \$50,000, and the cheapest water testing machines can be \$100 per sample analyzed. By combining the principles of spectrometry with the need for cheap water testing, a device has been created that could revolutionize how water is tested around the world. The general principle of the device can also be applied to finding explosive chemicals at airports or finding hemoglobin content in human blood. I created a low-cost chemical analyzer that is able to identify contaminants in water with close to 85% accuracy.	
Summary Statement Developed a smart-phone based spectrometer that analyzes contaminants in water with 85% accuracy	
Help Received Ran my ideas by my high school teacher to get his feedback.	



CALIFORNIA STATE SCIENCE FAIR 2014 PROJECT SUMMARY

Name(s) Jade Tso	Project Number S0622
Project Title Developing Spectrophotometric & Colorimetric Field Tests to Measure Beta-Carotene Concentration of Biofortified Cassava	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals In an effort to fight vitamin A deficiency, a leading cause of morbidity and mortality in Africa, South America, and Southeast Asia, HarvestPlus and BioCassavaPlus have biofortified cassava to increase its beta-carotene concentration. Because carotenoid concentration is affected by climate and growing conditions, field tests are needed to maintain the integrity of these biofortification programs. Current HPLC methods are timely and expensive, making spectrophotometric and colorimetric assays more desirable for field tests.</p> <p>Methods/Materials Samples were prepared in two ways: beta-carotene was extracted and then reconstituted to 1:2 dilutions to be measured on the spectrophotometer and colorimeter; and dry samples were homogenized and measured on the colorimeter. Linear regressions were plotted to depict the correlation between the known concentrations and the values obtained using the spectrophotometer and colorimeter.</p> <p>Results Spectrophotometric assays were reasonably effective, with $R^2 = 0.7284$. For wet colorimetric assays, there was a strong correlation between the a^*, b^*, C^*, and h values and the concentration of beta-carotene, with $R^2=0.82$, $R^2=0.89$, $R^2=0.90$, $R^2=0.74$, respectively. Both wet assays were more effective than dry colorimetric tests. It is important to note that for actual field tests, standard curves must first be created for each individual spectrophotometer and colorimeter.</p> <p>Conclusions/Discussion Excitingly, both spectrophotometric and colorimetric assays have much potential to be used as field tests, saving nonprofit organizations like HarvestPlus and BioCassavaPlus time and money, resources they can use to further their impact preventing vitamin A deficiency and saving lives doing so. This study also suggests that carotenoid concentration determines the color values of extracted samples. More broadly this suggests that higher concentrations of beta-carotene results in a color shift to a more vivid yellow-green, away from being a white-yellow color. More research should be done to evaluate the limitations of spectrophotometric and colorimetric assays as field tests and their potential applications to other biofortified foods.</p>	
Summary Statement The purpose of this project was to evaluate the potential use of expeditious and cost-efficient methods of beta-carotene measurement of biofortified cassava such as spectrophotometry and colorimetry in place of timely and costly HPLC.	
Help Received Used lab equipment at University of California, Davis; I was supported by Dr. Betty Burri who gave me the freedom to conduct this investigation; HPLC results were provided by Dr. Michael La Frano at the University of California, Davis	



CALIFORNIA STATE SCIENCE FAIR 2014 PROJECT SUMMARY

Name(s) Nathaniel B. White	Project Number S0623
Project Title In Pursuit of a Major Breakthrough in Cryobiology	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals If an applied electric field can affect the formation of hydrogen-bonds in water during freezing such that the molecules no longer align to form a crystalline lattice structure, then water frozen in an electric field will experience an increase in density and will no longer crystallize and puncture the tissues.</p> <p>Methods/Materials</p> <ol style="list-style-type: none">1. Carefully measure two cups of water, fill the non-conductive bowl and freeze.2. Remove the ice and measure density using the water displacement method as a basis for comparison.3. Fully charge up the Van De Graff generator in a low humidity environment. (If you have access to an E-field meter, record the field at six inches from the charged surface)4. Measure out 2 cups of water and fill the non-conductive bowl (use the same type of water)5. Place both the water and generator in the freezer environment at -18 C or lower6. Suspend the water near the charged generator and freeze the entire assembly.7. Remove the ice and measure density using the water displacement method. (Observe whether the ice floats or sinks).8. Compare the volumes of the two frozen masses, and record approximate densities.9. Repeat experiment 3 times to obtain averaged results. <p>Results The density of the water tested was largely unaffected in the presence of an electric field. Although there were slight fluctuations in the densities, they were well within the expected levels of variability. The results show that the water was not conclusively affected by an electric field.</p> <p>Conclusions/Discussion Unfortunately, the results of the experiment did not support the hypothesis. This most likely indicates that the hypothesis is incorrect, or that the E field was not strong enough to cause the water molecules to realign. Furthermore, the methods employed to measure the quantitative data collected were crude at best. When conducting future experiments it is advisable to instead use a high voltage transformer in conjunction with parallel plates, one acting as an anode and one as a cathode, and also to use more sophisticated tools and procedures when conducting and measuring the results of the experiment. If a similar experiment can be conducted with positive results, methods could be developed in the field of cryobiology to potentially prevent blood crystallization and consequent puncturing of the blood vessels.</p>	
Summary Statement This project attempts to create "dense ice" in a manner practical for application to the field of cryobiology, which could enable major scientific advancements.	
Help Received Inspired by Australian Chemistry and Physics class; Parents funded materials; Parents revised diction and syntax.	



CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s) Cynthia L. Yin	Project Number S0624
Project Title Nanoscale Catalyst in Belousov-Zhabotinsky Reaction to Induce Self-Organization of Complex Spatiotemporal Structures	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals Pattern formation in nature has fascinating similarities to reaction-diffusion systems such as the classic oscillatory Belousov-Zhabotinsky (BZ) reaction in which an organic substrate is oxidized by bromate with a catalyst in an acidic environment. In existing approaches, BZ reactions occur globally in a continuous system of reactants and catalyst, oscillate between oxidized and reduced states, and produce spatiotemporal wave patterns. Contrarily, my investigation of a discrete BZ system with nanoparticle-based catalyst unveiled nanoscale-to-macroscale connections. I implemented a new approach to achieve three objectives: (i) to discretize the BZ system by catalyzing the reaction on the nanoscale and analyze subsequent pattern formation, (ii) to evaluate the effects of nanoparticle silica content on pattern formation, and (iii) to determine how the presence of an external magnetic field influences pattern formation.</p> <p>Methods/Materials Malonic acid was oxidized by sodium bromate and sodium bromide in sulfuric acid under the influence of the photosensitive BZ catalyst known as ruthenium. I synthesized silica nanoparticles that encapsulated magnetic nanoparticles and ruthenium catalyst. To analyze effects of nanoparticle silica content, I tested varying silica amounts ranging from 1 to 250 mg. To control pattern formation with a magnetic field, I placed the Petri dish containing BZ reactants and nanoparticles in two different settings: (i) on a hot plate above a magnetic stirrer, and (ii) above neodymium magnets.</p> <p>Results BZ reaction waves propagated and self-organized into spatiotemporal structures on the macroscale. Labyrinthine-like Turing patterns formed and de-formed over time even after repetitive stirring. Greater silica content in nanoparticles increased nanoparticle size and resulting pattern initiation times. Further, a magnetic field guided nanoparticles to create new patterns including stripes and honeycombs.</p> <p>Conclusions/Discussion Unlike the traditional continuous system, this discrete system catalyzed the BZ reaction on the nanoscale to produce complex spatiotemporal structures on the macroscale. This linkage between the nanoscale and the macroscale induces self-organization of Turing patterns. My work explored new frontiers in complex pattern formation that enable the BZ reaction to serve as a model for other oscillatory systems.</p>	
Summary Statement By incorporating nanoparticles into this discrete BZ system, I unearthed macroscale spatiotemporal structures that arise from nanoscale initiation sites, and potentially contributed to simulations of analogous oscillating networks.	
Help Received Used lab equipment at University of California, Los Angeles under the supervision of Dr. Chih-Ming Ho.	