Fifty-Sixth Connecticut

JUNIOR SCIENCE and HUMANITIES SYMPOSIUM

at UConn Health, Farmington, Connecticut
March 9, 2019

THE NATIONAL SCIENCE TEACHERS ASSOCIATION
under contract with
THE U.S. ARMY, NAVY, AIR FORCE and
UCONN HEALTH/CT AREA HEALTH EDUCATION CENTER

OBJECTIVES

...To promote research and experimentation in the sciences, mathematics, and engineering at the high school level;

...To recognize the significance of research in human affairs, the importance of humane and ethical principles in the application of research results;

...To search out talented youth and their teachers, recognize their accomplishments at symposia, and encourage their continued interest and participation in the sciences, mathematics, and engineering;

...To expand the horizons of research-oriented students by exposing them to opportunities in the academic, industrial, and governmental communities;

...To enlarge the number of future adults capable of conducting research and development.

A part of

THE U.S. ARMY/NAVY/AIR FORCE JUNIOR SCIENCE AND HUMANITIES SYMPOSIA PROGRAM

with support from

UCONN HEALTH/CT Area Health Education Center (AHEC)

and

CONNECTICUT ACADEMY OF SCIENCE AND ENGINEERING

Program Summary

	7:30 – 8:15 a.m.	Registration and Breakfast Service			
	8:30 – 8:45 a.m.	Welcome and Briefing			
	8:45 – 9:30 a.m.	Keynote			
	9:30 – 9:45 a.m.	Break/Snack			
BLOCK 1	9:45 – 10:30 a.m.	1st Oral Session	Health & Research Careers Panel	Humanities Activity	Competitive Poster Judging
	10:30 – 11:15 a.m.		Lab Tour		
	11:15 – 11:30 a.m.	Break/Poster Viewing/Snack			
BLOCK 2	11:30 a.m. – 12:15 p.m.	2nd Oral Session	Health & Research Careers Panel	Humanities Activity	
	12:15 – 1:00 p.m.		Lab Tour		
	1:00 – 1:45 p.m.	Lunch/Poster Viewing			
BLOCK 3	1:45 – 2:30 p.m.	3rd Oral Session	Health & Research Careers Panel	Humanities Activity	
	2:30 – 3:15 p.m.		Lab Tour		
	3:15 – 3:30 p.m.	Break/Snack			Judges' Deliberation
BLOCK 4	3:30 – 4:45 p.m.	STEM Poster Exhibition Peoples' Choice Award Voting	Hartford Medical Society Library research scavenger hunt (x 3)	Data analysis interactive demo (x 3)	
	4:45 – 5:00 p.m.	Evaluation and Raffle, then Dismissal or Dinner			
	5:00 – 6:30 p.m.	Dinner and Awards Ceremony			

Fifty-Sixth Connecticut
JUNIOR SCIENCE and HUMANITIES SYMPOSIUM
at UConn Health

SATURDAY, MARCH 9, 2019

REGISTRATION
7:30 – 8:15 a.m. Academic Lobby
Breakfast Service in Rotunda Hallway

OPENING
8:30 – 9:30 a.m. Rotunda

Welcome

Bruce Gould, MD
Associate Dean for Primary Care
Professor, Department of Medicine
Director, CT AHEC Program
UConn School of Medicine

Andrew Agwunobi, MD, MBA
CEO, UConn Health
Executive Vice President for Health Affairs

Briefing

Joy Erickson, MA
Director, CT-JSHS

Keynote Address

Olga Ancuzkow, Ph.D.
Assistant Professor
The Jackson Laboratory for Genomic Medicine
"Where the silver screen meets the genome:
Exploiting RNA splicing for cancer therapeutics"

BREAK/TRANSITION
9:30 - 9:45 a.m. Refreshments Rotunda Hallway

WORK ON YOUR ACTIVITY CARD (RAFFLE TICKET) THROUGHOUT THE DAY!

2019 HUMANITIES ACTIVITY: *Gene Editing and CRISPR*

BLOCK #1
9:45 – 11:15 a.m.

Of the below options, your assigned activity/room is on your name tag:

Activity	**Group A: 1st Oral Session (names are below)**	**Group B: Health & Research Careers Panel and Lab Tours**	**Group C: Humanities Activity**	**Competitive Poster Session (names are directly below)**
Location	Rotunda	Massey Auditorium	Patterson or Friends Hall	Academic Lobby

Poster Presenters

Ananya Aggarwal
Glastonbury High School
Mentors: Shanka Dissanayake and Steven L. Suib
The Selective Oxidation of Benzyl Alcohol to Benzaldehyde Using a Mesoporous Vanadium Doped Ceria Catalyst

Cynthia Chen
Greenwich High School
Mentor: Andrew Bramante
A Green Nanotechnological Approach for Energy Efficiency and Conservation: Tungsten-doped Vanadium Dioxide Thermochromic Smart Windows

Rebecca Cohen
Ridgefield High School
Mentor: Roderick Wilson
Establishing Limits of eDNA Preservation under Extreme Conditions through Cell Quantification

Megan Cunningham
Darien High School
Mentor: Rebecca Bose
Environmental Enrichment to Increase Explorative Behavior in Captive Wolves

Ethan Fancher
Bridgeport Regional Aquaculture Science & Technology Education Center
Mentor: Kirk Shadle
Biowaste of C. Nucifera, G. Max as an Effective Drywash Separation Media for Glycerin in Biodiesel Production

Hiba Hussain
Greenwich High School
Mentor: Andrew Bramante
Magnetically-Positioned, Lipase-Induced Degradation of Arterial Plaques with Simultaneous Smartphone Detection of Post-Dissolution Products

Paul Isaac
E.O. Smith High School
Mentor: Cheryl Granger
Effect of Heat Stress on DNA Methylation in Chlamydomonas reinhardtii

Keerthi Kongani
Amity Regional High School
Mentor: Catherine Piscitelli
Determining Whether Bitter Melon Possesses Antibacterial Properties

Manvi Malhotra
Darien High School
Mentor: Erica Holdridge
A Model System of the Emergent Effects of Increasing Temperature on Predator-Prey Interactions between Bursaria truncatella and Paramecium aurelia

Grace McGonagle
Green Farms Academy
Mentors: Yanrui Huang and Mathieu Freeman
Trx2 Deficiency Induced Impaired Mitochondrial Integrity and Adipocyte Dysfunction

Athulya Narayanan
Glastonbury High School
Mentor: Mary Anne Amalaradjou
Reducing Skin Cancer with Alpha-Lipoic acid

Emily Ngo
Academy of Aerospace and Engineering
Mentor: Lili Aramli
Effect of External Exposure of Low-Intensity Light on Breast Cancer Cell Proliferation with Plexiglass-Bead Radiation Absorption and Emission

Owen O'Reilly
Joel Barlow High School
Mentor: Joseph Audie
Testing and Subsequent Optimization of Various Polyphenol Molecules for Effectiveness of Non-Covalent Inhibition of TEM-1 Beta Lactamase in Penicillin-Resistant E. coli Bacteria

Jillian Paulin
Bethel High School
Mentor: Ray Turek
Quasar Luminosity Variability over Right Ascension and Declination

Anisa Prasad and Sirina Prasad
Staples High School
Mentor: Miriam Rafailovich
Optimization of High-Efficiency Organic-Inorganic Lead Halide Perovskite Solar Cells via a Novel Polycaprolactone Additive Pathway

Siavash Raissi
Amity Regional High School
Mentors: Hasan Öz and Emanuela Bruscia
The Effect of Cystic Fibrosis Transmembrane Conductance Regulator (CFTR) on Macrophage Polarization

Arushi Samal
Darien High School
Mentor: Kristine Nishida
The Effect of Fucosyltransferase-2 on the Binding of E-Cadherin

Leonard Tang
Glastonbury High School
Mentor: Pei Cao
Harnessing Machine Learning and Sentiment Analysis to Predict the Future Prices of Individual Stocks

Sienna Wang
Amity Regional High School
Mentors: Emmanouil Anagnostou, Diego Cerrai, and Peter Watson
Synthesizing Water Using the Chemical Reaction of Aluminum and Sodium Hydroxide, Decomposition of Hydrogen Peroxide, and Wastewater Treatment with Liquid Sodium Aluminate (LSA)

Melissa Woo
Greenwich High School
Mentor: Andrew Bramante
Rapid, Smartphone-Based Diagnosis of Skin Melanoma through Differences in Tumor Cell Thermal Regulation Combined with Diffuse Spectroscopic Analysis

First Oral Session Presenters

Anthony Antony
Academy of Aerospace and Engineering
Mentor: Z Ping Lin
Repressing HR Repair Through Cdc25 Inhibition to Sensitize Resistant Ovarian Cancer Cells to PARP Inhibitors

Hannah Goldenberg
Greenwich High School
Mentors: Andrew Bramante and Patrick Geraghty
Linking Continued Exposure to E-Cigarette Vapor Constituents with Chronic Obstructive Pulmonary Disease

Raina Jain
Greenwich High School
Mentor: Andrew Bramante
Control of Varroa destructor Infestation with a Dual-Function, Thymol-Emitting Honey Bee Hive Entranceway

Malcolm Katz
Bridgeport Regional Aquaculture Science & Technology Education Center
Mentor: Kirk Shadle
Biofiltration of Ferric Iron Utilizing Citrus Biowaste to Mitigate Freshwater Harmful Algal Blooms

Bradley Kerr
Danbury High School
Mentor: Valentina Berger
Effect of C-Reactive Protein on the Development of Atherosclerosis in ApoE Knockout Mice

BREAK/POSTER VIEWING/TRANSITION
11:15 - 11:30 a.m. Refreshments Rotunda Hallway

BLOCK #2
11:30 a.m. – 1:00 p.m.

Of the below options, your assigned activity/room is on your name tag:

Activity	**Group A: Humanities Activity**	**Group B: 2nd Oral Session (names are directly below)**	**Group C: Health & Research Careers Panel and Lab Tours**
Location	Patterson or Friends Hall	Rotunda	Massey Auditorium

Second Oral Session Presenters

Collin Marino
Greenwich High School
Mentor: Andrew Bramante
A Versatile, Genetic-Based Cancer Treatment Capable of Selectively Killing Cancerous Cells via the Detection of Single Mutations

Prastik Mohanraj
Engineering & Science University Magnet School
Mentor: Roger Rushworth
Novel Organic Synthesis of Usnic Acid Derivatives with Tumoricidal Properties

Annika Morgan
Joel Barlow High School
Mentor: Katherine Nuzzo
Deuterium Oxide (D_2O) on Maintaining Viability in Coliphage Bacteriophages under Low Temperatures to Model live Attenuated Viral Vaccine Additives

Abigail Slanski
Amity Regional High School
Mentor: Kayga Amoako
Engineering an Antiseptic Catheter Using a Bioinspired Approach

Isabella Sperry
Weston High School
Mentor: Stacey Greenberg
HPLC Analysis of a Solution of Low-Density Lipoprotein after an In Vitro Interaction with Dietary Supplements (Grape Seed Extract, Hawthorne, Polyphenol)

Shiyun Tang
Glastonbury High School
Mentor: Kenneth Campellone
Live Cell Fluorescence Imaging Showcases Autophagy in Mammalian Cells when Mitochondria are Depolarized

LUNCH/POSTER VIEWING
1:00 - 1:45 p.m.
Pick up lunch in cafeteria and make way to designated seating locations:

Role	***Judges***	***All Others***
Seating location	Classrooms A1 and A8	Cafeteria (incl. Onyiuke Dining Room), Massey Auditorium, Rotunda, Patterson Hall, Friends Hall

BLOCK #3
1:45 – 3:15 p.m.

Of the below options, your assigned activity/room is on your name tag:

Activity	**Group A: Health & Research Careers Panel and Lab Tours**	**Group B: Humanities Activity**	**Group C: 3rd Oral Session (names are directly below)**
Location	Massey Auditorium	Patterson or Friends Hall	Rotunda

Third Oral Session Presenters

Sophia Wang
Amity Regional High School
Mentors: James Wilson and Khushboo Mittal
Real Time Sinkhole Detection Using Civil Engineering Techniques, the Internet of Things (IoT), and Artificial Intelligence

Lila Wells
Greens Farms Academy
Mentor: Mathieu Freeman
Fabrication of a Biosensor Using Carboxyl MWCNTs and PTPN22 Antibodies to Detect Antigen Levels through Resistivity Changes

Olivia Yoo
Darien High School
Mentor: Diane Lane
Angiotensin-II Hypertension Enhances Morphological Alterations of Tight Junctions

Wendy Zhang
Amity Regional High School
Mentor: Ann Haberman
Characterizing Macrophage and Dendritic Cell Populations in the Germinal Center

David Zhou
Hopkins School
Mentor: Wei Zhu
Combinations of Phloroglucinol, Kaempferol, 3,5 Dimethoxyphenol and 1,3,5 Trimethoxybenzene as Novel Treatments for Non-Hodgkin Lymphoma

BREAK
(Optional) GET TICKET TO RESERVE YOUR SPOT
FOR "YOU CHOOSE" TOUR AND/OR DEMO (*see below)
3:15 - 3:30 p.m. Refreshments Cafeteria

MODERATORS' AND JUDGES' DELIBERATION
3:15 - 5:00 p.m. Classroom A8

STEM POSTER EXHIBITION
3:30 - 4:45 p.m. Cafeteria

To vote for the People's Choice Award:

- Locate your paper ballot in your conference folder.
- Place your completed ballot in the basket in the cafeteria between 3:00 to 4:45 p.m.

***"YOU CHOOSE" ADDITIONAL TOUR AND/OR DEMO**
3:30 - 4:45 p.m. Tour groups form in Cafeteria

- Get ticket to reserve your spot
- First come, first serve (limited spaces)

25-minute tours/demos step off at 3:30, 3:55 and 4:20 p.m.

- Hartford Medical Society Library research tour/scavenger hunt: limit 15 people each
- "Data Analysis Using R" interactive demo: limit 19 people each

EVALUATION AND RAFFLE, THEN DISMISSAL OR DINNER
4:45 - 5:00 p.m. Cafeteria

- Submit completed activity cards (raffle ticket) with evaluation form
  - **If staying for the dinner and awards ceremony, submit after dinner instead**
- Raffle prizes drawn 4:45 - 5:00 p.m. and again at 6:30 p.m.

CHAPERONES: PLEASE RETURN TO THE REGISTRATION AREA TO SIGN OUT YOUR STUDENT(S).

STEM Poster Exhibitors

Dina Allam, Glastonbury High School
Influence of the Ionic Strength on the Cleavage Rate of DNAzyme Tethered Nanocapsules

Cambria Andrews, Manchester High School
Nitrate Absorbing Plants Effect on Acidic Water

Nithila Annadurai, Academy of Aerospace and Engineering
Addiction and Regeneration in Planaria

Samuel Applegate, Hamden Hall Country Day School
Effects of Hemolysis on Plasma Potassium Measurement

Richa Balamurugan, Academy of Aerospace and Engineering
Stress in the Zebrafish

Erica Carpenter, Bridgeport Regional Aquaculture Science & Technology Education Center
Sorption of Hydrogen Sulfide Contaminates Through Methyl Diethanolamine Doped Ceramic Beads Coupled with a Piperazine Catalyst

Felix-Alexander Curtiss, Hamden Hall Country Day School
The Effect of Biochar on the Concentration of Carbon Dioxide Gas in a Sealed Environment

Olivia Fassman, Joel Barlow High School
Chlorophyll Deficiency in Acidic Soils on Eruca vesicaria sativa

Samuel Florin, Greenwich High School
Measuring Convexness of Electoral Districts Using Graph Theory to Flag Potentially Gerrymandered Districts

Jeremy Garskof, Bridgeport Regional Aquaculture Science & Technology Education Center
Maximizing Photodynamic Therapy Though a Highly Focused (200-400nm) Beam to Promote Tumor Cell Apoptosis

Martin Gnidula, Amity Regional High School
Effects of Community Factors on the Likelihood of Adolescent Drug Use

Christopher Gomolak, Joel Barlow High School
Testing the Capacity of Nymphaeaceae for the Phytoremediation of Zinc in Freshwater Applications

Alicia Gopal, Amity Regional High School
Developing Land-Use Regression Models to Predict Ambient NO2 Levels

Tyler Greene, Manchester High School
Application of Cyanobacteria Anthrospira as a Polyfiber Paper

Sophia Haber, Ridgefield High School
Investigating the Role of Substance P in Reducing Hunger Signals in Anorexia Nervosa

Anna Hepfer, Bridgeport Regional Aquaculture Science & Technology Education Center
The Effect of Indole-3-Acetic Acid and 6-Furfurylaminopurine on Root Meristems to Enhance Nutrient Assimilation in an Aeroponic System

Danya Jafri, Darien High School
Determination of LVEF and PA Pressure as Valuable Indicators of Long Term Left Ventricular Damage and Deterioration in Patients with Hypertrophic Cardiomyopathy

Mina Kim, Amity Regional High School
Degradation Study of Polymeric Scaffolds with Different Compositions for Bone Healing and Regeneration

Lily Kosnik, Darien High School
Effect of Site History and Organic Matter Content on Methylmercury Contamination in River Sediments

Kathryn Liu, Joel Barlow High School
Augment Symbiotic Nitrogen Fixation in Helianthus annuus L. by Inoculation of Rhizobium Diazotrophs to Improve Drought Tolerance

Samantha Margolin, Ridgefield High School
The Analysis of Lead using SCiO Handheld Scanner

Madeline McHale, Joel Barlow High School
Association of Tachycardia in Academic Performance in Youth

Sean McHale and Kol Crooks, Joel Barlow High School
2D and 3D Convolutional Neural Networks for Real-Time Classification of Dynamic American Sign Language (ASL) for Lightweight Applications

Quinn Mulineaux, Greens Farms Academy
Mobile Phone EMFs and Induced Acoustic Behavior of Apis mellifera as Related to Colony Collapse Disorder

Jennifer Rivard, Manchester High School
Investigating the Effects of Social Media on Loneliness

Joshua Salem, Bridgeport Regional Aquaculture Science & Technology Education Center
Phytoremediation of 17 Beta Estradiol Using Lemna minor in Freshwater Bodies

Zachary Shortt, Joel Barlow High School
Effect of Compostable PHA Plastics' Biodegradation on Marine Environments

Elizabeth Silva, Bridgeport Regional Aquaculture Science & Technology Education Center
Effect of Metal Ion Chelation by Curcumin on the Progression of Alzheimer's Disease

Justin Speaker, Greenwich High School
Design of a Dual-Acting Riboflavin and UV-Enhanced Contact Lens Disinfecting System

Allison Su, Amity Regional High School
The Perceived Impact of Migraine

Sheela Tavakoli, Glastonbury High School
Clinicians' Opinion Regarding Using a Radio Frequency Identification-Based Device to Measure Gait Speed in Clinical Settings

DINNER & AWARDS CEREMONY
5:00 - 6:30 p.m. Cafeteria

Welcome

Barbara Kream, Ph.D.
Associate Dean, UConn Graduate School
Professor, Department of Medicine,
and Genetics and Genome Sciences

Lawrence Klobutcher, Ph.D.
UConn Health
Assistant Dean for Research Coordination and Planning
Professor, Department of Molecular Biology and Biophysics

Acknowledgments

Joy Erickson, MA
Director, CT-JSHS

Awards

- STEM Poster Exhibition: People's Choice Award
- Poster Presenters
- Backyard Scientist Award
- Presidential Award Nominees
- Oral Presenters
- Teacher Award

CHAPERONES: PLEASE RETURN TO THE REGISTRATION AREA TO SIGN OUT YOUR STUDENT(S).

Participating High Schools/Programs

Academy of Aerospace & Engineering
Amity Regional High School
Bethel High School
Bridgeport Regional Aquaculture Science & Technology Education Center
Central Connecticut State University TRiO Programs
Choate Rosemary Hall
Coginchaug Regional High School
Conard High School
Danbury High School
Darien High School
East Granby High School
Enfield High School
E.O. Smith High School
Engineering & Science University Magnet School
Farmington High School
Glastonbury High School
Greens Farms Academy
Greenwich High School
Hamden Hall Country Day School
Hamden High School
Hopkins School
Joel Barlow High School
Killingly High School
Manchester High School
Mercy High School
Middletown High School
New Britain High School
Newington High School
Newtown High School
O.H. Platt High School
Putnam High School
Ridgefield High School
Staples High School
Thomaston High School
The Williams School
Wesleyan University Upward Bound Math/Science
Westbrook High School
Weston High School
Wolcott High School

SPONSORS

- Connecticut Academy of Science and Engineering
- Connecticut Science Teachers Association, Inc.
- Connecticut Science Supervisors Association
- EASTCONN Mobile STEM Lab
- The National Science Teachers Association under contract with the U.S. Army, Navy, Air Force and UConn Health/CT Area Health Education Center (AHEC)
- Talcott Mountain Science Center
- UConn Office of Undergraduate Admissions

DONORS

- Bar Taco, West Hartford (raffle prizes)
- Barnes & Noble at UConn Health (raffle prizes, coupons)
- Bridgewater Chocolate, West Hartford (raffle prize)

COOPERATING ORGANIZATIONS

- AmeriCorps Service to Improve Community Health (STICH) Program
- AmeriCorps State Program (CT AHEC Network)
- Connecticut Association of Secondary Schools
- CT AHEC Urban Service Track/AHEC Scholars Program
- Hartford Medical Society Library, UConn Health
- Lambda Kappa Sigma, Alpha Beta Chapter
- Lyman Maynard Stowe Library, UConn Health
- National Association of Secondary School Principals
- Pratt & Whitney
- UConn Bridge to the Doctorate Fellows
- UConn College of Liberal Arts and Science
- UConn Graduate School
- UConn School of Dental Medicine
- UConn School of Engineering
- UConn School of Medicine

EXECUTIVE COMMITTEE

- Terri Clark, Connecticut Academy of Science and Engineering, Rocky Hill
- Petra Clark-Dufner, CT AHEC, UConn Health, Farmington, Co-Director CT-JSHS
- Jonathan Craig, Talcott Mountain Science Center, Avon
- Deborah Day, Smith College, Northampton
- Joy Erickson, Director CT-JSHS
- Robert Erickson, Pratt & Whitney, United Technologies Corporation, East Hartford
- Barbara Fischler, U.S. Army Nurse Corps (Veteran)
- Sandra Justin, CT Science Supervisors Association
- John Listorti, Killingly High School, Danielson
- Frank LaBanca, Westside Middle School Academy, Danbury
- Dave Lopath, Connecticut Science Teachers Association and Connecticut Science Supervisors Association
- Diane Pintavalle, Glastonbury High School, Glastonbury
- Jon Swanson, E.O. Smith High School, Storrs
- Ralph Yulo, Eastern Connecticut State University, Willimantic

STUDENT PRESENTATION MODERATORS

- Terri Clark, Associate Director, Connecticut Academy of Science and Engineering, Rocky Hill
- Robert Erickson, Manufacturing Engineer, Pratt & Whitney, United Technologies Corporation, East Hartford

JUDGES, REVIEWERS, CAREER PANELISTS, TOUR AND DEMO GUIDES, AMERICORPS MEMBERS, URBAN HEALTH/AHEC SCHOLARS, LAMBDA KAPPA SIGMA, AND ALL OTHER VOLUNTEERS : THANK YOU !

ABSTRACTS

Oral Presenters

Repressing HR Repair Through Cdc25 Inhibition to Sensitize Resistant Ovarian Cancer Cells to PARP Inhibitors

Anthony Antony
Academy of Aerospace and Engineering, Windsor, CT
Mentor: Dr. Z Ping Lin, Yale University School of Medicine

PARP inhibition has proved successful in treating epithelial ovarian cancer (EOC) patients with defective BRCA2 genes and homologous recombination (HR) repair. However, these treatments prove ineffective for recurrent EOC cells that acquire chemoresistance and proficient HR repair. In this experiment, two phosphatase inhibitors were studied to evaluate their potential value as synergistic therapies against BRCA2 wild-type EOC cells in combination with the PARP inhibitor olaparib. EOC cell lines PEO1, with mutant BRCA2 genotype, and PEO4, with restored HR functionality, were used. Two Cdc25 phosphatase inhibitors (BN82002 and NSC663284) were utilized to indirectly inactivate HR repair and sensitize resistant PEO4 cells to olaparib. Cell line responses and inhibitor relationships were measured through cytotoxicity assays and excess over bliss (EOB) calculations. HR repair inactivation was measured through an increase in CDK1/2 phosphorylation during western blot analysis. Phosphorylated CDK1/2 levels increased in both EOC cell lines treated with BN82002 and NSC663284. EOB analysis indicates that BN82002 selectively sensitizes PEO4 cells alone to olaparib while NSC663284 treatment causes significant cell viability declines in both cell lines, indicative of its unknown and non-selective effects on EOC cellular mechanisms. BN82002 exhibits greater potential than NSC663284 as an effective sensitizer of chemoresistant PE04 cells to PARP inhibition and a potential clinical treatment for patients with recurrent EOC. However, NSC663284 may provide benefits for patients suffering from other forms of EOC if properly investigated.

Linking Continued Exposure to E-Cigarette Vapor Constituents with Chronic Obstructive Pulmonary Disease

Hannah Goldenberg
Greenwich High School, Greenwich, CT
Mentors: Mr. Andrew Bramante, Greenwich High School
Dr. Patrick Geraghty, SUNY Downstate College of Medicine

E-cigarette usage is becoming a global epidemic, but the correlation between frequent e-cigarette use, subsequent exposure to yet-to-be identified components, and ensuing respiratory disease remains unexplored. To that end, a hollow 3D-model of an adult lung was created to trap/detect compounds of e-cigarette vapor that enter the lungs as gas and re-condensate with propylene glycol (PG) solvent. Absent of water, 50+ compounds were detected, including nicotine, PG, ethanol, and diacetyl, a flavorant linked to popcorn lung. A correlation between exposure to e-cigarette compounds and COPD was then sought. Human bronchial epithelial cells (HBEs) were exposed to practical concentrations of e-cigarette liquid, nicotine, diacetyl, ethanol, and phosphate-buffered saline; an LDH cytotoxicity assay measured the toxicity of e-cigarette liquid, nicotine, and diacetyl. Increased LDH indicates tissue/cell damage. E-cigarette liquid caused a 32% increase in LDH, while diacetyl caused a 26% increase. Concurrently, the mRNA produced by cells was templated by reverse transcriptase to produce cDNA, which was analyzed for augmentation of genes MUC5AC and MUC5B. Increased MUC5AC/MUC5B is indicative of increased mucin production, which is directly linked to COPD. Increased MUC5AC gene expression was found for diacetyl (1.3x), e-cigarette liquid (2.2x) and nicotine (2.3x). Diacetyl caused 1.2x increase in MUC5B gene expression. A Western Immunoblot of proteins within e-cigarette-treated HBEs highlights a 54% increase of MUC5AC protein that codes for the MUC5AC gene, further supporting increased mucin production and increased COPD risk. Collectively, LDH and MUC5AC/MUC5B increases highlight COPD risk for e-cigarette users.

Control of <u>Varroa destructor</u> Infestation with a Dual-Function, Thymol-Emitting Honey Bee Hive Entranceway

Raina Jain
Greenwich High School, Greenwich, CT
Mentor: Andrew Bramante, Greenwich High School

In the last decade, one-third of all honey-bee colonies have vanished, in Colony Collapse Disorder (CCD). The root cause of CCD has been debated, with focus on pesticides, and varroa mite infestation of hives. Recent literature provides evidence that v.mites feed on fat bodies of the honey-bee, which when depleted, weakens the honey-bee so that pesticides can cause death. Therefore, a simple and effective method to remove v.mites from hives is urgently needed, and is the focus of this research. To

begin, v.mite-infected honey-bees were captured and frozen in liquid-N 2. ATR-FTIR analysis of the mite internal contents, versus the fat body of honey bee provides analytical evidence for v.mite fat body depletion. In phase-two, a beehive entranceway was designed, that released thymol "miticide" onto the bees upon contact, as they enter/leave the hive. The entranceway is dual-function, also time-releasing gaseous thymol into the hive. A 20x20x150mm entranceway, with 13 alternating 9mm circular holes, was 3D printed and coated with a 50/50 (%w/w) mixture of thymol/Hydromed-D in ethanol. The entranceway was placed onto a bee-hive, where bees demonstrated indifference to the entranceway. GC-FID analysis of bee-body for a single-pass highlights as much as 1ug of thymol released onto the bee by contact, so that the thymol LD50 for the varroa mite is easily attained with multiple passes of the worker-bee. Similar analysis of the headspace for the same ~4L hive revealed 6.7µg/L of thymol released, acting as ongoing v.mite control throughout the hive that well surpasses that of the most widely-used thymol varroacide. GC-FID modeling suggests a 2-month lifetime of the entranceway, which is easily replaced without disturbing the hive.

Biofiltration of Ferric Iron Utilizing Citrus Biowaste to Mitigate Freshwater Harmful Algal Blooms

Malcolm Katz
Bridgeport Regional Aquaculture Science & Technology Education Center, Bridgeport, CT
Mentor: Kirk Shadle

Most harmful algal blooms are a result of an excess of nutrients in both salt and fresh waters, causing the spread of toxic cyanobacteria. Every U.S. coastal state and great lakes state experiences Harmful Algal Blooms, which not only affect the health of the people and marine ecosystems but the economy as well. The goal of this experiment is to utilize an economically stable and renewable source to mitigate algal growth. In order to do this, the citrus biowaste of grapefruit, orange and lemon was extracted and will be tested for their capacity to absorb iron. The utmost performing sample will be put to the test with deterring algal growth of Spirulina. The biowaste was dried using a drying oven and minced to a uniform particle size using a pestle and mortar. The lemon, orange and grapefruit were found to contain 206ppm, 4372 ppm and 608 ppm of iron respectively. The stock solution was created using ferric nitrate and distilled water at 1460 ppm of iron. This experiment is being conducted under the hopes of furthering the importance of iron reduction strategies to mitigate freshwater algal blooms and the utilization of citrus fruit biowaste for its absorption potential.

Effect of C-Reactive Protein on the Development of Atherosclerosis in ApoE Knockout Mice

Bradley Kerr
Danbury High School, Danbury, CT
Mentor: Valentina Berger

Heart disease is a serious health issue caused by atherosclerosis, extreme arterial plaque buildup. A possible cause for plaque buildup is inflammation due to C-reactive protein (CRP), which correlates with heart disease risk. To address this concern, I determined if the amount of plaque buildup in arteries depended upon CRP. To test this hypothesis, a mouse model of atherosclerosis was used in which the ApoE protein was knocked out; these mice develop severe plaque in arteries. I used three groups of mice to test this: mice with the ApoE gene knocked out, mice with CRP and ApoE genes knocked out, and control mice. After analyzing arterial plaque buildup of each group, CRP and ApoE double-knockout mice had significantly lower area of plaque than ApoE knockout mice. Additionally, I measured blood cholesterol levels of each group and observed no change between cholesterol in mice with CRP and the CRP knockout mice. This indicates CRP plays a significant role in the development of arterial plaque, the major cause of atherosclerosis. Additionally, the effect of CRP is likely due to reduced vessel inflammation, and not cholesterol. This research supports the possibility that blockade of CRP may reduce human heart disease.

A Versatile, Genetic-Based Cancer Treatment Capable of Selectively Killing Cancerous Cells via the Detection of Single Mutations

Collin Marino
Greenwich High School, Greenwich, CT
Mentor**:** Andrew Bramante

One of the main issues with personalized cancer treatments heretofore has always been the diverse nature of cancer. However, in every type of cancer at least one specific mutation can be identified which contributes to the tumorigenicity. The purpose of this research was to develop a tool for use in precision medicine which can selectively kill the cells containing a mutation of interest. In order to achieve this, the system intercepts a template molecule (mRNA) which the cell is using to produce the tumerogenic protein coded for by the mutation. After intercepting this template, the system then releases a second template

which can code for another protein which can kill the cell or perform any other desired task. In order to test the system, a version of it was made to detect a template coding for a protein known as hTERT and to produce Green Fluorescent Protein (GFP) in its presence. This way, any cells that appeared green upon exposure to the system would represent selectively killed cells in an application where GFP was replaced with a cytotoxic protein. Two cell lines which are hTERT positive and negative (HeLa and IMR90 cells respectively) were then exposed to the system to assess its specificity. As expected, the system only led to the production of GFP in the hTERT expressing cells which strongly implies that the system works as intended. Additionally, when a synthetic hTERT template was added to the hTERT negative cells GFP production was also seen. This further proved the system's dependence on the specified template. Due to the nature of the system, both the hTERT recognition and GFP production can be substituted as desired. This means that in a clinical application, the system could be easily made to detect a template encoding a cancerous mutation, and to kill any cells containing it through the activation of a cytotoxic protein.

Novel Organic Synthesis of Usnic Acid Derivatives with Tumoricidal Properties

Prastik Mohanraj
Engineering and Science University Magnet School, West Haven, CT
Mentor: Roger Rushworth

Over-expressed/induced Cytochrome P450 acts carcinogenic when, in oxidative stress, it produces increased amounts of reactive oxygen species that modify cellular DNA, inducing cancer. Inhibitory chemicals that can target this over-expressed enzyme remain unknown. However, usnic acid is a complex antibacterial agent with the potential to inhibit oxidative phosphorylation, through attacking mitochondrial/microsomal enzymes. This feature can be exploited to inhibit the cancer-inducing over-expressed Cytochrome P450 enzyme. It was hypothesized that modifying usnic acid's structure by making its aromatic ring less electron-rich would allow for redox interactions with Cytochrome P450 that inhibit the enzyme's activity, effectively removing cancerous activity. Various organic reactions at 200°C/20-bar-pressure were performed for a 24-hour constant period within flash reactor conditions. Products were extracted, purified, and characterized using NMR, mass spectroscopy, and chromatography. The product with maximum kinetic rate during synthesis had an acyl-chloride group bound to the aromatic ring, removing electron-rich pi bonds. By exposing PLHC-1 hepatocellular carcinoma cells to this compound and tagging them with the 2EN-ABP proteomic molecule, it was found that the over-expressed Cytochrome P450 decreased in activity in cancer cells. By exposing PLHC-1 cells and healthy hepatic cells to this analog and measuring death rates using flow cytometry with propidium iodide uptake, it was found that cancer cells had a higher induced death rate. These results demonstrate tumoricidal properties in this analog compound. Further research would explore other analogs incorporating electron-withdrawing groups on usnic acid's aromatic ring, and investigate improving the efficiency of synthesizing these analogs, for implementation in future tumoricidal chemical treatments.

Deuterium Oxide (D_2O) on Maintaining Viability in Coliphage Bacteriophages under Low Temperatures to Model live Attenuated Viral Vaccine Additives

Annika L. Morgan
Joel Barlow High School, Redding, CT
Mentor: Katherine Nuzzo, Ph.D.

Live attenuated vaccines are often not stable at normal temperatures, deteriorate quickly and become ineffective. The Ebola vaccine rVSV ZEBOV is one of these vaccines that is damaged due to the molecular movement of the solution it is stored in and can only be stored for long periods of time at extremely low temperature such as -40 Celsius. A bacteriophage acts similarly to the viral particles that are the vector bases for vaccines, and is a good model for how an actual vaccine would react to its environment. Heavy water (D_2O) is made with deuterium, an isotope of hydrogen that is twice as heavy; when viral particles are stored in heavy water this increased weight slows down the molecular speed of the water molecule, causing less trauma to the bacteriophage, therefore increasing the amount of time the viral sample remains infectious. This experiment compares how a sample of Coliphage bacteriophages survives when it is stored at 16 Celsius in heavy water compared to normal deionized water after it has been diluted to a lower tilter. By determining the infectivity tilter of the samples over time using a plaque assay, the degradation of the phage samples can be determined and the effectiveness of D_2O can be measured as an additive for extending the lifetime of a viral sample.

Engineering an Antiseptic Catheter Using a Bioinspired Approach
Abigail Slanski
Amity Regional High School, Woodbridge, CT
Mentor: Kayga Amoako, Ph.D., University of New Haven BMD iLab

Intravascular catheters are thin, flexible tubes inserted into a vein or artery. They are used for many purposes, including blood monitoring and the delivery of medications and fluids. Unfortunately, though, IV catheters are also one of the leading causes of bloodstream infection within hospitals. Infections can lead to longer hospital stays, increased costs, and severe health complications. Treatment currently relies on antibiotics, but the creation of an antiseptic catheter could circumvent these issues entirely. One novel approach has used Nitric Oxide (NO), as it is a compound naturally created within the body for its antibacterial properties. This project aimed to create an antiseptic catheter by functionalizing it with nitric oxide. Polydimethylsiloxane catheters were fabricated using a spin casting method and coated with a mixture of diazeniumdiolate dimethyl-1,6-hexadiamine (DMHD-N2O2), a nitric oxide donor. NO release was measured with a Nitric Oxide Analyzer (NOA) over a period of 48 hours. To test its effectiveness, the experimental catheter and control catheter samples were submerged in a *Pseudomonas Aeruginosa* solution for 24 hours. NOA data showed release for a period of 18 hours. Qualitative observations showed significantly less bacterial growth on experimental catheters as compared to controls.

HPLC Analysis of a Solution of Low-Density Lipoprotein after an In Vitro Interaction with Dietary Supplements (Grape Seed Extract, Hawthorne, Polyphenol)
Isabella Sperry
Weston High School, Weston, CT
Mentor: Stacey Greenberg

Dietary supplements are not required by the FDA to be tested in clinical trials that potentially identify risks and therefore the efficacy of supplements is presumed by the manufacturer rather than proven. This project tests the possibility of a chemical interaction between supplements that allegedly lower vascular cholesterol and a low-density lipoprotein solution by analyzing absorbance as shown by HPLC chromatograms. It was hypothesized that an in vitro interaction between supplements and LDL cholesterol would lower LDL concentration, based on manufacturer's claims. Alternatively, supplements may not affect levels of LDL because in vivo systemic interactions are required. Though this project does not study the effects of supplements on cholesterol carriers while taking into account bodily processes, it may identify trends between the analytes in vitro. LDL was eluted at a flow rate of 1.0 ml/min, acetonitrile-isopropanol (30:70, v/v) on a 5µ, C18 reversed-phase column within 17 min and detected at 210 nm to identify an average retention time of 2.8 minutes which was confirmed with the same sample of LDL diluted 50%. Under the same method and sequence, 20.0 µL injections of 0.025g of Grape Seed extract in 1.5mL of 0.15 M NaCl solution were run to ensure peak clarity around the 3-minute mark. LDL mixed with a detergent serves as a positive control. This experiment seeks to identify the influence of Grape Seed Extract, Hawthorne, and Polyphenol on LDL peak area, which may provide evidence for the importance of clinical trials in dietary supplement production for full transparency of their effects.

Live Cell Fluorescence Imaging Showcases Autophagy in Mammalian Cells when Mitochondria are Depolarized
Shiyun Tang
Glastonbury High School, Glastonbury, CT
Mentor: Dr. Kenneth Campellone, University of Connecticut

Autophagy is a cellular process in which harmful cytoplasmic materials like damaged organelles are sequestered into vesicles called autophagosomes. Fusion of autophagosomes with lysosomes creates autolysosomes to enable degradation of the defective materials and help maintain cellular homeostasis. One specific type of autophagy called mitophagy leads to degradation of mitochondria, cellular organelles that normally produce ATP but can also produce damaging intermediates. Improper regulation of autophagy and mitophagy is associated with neurodegenerative diseases, diabetes, cardiovascular disease, and cancer. A better understanding of autophagy and mitophagy may lead to potential treatments through suppressing or inducing autophagy. My goal was to determine the rates of autophagosome formation, movement, and degradation when mitochondrial membranes were depolarized. LC3, a protein found in autophagosome and autolysosome membranes, was previously tagged with Green Fluorescent Protein and Red Fluorescent Protein to illuminate autophagosomes and autolysosomes. I transfected mouse NIH3T3 and human HeLa cells with RFP-GFP-LC3 to visualize autophagosomes and autolysosomes. Using fluorescence microscopy, I measured changes in autophagosome and autolysosome quantities before and after mitochondrial depolarization in live cells. Initially, HeLa cells had a 4:1 ratio of autolysosomes to autophagosomes, while NIH3T3 cells had similar numbers of autophagosomes and autolysosomes. After depolarization, both cell lines showed increased

autophagosome formation and turnover rates. NIH3T3 cells had larger increases in autophagosome numbers after depolarizing mitochondria, whereas HeLa cells exhibited faster autolysosome and autophagosome mobility. These data provide crucial measurements of autophagosome changes in both cell lines, which is an important step in understanding autophagy.

Real-Time Sinkhole Detection Using Civil Engineering Techniques, the Internet of Things (IoT), and Artificial Intelligence
Sophia Wang
Amity Regional High School, Woodbridge, CT
Mentors: James Wilson and Khushboo Mittal, University of Connecticut

In the United States, 20% of land is susceptible to sinkholes. Designs derived from civil engineering (structural health monitoring system (SHMS) and wireless sensor network (WSN)) and computer science (the Internet of Things (IoT) and Artificial Intelligence/Machine Learning (ML)) were used to more accurately and efficiently detect sinkholes compared to current methods, which are inapplicable to the most dangerous sinkhole type (cover collapse) and are not practiced in real-time. SHMS and WSN were used to create a sensor network that could diagnosis underground structural state in real time. A sensing device which modeled the limestone dissolution process was used to encapsulate the sensor network. IoT was applied to create a user friendly interface, and ML algorithms were developed to analyze data in realtime. ML allowed for system automation. To test the system, a cover collapse sinkhole was physically modeled using karst geology. The sensing devices were placed in set locations prior to simulation. The sensor data was recorded during simulation and ML analyzed in real-time. The ML Algorithms (Neural Network, Naive Bayes, K-Nearest Neighbor, Random Forest, SVM) had high testing accuracy, with Random Forest obtaining a 93% testing accuracy after training. The Algorithms provided for a significant detection period prior to the collapse and served as a prediction model. The detection system accurately and efficiently detected future sinkhole occurrences in realtime, and when advanced, these designs have the potential to not only reduce property damage, but more importantly, reduce the massive public health threat that sinkholes pose.

Fabrication of a Biosensor Using Carboxyl MWCNTs and PTPN22 Antibodies to Detect Antigen Levels through Resistivity Changes
Lila Wells
Greens Farms Academy, Greens Farms, CT
Mentor: Dr. Mathieu Freeman, Greens Farms Academy

Approximately one in five Americans suffers from an autoimmune disease. A common diagnostic option for this is a blood test; however, the propensity for misdiagnosis and inconclusive results is endemic. Biosensors are devices used to detect substances by combining a physicochemical detector with a biological agent. In this study, a biosensor was synthesized using carboxyl-functionalized, multi-walled carbon nanotubes (MWCNTs)—due to their high conductivity and low resistivity levels—and PTPN22 antibodies, as their dysregulation often leads to autoimmune diseases. This project aimed to determine if the biosensor could be used to detect antigen irregularities. The phases of this project were as follows: synthesizing the biosensor, testing in solution with PTPN22 antigen, analyzing results and completing these steps again with 6% functionalized plasma MWCNTs (pMWCNTs). A general trend observed in pMWCNT trials: as the amount of PTP antigen increased in solution, the pMWCNT sensor's resistivity decreased. The most dramatic results were illustrated in the biosensor with 4 µL antibody and .3000 g of pMWCNTs with 10-20 nm diameters: its resistivity decreased from 1.78 to – 1.91 kΩ when placed in 2% and 3% PTP solutions, respectively. When antigen levels in solution were increased, the biosensor's resistivity decreased, indicating that the conductivity of the MWCNT-antibody complex increased as it interacted with the antigen, as conductivity is inversely tied to resistivity. This sensor can potentially be implemented as a diagnostic tool for patients with a family history of autoimmune diseases or those who currently struggle with them.

Angiotensin-II Hypertension Enhances Morphological Alterations of Tight Junctions
Olivia Yoo
Darien High School, Darien, CT
Mentors: Diane Lane, Ph.D., Assistant Professor of Neuroscience, Weill Cornell Medical College

The brain is a major target of hypertension, and high blood pressure is correlated with an increased risk for dementia and stroke. Hypertension, dementia, and stroke are devastating conditions that currently affect millions worldwide, a number that will continue to grow as the global population ages. Previous studies indicate that hypertension induces structural and regulatory alterations of blood vessels, increasing the permeability of the blood-brain barrier (BBB), a key structure that maintains the environment of the brain. The BBB is comprised of twisted tight junctions (TJs) between the endothelial cells of the cerebral

blood vessels, which prevent unregulated substances from entering or exiting the brain. In an effort to discover the mechanism for which hypertension induces this permeability, this study examines the morphology of cerebral blood vessels and TJs in hypertensive and normotensive mice. This blind study examined tissue samples from eight C57BL6/J mice, four that received slow-pressor angiotensin-II hypertension and four that received control treatment. Electron micrographs of blood vessels and TJs were collected. Blood vessel size and TJ length were measured, and the tortuosity index, a measure of how twisted a TJ is, was calculated. There was no significant difference in blood vessel size between hypertensive and control mice. However, the TJs in hypertensive mice were found to be significantly less tortuous than the TJs in control mice. This difference suggests that angiotensin-II hypertension induces morphological changes of the TJs, a potential mechanism for BBB permeability, as less tortuous tight junctions can leave gaps in the BBB.

Characterizing Macrophage and Dendritic Cell Populations in the Germinal Center

Wendy Zhang
Amity Regional High School, Woodbridge, CT
Mentor: Dr. Ann Haberman, Yale University

Macrophages and dendritic cells are both essential to germinal center processes, such as the formation of plasma cells and the development of long-lived memory B cells. However, there is still a lack of understanding involving the protein profile of these two cell types. This research project utilized the newly developed multiplex staining method to identify differing characteristics between dendritic cells and macrophages in the light zone and dark zone of the germinal center. The data, gathered by the mentor, included 49 images of individual stains on a human tonsil. By using spacial information about T cells in the follicles, germinal center B cells, and many different dendritic cell and macrophage subsets, the relative location in comparison to other cell types was considered along with the protein profile. CellProfiler and HistoCAT, both open source software, was used to analyze these images. CellProfiler was used to perform object segmentation using CD45, a protein in all innate immune system cells, to separate the cells in the images for individual cell analysis. This mask was then used in HistoCAT, which generated heatmaps, phenographs, scatterplots, and t-SNEs which categorized the cells into 44 unique clusters. With the extensive information given about macrophages and dendritic cells, conclusions supported a variation of characteristics in different locations of the germinal center. This project has potential to further the current understanding of cellular interactions in germinal centers and how this might promote the formation of long-term memory immune responses, which is essential information for developing effective vaccines.

Combinations of Phloroglucinol, Kaempferol, 3,5 Dimethoxyphenol and 1,3,5 Trimethoxybenzene as Novel Treatments for Non-Hodgkin Lymphoma

David Zhou
Hopkins School, New Haven, CT
Mentor: Prof. Wei Zhu, State University of New York at Old Westbury, NY

Non-Hodgkin's lymphoma (NHL) is a common cancer, killing about twenty thousand people worldwide each year. Existing chemotherapeutic drugs have severe side effects and high cost, limiting their use on lymphoma patients. Many chemicals from plants have anticancer effect but never been studied for the treatment of lymphoma. My project aims to test if these chemicals can work to kill lymphoma cells individually or synergistically. Four of these chemicals, Phloroglucinol(PG), Kaempferol(KF), 3,5 Dimethoxyphenol(DMP) and 1,3,5 Trimethoxybenzene(TMB), were chosen in my experimentation. PG and KF were chosen because of their proven effectiveness in treating other cancers; DMP and TMB were selected due to their similar chemical structures to PG and KF. These chemicals and their combinations were treated on U937 lymphoma cells. MTT assays and cell attachment assays were used to determine the number of viable cells and metastatic ability after treatment and incubation. Significance of results were analyzed using T-test. ImageJ was used to take photos of chemicals and to analyze the proliferation. My test results indicate that all four chemicals have anticancer effects on U937 lymphoma cells; furthermore, combinations of the chemicals are more effective than individual ones. The combination of DMP + TMB at 0.2μM concentration was the most effective, blocking 70% of the cells versus 30% by individual chemicals. My next step is to test the effects of these chemicals with current chemotherapeutic drugs. These findings could lead to further investigation of anticancer effects of chemicals from plants, and potential development of alternative treatments for NHL.

Poster Presenters

The Selective Oxidation of Benzyl Alcohol to Benzaldehyde Using a Mesoporous Vanadium Doped Ceria Catalyst

Ananya Aggarwal
Glastonbury High School, Glastonbury, CT
Mentors: Shanka Dissanayake, Department of Chemistry, University of Connecticut
Dr. Steven L. Suib, Department of Chemistry, University of Connecticut

In this study a mesoporous vanadium doped ceria catalyst was synthesized to help make the production of benzaldehyde more economical, environmental, and safer. Benzaldehyde (C_6H_5CHO) is a compound with numerous industrial applications in pharmaceuticals, cosmetics, and more. Current conventional methods to synthesize benzaldehyde harm the environment, contaminate products, and endanger human health. The selective oxidation of benzyl alcohol to benzaldehyde decreases these issues; however, it is too expensive to implement conventionally. Since known catalysts use expensive metals, here we create a more cost effective catalyst. Our catalysts were mesoporous due to their tunable structural properties, used ceria due to its high oxygen storage capacity (OSC), and used vanadium to enhance ceria's high OSC. This reaction is green chemistry since using hydrogen peroxide (H_2O_2) as an oxidizer created a water by-product. The catalysts were created using a sol gel inverse micelle method and tested for conversion and selectivity rates by heating to reflux for 24 hours. The results were analyzed using gas chromatography and mass spectrometry. Structural properties of the catalyst were tested using nitrogen sorption and scanning electron microscope, and the cubic phases were characterized using Powder X-Ray Diffraction. The 5% vanadium doped ceria catalyst exhibited the greatest conversion of 79% and 100% selectivity without optimization trials. This catalyst also exhibited an intermediate cubic phase between ceria and cerium vanadate and has a 3.41nm pore size. With future studies optimizing this reaction our catalyst will hopefully achieve greater efficiency and potentially be used conventionally.

A Green Nanotechnological Approach for Energy Efficiency and Conservation: Tungsten-doped Vanadium Dioxide Thermochromic Smart Windows

Cynthia Chen
Greenwich High School, Greenwich, CT
Mentor: Andrew Bramante, Greenwich High School

Vanadium dioxide (VO_2) is a "functional material" that has gained notoriety both in fundamental research and smart window applications. It can respond to environmental temperatures, making reversible structural changes from an infrared-transparent semiconducting state to an infrared-translucent metallic state, partially blocking light while remaining transparent. Features of modern buildings like large windows and glass facades are often detrimental to their energy efficiencies. Chromogenic glazing can regulate the inflow of visible/infrared light and solar energy between widely separated limits and hence achieve good energy efficiency. Thermochromic smart windows, which have advantages in terms of simplicity of operation, have been little used in practical applications. In this research, successful efforts have been made to lower the transition temperature to close to room temperature and improve the optical properties of the smart window by doping 1.3% tungsten into the VO_2 thin film. A custom optical bed with calibrated sample heating, and thermal imaging, was built to investigate the thin-film solar light throughput as a function of temperature. The temperature-dependent optical properties were also studied via reflectance and transmittance spectroscopies, in the UV-visible, near-infrared, and mid-infrared regions. Results to date highlight decreases of 25.3% and 12.8% light throughput of the W-VO_2 window in the near-infrared and mid-infrared regions, respectively, with a temperature change from 29-60^oC, relative to non-doped VO_2 -thin-film coated windows. Modelling of overall increase in room heating efficiency versus external house temperature is ongoing, using $8in^3$ model wooden homes with W-VO_2 doped (and control) windows, and constant infrared illumination.

Establishing Limits of eDNA Preservation under Extreme Conditions through Cell Quantification

Rebecca Cohen
Ridgefield High School, Ridgefield, CT
Mentor: Prof. Roderick Wilson, UConn Stamford Department of Biology

The removal of invasive species is crucial to maintaining the biodiversity of ecosystems. The most efficient removal of these species occurs when they are detected early, otherwise they become much harder to remove and can have detrimental effects on their introduced environment. The use of eDNA sample analysis–or environmental DNA: a sample taken from the environment containing secreted DNA–allows for earlier detection. However, eDNA samples are susceptible to degradation which can cause false-negatives. Since freezing is not feasible for preservation in remote locations, buffers such as CTAB and

Longmire's have been shown to preserve environmental DNA samples for up to 150 days at room temperature. To determine whether the less toxic NAP Buffer is effective for eDNA preservation and to quantify a rate of eDNA degradation, human cheek cells suspended in water were used to mimic eDNA. Concentrations of cells were varied, as were temperature and length of exposure to the varying conditions. The use of a PCR reaction followed by gel electrophoresis revealed which samples were degraded past the point of detection. It was concluded that NAP buffer is an effective preservative that does not inhibit the PCR reaction, and that cell concentration in the eDNA sample correlates with low levels of degradation– suggesting that with more DNA present it is less likely that all amplifiable sequences will be degraded. Thus, the use of NAP buffer combined with highly concentrated cells in eDNA samples can greatly decrease the concern of false negatives due to degradation in invasive species research.

Environmental Enrichment to Increase Explorative Behavior in Captive Wolves

Megan Cunningham
Darien High School, Darien, CT
Mentor: Rebecca Bose, New York Wolf Conservation Center

With populations of keystone species and ecosystems deteriorating around the world, it is critical that zoos promote the most natural behaviors in their captive endangered animals to improve their longevity. This study aims to test the effect of environmental enrichment combinations on the frequency of natural, explorative behavior in captive gray wolves. The experiment observed 3 captive subjects of *Canis lupus* over the span of 4 weeks. Observations were divided into 4 enrichment periods - no enrichment, scent enrichment, cognitive enrichment, and scent and cognitive enrichment. Over the four time periods, a total of 4,320 observations were taken, 1,440 behavioral observations for each subject. Instantaneous group scan sampling was used to categorize behaviors at 30-second intervals as one of three categories: Explorative, Stereotypic, and Resting. A standard chi-square test was used to analyze the female and male data separately. The males demonstrated a significant increase in explorative behavior during the combination enrichment time period while females showed no significant change. Techniques that incorporate multiple methods of environmental enrichment can be suggested for other captive mammals, as environmental enrichment that uses a combinations of scent and cognitive methods is the most effective to increase explorative behaviors in captive wolves.

Biowaste of C. Nucifera & G. Max as an Effective Drywash Separation Media for Glycerin in Biodiesel Production

Ethan I. Fancher
Bridgeport Regional Aquaculture Science & Technology Education Center, Bridgeport, CT
Mentor: Kirk Shadle, Bridgeport Regional Aquaculture Science & Technology Education Center

The future development of alternative fuels is critical to the sustainability of our earth. Biodiesel is currently one of the most popular alternatives to natural gasoline and is similar to conventional or 'fossil' diesel. Biodiesel is the only alternative fuel to have fully completed the health effects testing requirements of the 1990 Clean Air Act Amendments. However, the major drawback of Biodiesel is during production, when the process of transesterification occurs. The byproduct glycerin is produced in excess, about 10 kilograms of crude glycogen is produced per every 100 kilograms of biodiesel. Current methods of filtering these byproducts are wasteful and inefficient, I propose a method of drywash filtering utilizing the biowaste of *Cocos* and *Glycine* genera as an effective separation media for glycerin. In my experiment, I have produced small-scale batches of biodiesel subsequently filtered through media. Raw biodiesel is collected and prepped for XRF (X-ray fluorescence) analysis then collected again after being filtered. Data thus far indicates that the glycerin waste material has a high Magnesium oxide content about 6500ppm, while pure Biodiesel contains none. This data will be used as the chemical marker for the purity of the biodiesel. I will be able to determine whether filtration through said media is effective and efficient for future and commercial use.

Magnetically-Positioned, Lipase-Induced Degradation of Arterial Plaques with Simultaneous Smartphone Detection of Post-Dissolution Products

Hiba Hussain
Greenwich High School, Greenwich, CT
Mentor**:** Andrew Bramante

Coronary artery disease (CAD) is currently the leading cause of death worldwide. Current methods of treatment for CAD include bypass surgery, as well as medications to manage the condition. Therefore, a simple, inexpensive, non-invasive, and effective treatment is needed to manage the disease in its earliest of stages. Of late, Fe_3O_4 nanoparticles have gained notoriety as motorized nanocarriers, magnetic sensors, and for targeted therapeutics. Concurrently, human pancreatic lipase is known to

break down digestive fats, and may provide an opportunity for *in situ* arterial plaque degradation. Inspired by innovative sensing of blood glucose levels in real time for diabetic patients, the goal of this research is to first create a motorized, easily maneuverable Fe_3O_4-lipase nanotherapy to remove arterial blockage. Human pancreatic lipase was first loaded onto 10-30nm Fe_3O_4 nanoparticles via a chitosan binding layer, resulting in 400 nm motorized therapeutics, that deliver 3µg-lipase/mg-Fe_3O_4 in 25 minutes. For *in situ* sensing of lipase release, and subsequent dissolution of Fe_3O_4 in the bloodstream, a magnetic sensing filament was created by embedding synthesized magnetite within a conductive carbon thread, and later incorporated onto an NFC-tag. Exposure of the thread-tip to 100µg free Fe_3O_4 nanoparticles decreased thread resistance from 98 to 93Ω, thereby increasing the current drawn from a Smartphone (when reading the NFC-tag) from 43 to 46 mA. Increase in current drawn is interpreted by a new smartphone application against no change for normal *in situ*-blood conditions, and a calibration of nanotherapy Fe_3O_4 delivery concentrations, to determine lipase delivered to the arterial blockage.

Effect of Heat Stress on DNA Methylation in Chlamydomonas reinhardtii

Paul Isaac
E.O. Smith High School, Storrs, CT
Mentor: Dr. Cheryl Granger, E.O. Smith High School

Recent genetic research has revealed the existence of the epigenome, the chemicals and processes that regulate DNA expression. One of the most common epigenetic process is the addition of methyl groups to the DNA to block transcription. In this experiment, we observed how heat stress would affect the methylation of heat shock proteins (Hsp60 and Hsp70) in *Chlamydomonas reinhardtii* (green algae). We used *Chlamydomonas* as its genome had been mapped and sequenced and because algae play a pivotal role in aquatic ecosystems. Water based heat shock was employed due to *Chlamydomonas'* aquatic nature. Two cultures of *Chlamydomonas* were made, the control was placed in room temperature water while the experimental was placed in a 30°C water bath for one hour. Subsequently, the DNA of both cultures was extracted using a Qiagen kit and was purified. These samples were then amplified through conventional PCR and then run through qPCR with methylation sensitive restriction enzymes to determine methylation of the Hsp60, Hsp70, and CBLP genes; the latter being identified as a "housekeeping" gene in other studies that shouldn't methylate. Hsp90 showed a decrease in methylation in the experimental culture and relatively unchanged methylation for the other genes. This procedure was repeated for a second generation, in which similar methylation results were found. There was also no significant change in methylation amount in the control between generations. From this it can be concluded that heat stress does cause an observable epigenetic change but doesn't have significant transgenerational effects.

Determining Whether Bitter Melon Possesses Antibacterial Properties

Keerthi Kongani
Amity Regional High School, Woodbridge, CT
Mentor: Jesse Collins, Yale Spieglar Lab

Today *E. coli* is a major problem in the world. Seventy-three million people are infected with *E. coli* worldwide and five thousand people die every year. As a result it is important to act fast in order to come up with a new cost effective way to treat *E. coli*. Bitter melon is a type of vegetable that is used in South Asian cuisine. The seeds, fruit and leaves of the bitter melon contain antidiabetic properties as well as anti-virulent and anti-fungal properties. This led to the question of whether bitter melon has antibacterial properties. This project tested if bitter melon, in various proportions of rind, inside, and seeds, could kill bacteria. It was hypothesized that if bitter melon was placed on puree-soaked disks, on a lawn culture of bacteria, it will result in the death of most of the bacteria as evidenced by a clearance zone around the disk spots of the culture. Bitter melon was made into proportions by weight. After plating the bacteria and the bitter melon mixtures at the same time on the agar plates, they were checked every twenty-four hours for three days. Trends thus far show that neither the inside nor the exterior of the bitter melon possesses bacteriostatic or bactericidal properties. However, the seeds of the bitter melon showed signs of having bacteriostatic properties, although there are no signs of bactericidal properties. In the future this research's findings can be used in order to slow, or prevent the growth of *E. coli*.

A Model System of the Emergent Effects of Increasing Temperature on Predator-Prey Interactions between Bursaria truncatella and Paramecium aurelia

Manvi Malhotra
Darien High School, Darien, CT
Mentor: Erica Holdridge, Vasseur Lab of Theoretical Ecology

As global temperatures rise, it is essential to study the implications of changing temperatures on the behavior and metabolic processes of species, the relationship between predator and prey, and the ecological food web. This study aims to model the emergent effects of temperature and the addition of predators on population density and stability using the ciliates *Bursaria truncatella* (predator) and *Paramecium aurelia* (prey) in a microcosmic environment. As the temperature increases over intervals of 5℃ from 10℃ to 30℃, previous studies demonstrate increased metabolic processes of the predator, which significantly affect predator-prey interactions. A total of 40 microcosms were prepared for five temperature treatments, with eight microcosms for both predator and control samples. Prey population densities in each sample were measured approximately every 24 hours for 14 days using a dissecting microscope. Without predators, prey populations followed a typical pattern where the cycles dampened over time, occurring more rapidly at cooler temperatures. In the presence of predators, prey were found to be generally less abundant. However, populations tended to fluctuate with temperature; prey still dampened at cooler temperatures but amplified at higher temperatures with greater peaks over time, vaguely following a boom and bust cycle. This study defines how predator-prey interactions change with increasing temperatures and serves as a theoretical model for other keystone species and key elements of the food web, an important ecological investigation into future climate change.

Trx2 Deficiency Induced Impaired Mitochondrial Integrity and Adipocyte Dysfunction

Grace McGonagle
Greens Farms Academy, Westport, CT
Mentors: Dr. Yanrui Huang, Laboratory at Yale Medical Campus
Dr. Mathieu Freeman, Greens Farms Academy

Previous research has been conducted studying the crucial role of the Thioredoxin-2 (Trx2) protein in the mitochondria, and the impacts of its deficiency through mutation. This research explores how those with a Trx2 deficiency mutation may suffer from mitochondrial dysfunction and Type 2 diabetes development. Excess reactive oxygen species (ROS) have damaging effects, such as RNA and DNA damage, the oxidation of fatty acids and amino acids, and the deactivation of enzymes. However, normally, the Trx2 protein prevents the production of excess ROS. Adipocyte (fat cell) dysfunction is linked to Type 2 diabetes. In Type 2 Diabetes, adipocytes cannot control blood glucose balance through adipokine (cell-signaling protein) secretion. Glucose cannot properly enter the cells, preventing energy production, causing insulin and glucose levels to rise in the blood, and leading to mitochondrial dysfunction and insulin resistance. The samples were taken from two groups of mice: the wild type/control mice and the "Knockout" mice (TRX2 gene removed), with varying types of fatty tissue and age groups. Both protein expression and mRNA expression were detected using Western Blotting techniques and real time Quantitative Reverse Transcription PCR (rt-qPCR), respectively. Trx2 deletion resulted in decreased mitochondrial gene expression, Oxidative Phosphorylation dysfunction, impaired lipid metabolism and impaired adipokine secretion. Reduced expression of adipokines indicated an inability to properly control blood glucose balance. This mitochondrial and fat cell dysfunction suggests that Trx2 deficiency leads to Type 2 Diabetes development.

Reducing Skin Cancer with Alpha-Lipoic acid

Athulya Narayanan
Glastonbury High School, Glastonbury, CT
Mentor: Dr. Mary Anne Amalaradjou

Skin cancer represents the most common malignancy reported in the United States, especially in the Caucasian population. Squamous cell carcinoma (SCC) represents the most common skin cancer reported in the US. Although a variety of treatment strategies are available for treating SCC, the incidence of skin cancer in the US has been consistently increasing. Thus, there is a need for novel and effective approaches for treating skin cancer. Alpha-lipioic acid is an organosulfur compound critical for the function of a variety of enzymes that are involved in mitochondria's oxidative metabolism. It is also a potent antioxidant with anti-ageing effects on skin. The objective of my research was to investigate the efficacy of alpha-lipoic acid in reducing skin cancer. Skin cancer cells (SCC) were treated with various concentrations of alpha-lipoic acid (0, 0.25%, 0.50% and 1%) for 24 h and their viability was determined by MTT assay. All tested concentrations of alpha-lipoic acid reduced skin cancer cell viability compared to controls. Additionally, the inhibitory effect of alpha-lipoic acid on skin cancer cells was found to increase with

concentration, with highest anticancer effect produced at 1% level. Currently, experiments to determine the mechanisms behind the anticancer property of alpha-lipoic acid using real-time quantitative PCR are in progress. Moreover, the effect of alpha-lipoic acid on normal skin cells will be determined. This research could potentially yield a novel and safe method for reducing the incidence of skin cancer.

Effect of External Exposure of Low-Intensity Light on Breast Cancer Cell Proliferation with Plexiglass-Bead Radiation Absorption and Emission

Emily Ngo
Academy of Aerospace and Engineering, Windsor, CT
Mentor: Dr. Lili Aramli

The Resonant Recognition Model (RRM) states that an external electromagnetic field at a distinct activation frequency produces resonant effects on protein biological activity. Through two calculations involving Electron-Ion Interaction Potential and RRM Postulates, it can be concluded that the light emitting system used to irradiate the cells should be within the range of 3500nm-6400nm to demonstrate the proposed effects on oncogenes. This study sought to modify current radiation therapy practices by the incorporation of plexiglass beads, a novel approach that disperses light more evenly amongst affected cells. Optimizing the exposure of the cancerous cells to infrared light demonstrates a more effective approach to combatting surface and near-surface tumors. Specifically, this study investigates the effect of plexiglass beads upon implementation towards the expression of the p53 oncogene of cancerous and normal cells. By exposing *Mus musculus* breast cancer and normal cells to the infrared light assisted by the beads, it was found that the proliferation of the cancer cells was hindered more than that of normal cells under the same conditions, which is linked to a difference in protein expression as indicated by conducted tests. The higher induced death rate of the cancerous cells demonstrate the successful assistance of the beads. Further research will delve into the understanding of the overall effect and precise refraction of the plexiglass beads upon implementation.

Testing and Subsequent Optimization of Various Polyphenol Molecules for Effectiveness of Non-Covalent Inhibition of TEM-1 Beta Lactamase in Penicillin-Resistant E. coli Bacteria

Owen O'Reilly
Joel Barlow High School, Redding, CT
Mentor: Prof. Joseph Audie, Sacred Heart University

This project was conducted to explore possible biomolecules that could be used in conjunction with penicillin in order to defeat penicillin-resistant *E. coli* bacteria. It should be noted that covalent, beta-lactam based inhibitors of the enzyme have already been produced and tested; this research focuses on finding an effective non-covalent molecule to take the place of said beta-lactam reliant inhibitors and bond to the enzyme with hydrogen bonds, rather than with covalent bonds. The research was carried out via docking simulations in the molecular modeling program VEGA ZZ. Roughly a hundred polyphenols were docked with beta-lactamase in order to test their binding affinity, or how well they would prevent it from destroying the penicillin molecules. The binding affinity was measured by the strength of the hydrogen bonds formed between a given molecule and the active site of the protein. Rhamnetin and sesamolin were found to have the highest binding affinities for "base" polyphenols, at -9.1 kcal/mol, and subsequent optimization of rhamnetin yielded a molecule with a binding affinity of -10.4 kcal/mol. For comparison, the docking of penicillin with the enzyme resulted in a binding affinity of -7.3 kcal/mol. This disparity in bonding energy suggests that rhamnetin and sesamolin would be especially effective inhibitors of the enzyme, and that the optimized rhamnetin molecule would also be highly effective as an escort. In order to confirm these findings, however, a physical test of the enzyme and the substrate would have to be conducted via spectrometry.

Quasar Luminosity Variability over Right Ascension and Declination

Jillian Paulin, Bethel High School, Bethel, CT
Mentor: Ray Turek, Bethel High School

Quasars are the most distant and luminous objects detectable in the universe. They are so distant that they offer a look into the history and development of early astronomical objects and the universe as a whole. Typical characteristics of quasars include an accretion disk, large amounts of radio emissions, variability, high redshifts, and broad emission lines. Although it is known that quasars vary over time, this study is meant to track patterns related to variability with respect to their location in the sky, primarily right ascension and declination. To track these patterns, the Sloan Digital Sky Survey (SDSS) Data Release 7 was used, specifically the Quasar Time Variability from Large Data Sets, compiled by MacLeod et al. The data used in this study was the northern sample for which three or more observations of each quasar were made. The data was converted into a CSV file using

Excel, sorted by either right ascension or declination, and read into R to create a scatter plot and track patterns. Specific attention was paid to near-infrared wavelengths, represented by the "I" band described by the SDSS. Running tests showed little correlation in variability with respect to either right ascension or declination. However, as an extension, the same data was sorted with respect to redshift, another type of location indicator. The data showed oscillating levels of variance, similar to a sinusoidal function. Although this study did not fulfill its original intention, the results are applicable as another way to study the evolution of quasars.

Optimization of High-Efficiency Organic-Inorganic Lead Halide Perovskite Solar Cells via a Novel Polycaprolactone Additive Pathway

Anisa Prasad and Sirina Prasad
Staples High School, Westport, CT
Mentor: Dr. Miriam Rafailovich, Department of Materials Science and Engineering, Stony Brook University

The recent global energy crisis has resulted in a push for the development of renewable energy sources, most notably solar cells. In 2009, Kojima et al. revolutionized the field of photovoltaics by synthesizing the first perovskite-based solar cell (PSC). Perovskites are semiconducting materials with the crystal structure ABX_3. Techniques used to fabricate these devices, however, result in poor surface morphology. Our goal was to manufacture perovskite layers with fewer defects, resulting in solar cells with higher power conversion efficiencies (PCEs). We investigated the effect of a biodegradable, environmentally-friendly polycaprolactone (PCL) additive on the film quality and photovoltaic performance of methylammonium lead iodide ($MAPbI_3$) PSCs. The devices were fabricated using spin-casting and physical vapor deposition techniques. To characterize the film, we performed scanning electron microscopy, atomic force microscopy, UV-Vis spectroscopy, and X-ray diffraction; to quantify efficiency, we used an efficiency test. Our results indicate that PCL additives control perovskite crystallization rate during film formation and passivate grain boundary defects. The optimal doping concentration, 0.6 mg/mL, increased the efficiency of the device by 39.7% to a PCE of 13.2%. These high efficiency devices fabricated with the novel, biodegradable, and easily-processable PCL dopant suggest its viability as a promising component of commercial, high-efficiency PSCs.

The Effect of Cystic Fibrosis Transmembrane Conductance Regulator (CFTR) On Macrophage Polarization

Siavash Raissi
Amity Regional High School, Woodbridge, CT
Mentors: Hasan Öz, Ph.D. and Emanuela Bruscia, Ph.D., Yale University

Cystic fibrosis (CF) is a chronic, inherited systemic disease, which when affected, creates a viscous mucus, harming the lungs, pancreas, liver, and reproductive organs. CF is characterized by hyper-inflammation and its inability to resolve chronic lung infections, eventually resulting in death. The cause of the disease can be traced to a mutation in the CFTR gene. Little is known how mutations in the CFTR gene affect (pro-inflammatory) M1 and (resolving type) M2 macrophages. Using the monocyte/macrophage cell line THP-1, we want to test our hypothesis that decreased CFTR will impair M2 polarization, and increase M1 polarization. The presence of CFTR served as the independent variable, while the extent of polarization of M1/M2s served as the dependent variable. Therefore, THP-1 cells were split into two groups: one with CFTR intact as the control, and one with CFTR knocked down. The cells were differentiated to macrophages and polarized to M1 or M2 macrophages and M1/M2 specific (m)RNA expression data was collected using qPCR. Although the data collection has yet to be finished, our preliminary results support our hypothesis. Compared to the control group, we observed a greater expression of pro-inflammatory (M1) genes, and a lesser expression of anti-inflammatory (M2) genes in the CFTR-knockdown cells. The findings could help establish a model system for the use of THP-1 cells as a replacement for blood monocytes when studying the effects of cystic fibrosis, as well as illustrate the impact of CFTR on different types of macrophages.

The Effect of Fucosyltransferase-2 on the Binding of E-Cadherin

Arushi Samal
Darien High School, Darien, CT
Mentor: Kristine Nishida, Johns Hopkins Bloomberg School of Public Health

Chronic Obstructive Pulmonary Disorder (COPD), is the third leading cause of death in the United States today, and is characterized by difficulty breathing due to inflammation and a buildup of mucus. Prolonged exposure to cigarette smoke has been proven to be a leading cause of COPD. The epithelial monolayer, the layer of cells that line the airway serves as the barrier between outside pathogens and the lung tissue itself, and are held together by adherens junctions that maintain the integrity of the monolayer. The key protein in this junction is E-Cadherin because E-Cadherin dimerizes to bind to itself, therefore this

experiment aimed to better understand the mechanism of E-Cadherin. Previous clinical data looking at cigarette smoke and the barrier function has shown that fucosyltransferase-2 (FUT2) can affect the function of E-Cadherin. FUT2 adds fucosyls, or sugars, to the protein in question which may change the binding ability of E-Cadherin. First, a FUT2 activity assay was done in order to determine whether FUT2 could act on E-Cadherin in a laboratory setting. After this was confirmed, a nickel-binding assay was used in order to investigate the binding of E-Cadherin to itself, both with the presence of fucsolaytions from FUT2, and without. The data has shown that E-Cadherin has increased binding in the presence of FUT2 demonstrating that FUT2 has a molecular effect on E-Cadherin.

Harnessing Machine Learning and Sentiment Analysis to Predict Future Prices of Individual Stocks

Leonard Tang
Glastonbury High School, Glastonbury, CT
Mentor: Pei Cao, University of Connecticut

This research project aims to develop a novel stock forecasting model through the synthesis of machine learning and sentiment analysis algorithms. In particular, I hope to quantitatively categorize and measure public opinions (e.g. optimism, anxiety, doubt, positivity, neutrality, etc.) pertaining to individual stocks through the sentiment analysis of social media content (e.g. Tweets, Facebook comments, etc.). This analysis, then coupled with a traditional machine learning algorithm, such as a Neural Network, Multivariate Linear Regression, or Support Vector Machine, will hypothetically yield a novel, more precise predictive model. To accomplish this task, I executed four broad steps. First, I scraped the web for time-series company-specific stock price data from Quandl (a platform for financial and economic information, akin to the now-inaccessible Yahoo Finance API), as well as company-specific Twitter mentions. Then, I constructed a Long Short-Term Memory Recurrent Neural Network based solely off the collected stock price data. Afterwards, I utilized BeautifulSoup, a Python library for sentiment analysis, to categorize and assign weight values to each Tweet mentioning the company. Ultimately, I incorporated the sentiment analysis values for the Tweets back into my original Neural Network. As of now, my conclusions are still pending. However, in the near future, I plan on comparing the accuracy of the novel predictive model with previous algorithms. The primary metric of accuracy I intend on utilizing is the Mean Absolute Percentage Error (MAPE), which measures the difference between predicted and actual stock prices.

Synthesizing Water Using the Chemical Reaction of Aluminum and Sodium Hydroxide, Decomposition of Hydrogen Peroxide, and Wastewater Treatment with Liquid Sodium Aluminate (LSA)

Sienna Wang
Amity Regional High School, Woodbridge, CT
Mentors: Dr. Emmanouil Anagnostou, Diego Cerrai, and Peter Watson, UConn Eversource Energy Center

A novel system is needed to synthesize water that is efficient and limits the cost to the environment. To synthesize water, the reaction of aluminum and sodium hydroxide can create hydrogen and sodium aluminate in the chemical reaction: $2Al(s) + 6NaOH(aq) \rightarrow 3H_2(g) + 2Na_3AlO_3(aq)$. The hydrogen created can be combusted with oxygen created in the decomposition of hydrogen peroxide ($2H_2O_2 \rightarrow 2H_2O + O_2$) to synthesize potable water. The chemical reaction to create hydrogen creates the byproduct of liquid sodium aluminate (LSA), which can be used for the removal of phosphorus in industrial wastewater plants. When the wastewater is treated with LSA, the water can be used for irrigation and reintroduces water to the environment. Testing was done using a multi-chambered model. The first chamber contained aluminum and sodium hydroxide. The second chamber contained hydrogen peroxide. The third chamber contained produced hydrogen and oxygen. The fourth chamber contained sodium aluminate and wastewater. This is a water synthesizing and filter system and a proof of concept project. The student designed and did all the aforementioned steps, with help from mentor when attaining and dealing with chemicals. This engineered system successfully synthesized water and served as a wastewater treatment system. The system synthesized 15.34 mL of water when 1 M of the sodium hydroxide and hydrogen peroxide solutions were used. Excess hydrogen peroxide and sodium hydroxide solution remained. Addition of potassium permanganate and raw aluminum could produce additional oxygen and hydrogen gas to further the synthesis of water.

Rapid, Smartphone-Based Diagnosis of Skin Melanoma through Differences in Tumor Cell Thermal Regulation Combined with Diffuse Spectroscopic Analysis

Melissa Woo
Greenwich High School, Greenwich, CT
Andrew Bramante, Greenwich High School

Although melanoma is treatable with early detection, it accounts for nearly 80% of all skin cancer-related deaths. Diagnosis is limited to time-consuming and expensive biopsies, leading to late detection. Recent research suggests, however, that increased metabolic activity of skin cancer cells causes more pronounced heating after external cooling relative to normal cells (15-25^{o}C in 50sec for melanoma versus 15-21^{o}C for normal cells) and that slight color differences distinguish between malignant and benign lesions. This research focuses on the development of a smartphone-based device to easily diagnose a suspicious lesion through analysis of surface temperature change and examination of the diffuse spectrum of the light reflected from the tissue. First, a suspicious lesion is artificially cooled to 15^{o}C and thermal images are obtained for 1min using an infrared smartphone camera. A PCR-thermocycler was adapted and programmed to mimic heating rates of both normal and melanoma cooling. A new smartphone app converts the thermal metadata for comparative analysis against data from skin cancer patients, diagnosing the lesion in seconds. This diagnosis is reinforced by the supporting detection/analysis, where a traditional smartphone image of the lesion, taken through a newly designed-3D printed RGB analysis accessory, is converted to a ratio emphasizing the slight differences in proportions of red, green, and blue levels. This value is compared to internal, standard data for normal and melanoma lesions to confirm the initial diagnosis. With the new RGB -accessory, plug-in infrared camera, and newly written application, a smartphone can rapidly diagnose skin melanoma, with precise, two-fold detection.

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WEB SITE: h.uconn.edu/ct-jshs
E-MAIL: ctjshs.erickson@gmail.com