Fifty-Fifth Connecticut

JUNIOR SCIENCE and HUMANITIES SYMPOSIUM

at UConn Health, Farmington, Connecticut
March 24, 2018

THE ACADEMY OF APPLIED SCIENCE
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		
8:30 – 8:45 a.m.	Welcome		
8:45 – 9:30 a.m.	Keynote		
9:30 – 9:40 a.m.	Break		
9:45 – 11:00 a.m.	1st Oral Session	Competitive Poster Judging	Group A: Health Careers Presentation and Lab Tours or Demonstration
11:00 – 11:15 a.m.	Break Poster Viewing		
11:15 a.m. – 12:45 p.m.	2nd Oral Session	Group B: Health Careers Presentation and Lab Tours or Demo	
12:45 – 1:30 p.m.	Lunch		
1:30 – 3:00 p.m.	3rd Oral Session	Group C: Health Careers Presentation and Lab Tours or Demo	
3:00 – 3:45 p.m.	Judges' Deliberation	STEM Poster Exhibition	
3:45 – 4:45 p.m.		Humanities Activity	
4:45 – 5:00 p.m.	Evaluation and Raffle, then Break or Dismissal		
5:00 – 6:30 p.m.	Dinner and Awards Ceremony		

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

SATURDAY, MARCH 24, 2018

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

OPENING
8:30 – 9:30 a.m. Rotunda

Welcome

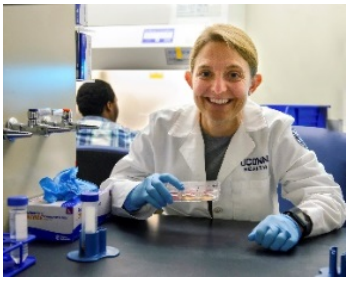
Bruce Gould, MD
Associate Dean for Primary Care
and Professor, Department of Medicine
Director, CT AHEC Program
UConn School of Medicine

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

Briefing

Joy Erickson, MA
Director, CT-JSHS

Keynote Address



Stormy Chamberlain, PhD
Raymond and Beverly Sackler Associate Professor
Department of Genetics and Genome Sciences
UConn Health
"Angelman and Prader-Willi Syndromes:
Looking for cures in the pockets of your genes"

BREAK
9:30 - 9:40 a.m. Refreshments Rotunda Hallway

BLOCK #1
9:45 – 11:00 a.m.

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

Activity	***1st Oral Session (names are directly below)***	***Competitive Poster Judging***	***Group A: Health Careers Presentation and Lab Tours or Demonstration***
Location	Rotunda	Academic Lobby	Massey Auditorium

Poster Presenters

Niti Bidja
North Haven High School
Mentor: Marc Hansen
Identifying the JNK/JUN Signaling Pathway to Block Ras Signaling in VPS4B Null Osteosarcoma Tumors

Onora Brown
Darien High School
Mentor: Amanda Maggio
Discovering the Pathogen Responsible for Gorgonian Wasting Syndrome on the Gorgonia ventalina sea fan

Maia Clarkin
Ridgefield High School
Mentor: Brian Herb
Genetic Mechanisms Regulating Expression of ToR and EGFR Genes in Eusocial and Primitively Social Insects

Adrianna Davis
Ridgefield High School
Mentors: Chad Lane and Joel Fodrie
Using Stable Isotope Analysis to Estimate the Trophic Position of Atlantic Sharpnose Sharks (Rhizoprionodon terraenovae)

Aysa Dunne
Manchester High School
Mentor: Megan Rader
Nurture vs. Nature in Stressed Mice Pups

Jacob Gross
Amity Regional High School
Mentor: Emily Wang
Racial Differences in Free Life Expectancy

Danny Jagoe
Bridgeport Regional Aquaculture Science & Technology Education Center
Mentor: Kirk Shadle
Inhibiting the Formation of Methane Hydrates using Zeolite Minerals and Hydrophilic Polymers in Natural Gas Pipelines

Fiona Jones
Glastonbury High School
Mentor: Brian Jones
Archaeological Soil Samples Taken from Native Grave Sites may Allow Anthropologists to Further Understand Northeastern Native American Burial Culture and Ritual

Tanmay Mehta
Darien High School
Mentor: Anandi Krishnan
Mean Platelet Volume as a Possible Diagnostic Marker for MPN Disorders

Nicole Nguyen
Glastonbury High School
Mentor: Alfredo Angeles-Boza
The Impact of Methoxy on the Nucleophilicity of Re(pyridine-oxazoline)$(CO)_3Cl$ and Its Rate of CO_2 Conversion

Catherine Odendahl
Bridgeport Regional Aquaculture Science & Technology Education Center
Mentor: Kirk Shadle
A Novel Heavy Metal Remediation Technique Utilizing a Photocatalyst Driven Graphene-Cupric Oxide Matrix

Romano Orlando
Greenwich High School
Mentor: Andrew Bramante
Design and Fabrication of a Smart, Medicated Gel Bandage to Deliver Antibiotics to a Draining Wound

Emily Philippides
Greenwich High School
Mentor: Andrew Bramante
Controlled-Release Delivery of Ovarian Anticancer Paclitaxel via Vortex Ring, Donut-Shaped Hydrogels

Abigail Slanski
Amity Regional High School
Mentor: Dequan Xiao
Simulating the Structure of Polymeric Nanospheres using Molecular Dynamics Software

Jack Tajmajer
Amity Regional High School
Mentor: Shipra Bhatia
Regulatory Mutations in the PAX6 Locus as Pathogenic Lesions in Aniridia

Jessica Tan
Cheshire High School
Mentor: Seth Guller
Pyroptotic Cell Death and NLRP3 Response to Infections in Hofbauer Cells

First Oral Session Presenters

Nicole Alindogan
Ridgefield High School
Mentor: Sabine Lang
Functional Impact of RBP2 on Cellular Senescence and Pluripotency in Murine Breast Cancer Cell Lines

Maya Geradi
Wilbur Cross High School
Mentor: Songye Li
Synthesis and Separation of Chiral Compounds in the Preparation of a PET Radiotracer Targeting Synaptic Vesicle Glycoprotein 2A

Carson Halabi
Darien High School
Mentor: Katherine Ineson
Monitoring Northeastern U.S. Bat Colonies for Pseudogymnoascus destructans, the Causative Agent of White Nose Syndrome

Hiba Hussain
Greenwich High School
Mentor: Andrew Bramante
Non-Invasive, Low-Cost Diagnosis of Chronic Obstructive Pulmonary Disease (COPD) via Smartphone Breath Analysis

Jamielyn Iquina
Bridgeport Regional Aquaculture Science & Technology Education Center
Mentor: Kirk Shadle
The Development of a Portable, Kinetic Driven, and Ozone Based Water Purification System for Application in Disaster Relief

REFRESHMENT BREAK/POSTER VIEWING

11:00 - 11:15 a.m. Refreshments Rotunda Hallway

BLOCK #2

11:15 a.m. – 12:45 p.m.

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

Activity	***2nd Oral Presentation Session (names are directly below)***	***Group B: Health Careers Presentation and Lab Tours or Demo***
Location	Rotunda	Massey Auditorium

Second Oral Session Presenters

Raina Jain
Greenwich High School
Mentor: Andrew Bramante
Magnetically Induced, Visual Detection of Trace Arsenic Contaminants in Water Using Fe_3O_4 Photonic Crystal Structures

Sophia Ladyzhets
Glastonbury High School
Mentor: Mayu Inaba
Localized Tkv Degradation Mechanism Maintains Germline Stem Cell and Gonialblast Populations in Drosophila Testes

Samarth Menta
Glastonbury High School
Mentor: Marc Hansen
Role of miR-433 in Osteosarcoma Initiation, Progression, and Drug Resistance

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

Sean Mullin
Joel Barlow High School
Mentor: Edward Faison
The Decline of Fraxinus americana as a Result of Ca^{+2}/Mg^{+2} Depletion in Soil Composition

LUNCH
12:45 - 1:30 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

BLOCK #3
1:30 – 3:00 p.m.

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

Activity	*3rd Oral Presentation Session (names are directly below)*	*Group C: Health Careers Presentation and Lab Tours or Demo*
Location	Rotunda	Massey Auditorium

Third Oral Session Presenters

James Porter
Academy of Aerospace & Engineering
Mentor: Yuan You
The Effect of BRD4 Inhibition on the Proliferation, Migration, and Invasion of Mus musculus Breast Cancer Cells

Siavash Raissi
Amity Regional High School
Mentor: Peiman Hematti
Phenotypic Characterization of Therapeutic Macrophages Using Tissue Specific Exosomes

Tushar Sondhi
Glastonbury High School
Mentor: Jessica Rouge
Engineering an Enzyme-responsive Genetic Delivery Vehicle

Shobhita Sundaram
Greenwich High School
Mentor: Andrew Bramante
Detection of Early-Stage Alzheimer's Disease via Hierarchical Classification of Proteomic and Clinical Profiles

Yuqi Zhou
Amity Regional High School
Mentor: Craig Bailey
Using Storybooks as a Context to Socialize Emotion in Preschool Classrooms

MODERATORS' AND JUDGES' DELIBERATION
3:00 - 4:45 p.m. Classroom A8

STEM POSTER EXHIBITION
3:00 - 3:45 p.m. Cafeteria

To vote for the People's Choice Award:
- Refer to your activity card for the phone number to use.
- Look for the entry number displayed at each poster.
- Text the entry number of the poster you think is best.
- Only one vote per phone allowed.
- Vote between Noon and 4:45 p.m.

STEM Poster Exhibitors

Dina Allam, Glastonbury High School
Adsorption of Antimony Using Mesoporous Alumina: a Comparison to Arsenic

Samuel Applegate, Hamden Hall Country Day School
Effect of Elevation on Patterns of Moisture in a Fallow Cranberry Bog

Connor Brescia, Bethel High School
Deca-Pods

Rhea Dey, Amity Regional High School
The Effect of Regional Disparities and Superfund Sites on Non-Hodgkin Lymphoma Outcome Data

Erin Doris, Bridgeport Regional Aquaculture Science & Technology Education Center
Development of an Early Warning Carbon Monoxide Direct Monitoring Olfactive System

Brian Duffy, Bridgeport Regional Aquaculture Science & Technology Education Center
Development of a Mucin Based Biomedical Adhesive

Natalie Ferrante, Bridgeport Regional Aquaculture Science & Technology Education Center
The Antimicrobial Properties of Stevia rebaudiana Whole Leaf Extract Post In Vitro Digestion

Cynthia Frimmet, Glastonbury High School
Development of an Elastomeric Tubular Device for Pediatric Esophageal Regeneration

Christian Gee, Notre Dame High School
The Effectiveness of Canine EGFR on Dogs

Urwa Hameed, Rockville High School
Polygraph Testing - Its Scientific Authenticity and Legal Complexities

Jinkuk Hong, Bridgeport Regional Aquaculture Science & Technology Education Center
Investigation of Recycled Concrete Aggregates as a Low-Cost CO_2 Sequestration Vehicle through Indirect Mineral Carbonation

Khundker Hossain, Manchester High School
Effect of Ambient Gases on Perovskite Film Stability

Taylor Keyt, Manchester High School
Does the Consumption of Certain Foods Affect Angiogenesis?

Mina Kim, Amity Regional High School
The Impact of Varying Environments on the Degradation of Polylactic Acid (PLA)

Ryan Lemone, Bethel High School
Lowering SLS Costs with Preexisting Solid Rocket Boosters

Jody Liu, Amity Regional High School
Comparison of 14-Day Survival and Development of Lymantria dispar asiatica and Lymantria dispar dispar on Out-of-Season Foliage

William Mergenthaler, Bridgeport Regional Aquaculture Science & Technology Education Center
Synthesizing a Flexible, Conductive, and Biodegradable Polymer Matrix, Containing Graphene and Chitin

Abhi Mohnani, Glastonbury High School
Electronic Stethoscope System for Monitoring and Analyzing Bowel Sounds

Athulya Narayanan, Glastonbury High School
Efficacy of Selenium and Manganese for Controlling Pneumococcal Infections

Rahul Nimmagadda, Greater Hartford Academy of Mathematics & Science
The Effect of Turmeric on p53 Gene Expression in Cancer Cells

Amit Ramachandran, Greenwich High School
Simple Gold Nanoparticle-Based Colorimetric Detection of Escherichia coli in a Tap Water Matrix via Microfluidic Chip Assay

Hannah Rappaport, Amity Regional High School
The Effect of Misophonia on Selective Attention Control

Lizbeth Serrano, Suffield High School
A Novel Approach to Holistic Medicine for Dog Allergies While Helping Aid People with Low-Income Gain Benefits from Having Pets

Alexandra Swift, Darien High School
The Bioaccumulation of Methylmercury in Atlantic Silversides

Christopher Vernal, Darien High School
Creation of a Screening Tool for Assessing Baseball Pitching Biomechanics

Rachel Wagner, Joel Barlow High School
Operation Compost

HUMANITIES ACTIVITY
Bioethics in research and medicine: The story of Henrietta Lacks

- Submit activity cards
- Submit evaluation forms if not staying for the dinner
- Raffle prizes drawn at end of session

3:45 - 4:45 p.m.

Your assigned room and group number (within the room) is on your name tag:

Friends Hall	Patterson Hall	Massey Auditorium

If staying for the dinner and awards ceremony, submit your evaluation after dinner (for final raffles).

EVALUATION AND RAFFLE, THEN BREAK OR DISMISSAL
4:45 – 5:00 p.m.

CHAPERONES: PLEASE RETURN TO THE REGISTRATION AREA TO SIGN OUT YOUR STUDENTS AND OBTAIN PARKING VALIDATION

DINNER & AWARDS CEREMONY

5:00 - 6:30 p.m. Cafeteria

Welcome

Bruce Liang, M.D., F.A.C.C
Dean, UConn School of Medicine
Director, Pat & Jim Calhoun Cardiology Center
Ray Neag Distinguished Professor of Cardiovascular Biology and Medicine

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

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 STUDENTS AND OBTAIN PARKING VALIDATION

Participating High Schools/Programs

Academy of Aerospace & Engineering
Amity Regional High School
Bethel High School
Bridgeport Regional Aquaculture Science & Technology Education Center
Cheshire High School
Coginchaug Regional High School
Conard High School
Darien High School
East Granby High School
Engineering & Science University Magnet School
Glastonbury High School
Greater Hartford Academy of Mathematics & Science
Greenwich High School
Haddam-Killingworth High School
Hamden Hall Country Day School
Hamden High School
Joel Barlow High School
Jonathan Law High School
Killingly High School
Kingswood Oxford School
Maloney High School
Manchester High School
Mercy High School
Middletown High School
New Britain High School
North Haven High School
Notre Dame High School
O.H. Platt High School
Putnam High School
RHAM High School
Ridgefield High School
Rockville High School
Sacred Heart High School
Suffield High School
The Williams School
Wesleyan University's Upward Bound Math-Science
Wilbur Cross High School
William H. Hall High School
Wilton High School

SPONSORS

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

DONORS

- Barnes & Noble at UConn Health (coupons, raffle prizes)
- Panera Bread (raffle prize)

COOPERATING ORGANIZATIONS

- AmeriCorps State Program
- AmeriCorps Service to Improve Community Health (STICH) Program
- Connecticut Association of Secondary Schools
- CT AHEC Urban Service Track/AHEC Scholars Program
- Lambda Kappa Sigma, Alpha Beta Chapter
- 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

- Petra Clark-Dufner, CT AHEC, UConn Health, Farmington, Co-Director CT-JSHS
- Terri Clark, Connecticut Academy of Science and Engineering, Rocky Hill
- Jonathan Craig, Talcott Mountain Science Center, Avon
- Deborah Day, Amity High School, Woodbridge
- Joy Erickson, Director, CT-JSHS
- Robert Erickson, Pratt & Whitney, United Technologies Corporation, East Hartford
- Barbara Fischler, U.S. Army Nurse Corps (retired)
- 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
- Timothy Reid, East Hartford High School, East Hartford
- 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 GUIDES, AMERICORPS MEMBERS, URBAN HEALTH/AHEC SCHOLARS, LAMBDA KAPPA SIGMA, AND ALL OTHER VOLUNTEERS:
THANK YOU !

ABSTRACTS

Oral Presenters

Functional Impact of RBP2 on Cellular Senescence and Pluripotency in Murine Breast Cancer Cell Lines
Nicole Alindogan
Ridgefield High School, Ridgefield, CT
Mentor: Sabine Lang, Yale University School of Medicine

Cellular senescence is a newly discovered metabolic state of a cell where a cell reaches its full size and stably exits the cell cycle. This state is the new goal of cancer treatments, because instead of proliferating uncontrollably, senescent cells stop multiplying and secrete proteins that induce senescence in other cells. Because of this secretory phenotype, Dr. Sabine Lang and I made a lentiCRISPRv2 lentiviral delivery mechanism to knock out RBP2, the gene regulator protein strongly correlated with lower tumor free survival rates, to try to induce senescence, turning cancerous cells into regularly metabolizing cells. Using the CRISPR-Cas9 system, we successfully knocked out RBP2 which induced senescence in our cell lines. In doing this knock-out, we created a new in vitro system that eliminates genetic factors that vary between mice and can affect experimental validity. After establishing that RBP2 was eliminated by the sgRNA using western blotting, I used a quantitative polymerase chain reaction to test the differential expression of the RNA of the different genes affected by RBP2 deletion. From this, we were able to conclude that our hypothesis was supported—absence of RBP2 induces senescence in cancer cells and therefore, viral delivery mechanisms containing the gene edit are viable options for future cancer treatment because personalized therapy targeting RBP2 is advantageous to radiation, chemotherapy, and invasive surgery.

Synthesis and Separation of Chiral Compounds in the Preparation of a PET Radiotracer Targeting Synaptic Vesicle Glycoprotein 2A
Maya Geradi
Wilbur Cross High School, New Haven, CT
Mentor: Dr. Songye Li, Yale University

Positron emission tomography (PET) is a promising technology that utilizes radiotracers for producing detailed, 3D images of the brain, tumors and other parts of the body. The radiotracer studied in this project targets the SV2A receptor in the brain, which is connected to Alzheimer's disease and epilepsy. This project aims to synthesize an enantiopure compound in preparation of a chiral PET radiotracer. The racemic compound was synthesized at -20C and purified using a silica gel column. Reaction progress was monitored by TLC and structure was confirmed utilizing NMR. Conditions required for separation using the HPLC system were optimized by testing varying combinations of organic solvents (0–100%), in conjunction with different chiral columns and flow rates (0.1 –2mL/min). Three chiral catalysts were tested under varying reaction conditions for synthesizing the enantiopure compound. The racemic compound was successfully synthesized and separated using the HPLC system. Full separation was achieved by using ethanol and hexane in a 25%/75% combination, 0.1% TEA, 1.0mL/min flow rate and the CHIRALCEL OJ-H column. Under tested conditions, the Quinidine catalyst successfully yielded a 90/10 enantiomeric ratio. The other 2 catalysts still produced a racemic compound. Currently, the Quinidine catalyst is being tested under new conditions to further improve the enantiomeric ratio. Optimizing synthesis of the enantiopure compound using chiral catalysts could increase yield of the PET radiotracer and lower the cost and reaction time of the synthesis. This increases the viability of this PET radiotracer for diagnostics and research of Alzheimer's disease, epilepsy and other neurodegenerative diseases.

Monitoring Northeastern U.S. Bat Colonies for <u>Pseudogymnoascus destructans</u>, the Causative Agent of White Nose Syndrome
Carson Halabi
Darien High School, Darien, CT
Mentor: Katherine Ineson, University of New Hampshire, Foster Lab

White-nose syndrome (WNS), a cutaneous fungal disease, has killed over 7 million bats since its introduction to North America in 2006. The associated fungus, *Pseudogymnoascus destructans (Pd)*, is psychrophilic, or cold-loving, and strikes bats during their hibernation. When a bat enters hibernation, its body fat content is high to enable it to survive months without daily sustenance. As the fungus irritates the bat and affects its physiological processes, the bat interrupts its lethargic state of torpor frequently. This causes a premature depletion of body fat which ultimately kills the bat. WNS especially afflicts the little brown bat *Myotis*

lucifugus, whose female adults migrate to summer maternity sites in May. We monitored seven such summer colonies in Vermont, Massachusetts, and New Hampshire. A population census was performed, bats were trapped, and individuals were assessed for the following: approximate age, sex, forearm measurement, weight, wing swab for *Pd*, and wing score (condition of wing). We focused on the relationship between the wing score, a visual assessment, and wing swab findings, a molecular assessment. Among bats given a wing score of 0 (no visual evidence of WNS damage), 95% tested negative for *Pd* in the lab. If wing scores are accurate, then DNA processing can be eliminated and accelerate WNS research. Additionally, we analyzed data from the most populous site, and found that the percentage of bats with *Pd* decreased over the summer. The ability of a population to recover from the effects of WNS over a single summer suggests gradual bat resistance.

Non-Invasive, Low-Cost Diagnosis of Chronic Obstructive Pulmonary Disease (COPD) via Smartphone Breath Analysis
Hiba Hussain
Greenwich High School, Greenwich, CT
Mentor: Andrew Bramante

Chronic Obstructive Pulmonary disease (COPD) is expected to become the third largest killer worldwide by 2030. Current diagnosis mechanisms are time consuming and costly, highlighting the need for a more accessible and rapid diagnosis, so that the disease can be treated in its earliest of stages. In this research, a rapid and simple smartphone-based detection of COPD was created. Single-walled carbon nanotubes (SWCNTs) were combined 2-hydroxy-1,1,1,3,3,3-hexafluoropropyl-1-naphthol (HFIPN) in a 2:1 mass ratio, to create a COPD-breath gas specific PENCIL powder. When integrated into a Texas Instruments NFC Tag, and exposed to COPD breath gases isoprene, octadecane, hexanal, and undecane, conformational change in the PENCIL-HFPN selector was realized by an increase in the material's resistivity. Exposure of the PENCIL-on-NFC tag to 1ppb and 1 ppm COPD breath gases caused an increase in PENCIL resistance from 13-13.7kΩ and 12.7-27kΩ, respectively. Change in PENCIL-on-NFC tag resistivity produces a change in current usage that is drawn from a Smartphone, when read by the device, and acts as the basis for COPD detection. After 1 minute of exposure to typical 1ppb concentration of COPD breath gases for an afflicted patient, the Smartphone read of the PENCIL-on-NFC tag drew only 1.5mA of current, which is 3.5mA less than current used under normal, ambient conditions. Increase in PENCIL resistance, and subsequent Smartphone current reduction, was found to be COPD gas specific, and was used to train a new Smartphone application to provide a 4-minute diagnosis for COPD, based on calibration of the circuit's current usage, and its effect on the phone's battery usage.

The Development of a Portable, Kinetic Driven, and Ozone Based Water Purification System for Application in Disaster Relief
Jamielyn Iquina
Bridgeport Regional Aquaculture Science & Technology Education Center, Bridgeport, CT
Mentor: Kirk Shadle

According to the World Health Organization, two billion people drink from a water source contaminated with biological contaminants. Modern technology and innovation have attempted to solve this water crisis through water purification products, improving access to clean water for water-scarce communities. However a majority of these products require a material that must be replaced after multiple uses. This project aims to eliminate that issue by developing a portable, kinetic driven, ozone based water purification system that operates using a 12 volt hand generator as opposed to the 110 volt wattage needed to plug in. The three main components of the purification system involve an ozone generator, air pump, and the 12 volt hand crank. After construction of the water purification system, simulated wastewater was prepared using *Escherichia coli*, (*E. coli*) and distilled water and was put through the water purification system for 15 minutes. Based on the before and after cell counts, the water purification system effectively succeeded in killing 99.9% of *E.coli*. The application of this water purification system can be used not just in communities without access to clean water, but it can also be used in disaster stricken areas.

Magnetically Induced, Visual Detection of Trace Arsenic Contaminants in Water Using Fe_3O_4 Photonic Crystal Structures
Raina Jain
Greenwich High School, Greenwich, CT
Mentor: Andrew Bramante

Arsenic, a highly toxic metal contaminant commonly found in our drinking water, is responsible for many accidental deaths. Currently, the only visual arsenic-in-water detection system is tedious, and can detect arsenic concentrations of 250ppb or more, well above the EPA 10ppb water-action-level. To combat arsenic drinking water contamination, a sensitive, inexpensive, portable, and easily-visualized detection system is needed, and has been developed in this research. To begin, superparamagnetic, SiO_2-coated, polyacrylic acid-capped Fe_3O_4 colloidal nanocrystals (CNC's) were synthesized, and their

photonic and physical properties characterized via SEM and UV-Visible spectroscopy. Application of 80-140G magnetic field from a portable, 3" magnet altered the refractive indices of the photonic structures, so that long-to-short wavelength, red-to-blue color change is easily visualized from the native brown CNC solution color. Addition of 1ml of 10ppb Arsenic, however, to 2ml of 8mg/ml CNCs causes alteration of the photonic characteristics, so that long-wavelength shift occurs with applied magnetic field (native brown to orange). This new color changing behavior is specific to arsenic contaminant, and attributed to As-O interactions at the surface of the SiO_2-coated CNCs. Other typical metal contaminants did not share this same metal-oxide CNC-coating affinity. For the consumer friendly, rapid Arsenic-in-water assay, a color code was developed to detect/indicate as little as 10ppb As-contaminant, with color change at 10ppb increments. In the field, drops of suspect water are added to the CNC solution at 1:2 (v/v) in a small vial; Arsenic contamination is determined in seconds via color change through the application of a small magnet.

Localized Tkv Degradation Mechanism Maintains Germline Stem Cell and Gonialblast Populations in Drosophila Testes

Sophia Ladyzhets
Glastonbury High School, Glastonbury, CT
Mentor: Dr. Mayu Inaba, Assistant Professor, Department of Cell Biology, UConn Health

Drosophila germline stem cells (GSCs) divide asymmetrically to produce one GSC (stem cell self-renewal) and one differentiating gonialblast (GB differentiation). Overabundant GSCs could cause cancerous tumor formation, while insufficient GSCs could promote tissue degeneration. Thus, asymmetric GSC division is crucial for maintaining healthy tissue. GSC self-renewal requires activation of Decapentaplegic (Dpp) ligand secreted by neighboring niche (hub) cells. Dpp receptor Thickveins (Tkv) localizes to GSC microtubule-based (MT) nanotubes. MT-nanotubes protrude into hub cells and facilitate Dpp signal reception. Since Tkv receptor amount remains minimal in GSCs, even during gene overexpression, I decided to investigate the mechanism of Tkv protein degradation as a means of preventing signal overactivation and GB non-differentiation, which leads to tumor formation. My preliminary study demonstrated that preventing MT-nanotube formation increases Tkv concentration within GSCs. Additionally, I often observed that Tkv transfers over MT-nanotubes into hub cells and associates with hub cell lysosomes. Therefore, I hypothesize that GSCs utilize an unconventional MT-nanotube-mediated mechanism of Tkv protein degradation within neighboring cells, instead of own cells (as in other cell types). I found that hub lysosomes, rather than GSC lysosomes, are responsible for Tkv degradation. Tkv-containing vesicle transfer from MT-nanotubes to hub cells is dependent on Smurf-mediated ubiquitination. Furthermore, preventing MT-nanotube formation caused a GSC-like tumor, which indicates that signal specificity is impaired. Taken together, I propose that this novel mechanism of membrane-protein degradation contributes to the short-range nature of niche-stem-cell signaling. These findings create a more complete pathway of Tkv degradation and strengthen understanding of GSC division.

Role of miR-433 in Osteosarcoma Initiation, Progression, and Drug Resistance

Samarth Menta
Glastonbury High School, Glastonbury, CT
Mentor: Dr. Marc Hansen

In children and young adults, approximately 400 new cases of Osteosarcoma (OS) are diagnosed in the United States each year, making it the eighth most common malignancy of childhood (Ottaviani & Jaffe, 2009). It is believed that microRNAs play a key role in cancer processes like bone homeostasis, orchestration of bone programming, and apoptosis. Differences in microRNA-433 expression are present in a number of cancers including ovarian, gastric, and lung cancers. In normal bone cells, miR-433 has been shown to promote differentiation and specialization. The aim of this project was to analyze expression levels of miR-433 in OS cell lines and then manipulate its expression in conjunction with anti-tumor drugs to find the most effective treatment. The steps of this project include isolation of miR-433, analysis of miR expression, and manipulation of miR-433. As of now, I have completed the isolation and analysis of levels of expression of miR-433 using qPCR. After analysis, I will either increase the expression of miR-433 through the means of transfecting a plasmid into the OS cells or I will decrease miR-433 expression by way of a miR sponge, which will remove all of the miR-433. To go even further, I will test how different chemotherapeutic drugs like methotrexate affect miR-433 expression or if the presence of miR-433 affects the effectiveness of these drugs. Essentially, I will be looking to find the best combination of treatments to attack this disease. This research can potentially change how OS is treated and will inspire cancer-related miRNA research.

Novel Organic Synthesis of Usnic Acid Derivatives with Tumoricidal Properties

Prastik Mohanraj
Engineering & 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.

The Decline of Fraxinus americana as a Result of Ca^{+2}/Mg^{+2} Depletion in Soil Composition

Sean Mullin
Joel Barlow High School, Redding, CT
Mentor: Dr. Edward Faison

White ash tree, *Fraxinus Americana,* has shown significant rapid decline in the past several years due to the invasive emerald ash borer (EAB) beetle. The ash trees resistance mechanisms and photosynthesis can possibly be linked to Ca^{+2}/Mg^{+2} for functionality, specifically the secondary phloem, which is the feeding substrate for the invasive EAB. Extreme weather conditions due to climate change have been shown to contribute to deficiencies in the soil nutrients required to maintain a healthy line of defense in the bark. These important cations were studied to determine the availability in trees located in Redding, CT. Soil from various trees with different levels of drainage was analyzed via colorimetric assays for concentrations of Ca^{+2}/Mg^{+2} and compared to their vigor (determined by quality of the leaf canopies, the condition of the bark and branches, epicormic sprouting, and bark damage). Analysis of the canopies, bark, and extreme weather in relationship to the presence (or lack thereof) of Ca^{+2}/Mg^{+2} indicates the overall ability of this tree to come back from decline. Therefore, if the ash tree's ability to maintain its defenses and nourishment hinges on its utilization of Ca^{+2}/Mg^{+2}, possible efforts for remediation of these trees might involve enriching the content of these nutrients in their soil. Otherwise, the failing ash population will continue to drop considerably, putting a dent in the overall tree population in the U.S. that may eventually not be able to be recovered from.

The Effect of BRD4 Inhibition on the Proliferation, Migration, and Invasion of Mus musculus Breast Cancer Cells

James Porter
Academy of Aerospace & Engineering, Windsor, CT
Mentor: Yuan You, Department of Obstetrics and Gynecology at the Yale School of Medicine

In the United States, one in eight women will develop breast cancer over the course of her lifetime. One significant obstacle facing those with breast cancer is the threat of metastasis. Understanding how a cancer proliferates, migrates, and invades is critical to understanding how it can metastasize. BET bromodomain inhibitors are a class of drugs that have shown promise as therapeutic targets for different cancers, including breast cancer. This study sought to describe the proliferation, migration, and invasion of *Mus musculus* breast cancer cells in response to BRD4 inhibition via JQ1. It also sought to describe the effects this inhibition has on epithelialmesenchymal transition (EMT) markers associated with breast cancer metastasis. Using a combination of live cell analysis techniques and protein detection methods, the study furthered understanding of BRD4 inhibition via JQ1 as a potential therapeutic target for breast cancer metastasis.

Phenotypic Characterization of Therapeutic Macrophages Using Tissue Specific Exosomes
Siavash Raissi
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Mentor: Dr. Peiman Hematti, University of Wisconsin

Cardiovascular disease and myocardial infarction are the most common cause of death in the Western world, and has similar mortality rates with some forms of cancer. Thus, novel therapeutic strategies are urgently needed. Our research group has hypothesized that a new form of macrophages (M2s), generated in conjunction with the extracellular vesicles (exosomes) derived from tissue stromal cells (MSCs), can be used to treat cardiovascular disease. To investigate this approach we investigated whether the phenotype of macrophages cultured with cardiac fibroblast (CF)-derived exosomes show greater properties for cardiac therapy than macrophages cultured with bone marrow mesenchymal stromal cell (BM-MSC) exosomes We hypothesized that if a macrophage is cultured with CF-derived exosomes, then the phenotype of those macrophages will depict more properties for cardiac therapy than macrophages cultured with BM-MSC-derived exosomes. Types of exosomes served as the independent variable, the phenotypes of the macrophages served as the dependent variable, and macrophages cultured without exosomes were used as control. Cytokine data using Magplex platform was used to measure expression levels of cytokines secreted by these cells. The results showed a significantly greater expression of EGF in the CF-derived exosome macrophages. It was concluded that macrophages cultured with CF-derived exosomes show a greater expression of properties suitable for cardiac therapy than BM-derived exosome and control macrophages. Knowledge of repair properties can be utilized to synthetically create anti-inflammatory and regenerative medications addressing cardiac repair. This data provides the rationale for testing the effect of our cells in future clinical trials.

Engineering an Enzyme-responsive Genetic Delivery Vehicle
Tushar Sondhi
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Mentor: Dr. Jessica Rouge, University of Connecticut

We are engineering a enzyme-degradable reverse micelle (RM) nanocapsule with the goal of encapsulating long strands of DNA (>100 bp) and delivering it to cells. RMs are nanoparticles composed of surfactants with a positive nitrogen head and a neutral hydrocarbontail, and are synthesized through a spontaneous response when exposed to organic solvents such as dichloromethane. The surface of the RM will also be functionalized through the bonding of short thiolated DNA to its surface via thiol-yne click chemistry. This also facilitates the entry of the RM into the cell, through a mechanism to be investigated using a gold nanoparticle immobilized liposome system as a proxy for a lipid bilayer. We can determine the composition of short thiolated DNA to maximize the efficiency of the cellular uptake of RMs. The RM is hypothesized to condense long DNA through electrostatic forces from the net positive charge of the polyarginine crosslinker, similar to how histones condense DNA in chromatin. We will use Zeta Potential measurements to determine the surface charge of the RM, and polymerase chain reaction (PCR) to determine whether the RM has successfully encapsulated DNA. If the encapsulation is successful, we can conduct further tests to determine the mechanism of DNA encapsulation by changing the crosslinking molecule to have different properties, such as a negative or neutral charge. The ability to encapsulate long DNA within these RMs is extremely important, as this will provide a reliable method to deliver long DNA, such as genes, to specific cells within the body.

Detection of Early-Stage Alzheimer's Disease via Hierarchical Classification of Proteomic and Clinical Profiles
Shobhita Sundaram
Greenwich High School, Greenwich, CT
Mentor: Andrew Bramante

Alzheimer's disease (AD) is a neurodegenerative, fatal brain disease characterized by impairments in memory, language, reasoning, and cognition. Identifying AD in its earliest stages of Mild Cognitive Impairment (MCI) allows patients access to the best possible treatments, and time to make crucial caregiving and financial decisions. Currently, no accurate diagnostic tests exist for early-stage AD; internationally just one in four patients are diagnosed. In this study, the development of a machine learning tool to accurately diagnose AD and identify high-risk MCI patients is proposed, using neuropsychological and blood proteomic profiles. A novel two-layer hierarchical framework was designed: The first layer diagnoses patients as healthy, MCI, or AD, and the second layer analyzes healthy/MCI patient profiles to predict future AD onset. A database of 560 patients was used to build the first model, and a subset of 368 patients was used for the second model, using multiple observations per patient across a 12-month time-span. For each classification layer a multi-pronged approach was developed to extract the most relevant biomarker data from patient profiles, integrating both univariate and multivariate methods. Upon evaluation the first

model diagnosed patients with a 92% ROC accuracy, based on linear components extracted from proteomic profiles. The second model then predicted future AD onset for current MCI patients with a 90% ROC accuracy within a 6-48-month timeframe, using biomarkers selected from both proteomic and neuropsychological profiles. These results far outperform prior research and indicate that this tool will provide a low-cost, minimally invasive method of detecting early-onset AD.

Using Storybooks as a Context to Socialize Emotion in Preschool Classrooms
Yuqi Zhou
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Mentor: Dr. Craig Bailey, Yale Center for Emotional Intelligence

Emotional competence is one's ability to understand, display, and regulate emotion. This study explored how teachers use storybook read-alouds to socialize young children's emotional competence. Along with teachers' emotion socialization strategies, demographic and psychological variables were explored. Preschool teachers were first asked to complete an online questionnaire regarding their demographic information and assessing their psychological characteristics. Then, teachers were provided with materials, instructions, and a package of four early childhood storybooks. Teachers were asked to "read" the four storybooks during their typical classroom story reading times and audio record these "readings." Recordings were analyzed using Parent-Child Affect Communication Task (PACT) for teacher's usage of emotion vocabulary and their emotion socialization strategy. After each reading, teachers asked questions evaluating children's emotion knowledge and understanding of the book. Data was analyzed using linear regression. It is hypothesized that there will be a relationship between teachers' psychological characteristics and teachers' strategy of emotion socialization, a relationship between teachers' demographic characteristics and teachers' strategy of emotion socialization, and lastly, a relationship between teachers' strategy of emotion socialization and children's knowledge of the story and emotion knowledge. Results may provide a better understanding of how emotions are socialized in classrooms and provide teachers guidance in language they use while engaging in storybook read alouds.

Poster Presenters

Identifying the JNK/JUN Signaling Pathway to Block Ras Signaling in VPS4B Null Osteosarcoma Tumors
Niti Bidja
North Haven High School, North Haven, CT
Mentor: Dr. Marc Hansen, UConn Health

Osteosarcoma is a primary type of bone cancer, most common in teenagers and accounts for 7% of all adolescent cancer. In 1984, a combination of therapeutic approaches and chemotherapy improved the survival of Osteosarcoma patients by about five-years; however, patient outcomes have not improved notably since then. There is a need for further research on new approaches to target the tumors in Osteosarcoma patients. Dr. Hansen's lab at the University of Connecticut Health Center focuses on a synthetic-lethal approach where inhibitors are created to block signaling pathways in the tumor cells, thus inducing apoptosis in the treated cells. Knowing that the tumors rely on Ras signaling to grow, this experiment was performed to determine which signaling pathway the cells are using. My experiment used Western blotting to prove tumor cells are using the JNK/JUN signaling pathway as a means to function. Proteins in U2OS and SAOS2 Osteosarcoma tumor cells were first separated by gel electrophoresis and transferred to a membrane. The membrane was processed with the Anti C-JUN antibody specifically to target the C-JUN protein. Images from a ChemiDoc Imaging System revealed a protein band around 36 kDa. Thus, I concluded that Osteosarcoma cells expressed the C-JUN protein and use the JNK/JUN signaling pathway to function.

Discovering the Pathogen Responsible for Gorgonian Wasting Syndrome on the Gorgonia ventalina sea fan
Onora Brown
Darien High School, Darien, CT
Mentor: Amanda Maggio, Institute of Marine and Environmental Technology

Corals are important ecosystems because fish live and feed on them, while people in the fishing and tourism industries rely on healthy reefs for their livelihoods. Over the past few decades, coral cover has decreased at extreme rates because stressors like climate change have led coral reefs to become vulnerable to pathogens that cause coral disease. Currently, an outbreak of the coral disease "Gorgonian Wasting Syndrome," identified by lesions of decaying necrotic tissue, has affected the *Gorgonia ventalina* sea fan species in Puerto Rico. This experiment ultimately aims to identify the pathogen responsible for Gorgonian Wasting Syndrome. During the summer of 2017, I created a physical and electronic library of possible pathogens by crushing,

diluting, and spreading both healthy and diseased samples of *Gorgonia ventalina* on agar plates. After incubation, I counted colonies and picked out isolates differing in size, color, and shape, resulting in 140 isolated colonies. The colonies were placed in nutrient broth and glycerol for long term storage. The sample's DNA was manually extracted to run a PCR and Gel Electrophoresis, the results were then processed into an electronic pathogen library. After analysis of the bacterial communities, it was found that pathogens from the vibrio genera may be responsible for Gorgonian Wasting Syndrome because the vibrio genus is prevalent on both healthy and diseased samples. Future work testing each of the pathogen isolates on healthy *Gorgonia ventalina* samples needs to be completed.

Genetic Mechanisms Regulating Expression of ToR and EGFR Genes in Eusocial and Primitively Social Insects

Maia Clarkin
Ridgefield High School, Ridgefield, CT
Mentor: Dr. Brian Herb, University of Illinois at Urbana-Champaign

Social insects display division of labor and the formation of distinct behavioral subcastes. Greater flexibility with physical morphologies is thus a characteristic of highly social insects, whose specific responsibilities within a colony cause all members to rely on one another. This research explores the genetic regulatory mechanisms that have influenced the development of sociality in bees and ants of the order Hymenoptera, analyzing differences and similarities in transcription factor binding sites (TFBS) within the promoter regions of the target of rapamycin (Tor) and epidermal growth factor receptor (EGFR) genes. These two genes are key to cell growth and development. Depending on their regulation, an organism may lose or gain phenotypic plasticity. The DNA sequences of both genes' promoter regions in ants and bees that were highly social, semi-social, and primitively social were retrieved from the National Center for Biotechnology Information and used to generate a DNA sequence alignment. The sequences were then input into a program called Find Individual Motif Occurrences to locate transcription factor binding site motifs. It was found that *Apis mellifera* and *Apis dorsata*, the two highly social bee species, had the greatest amount of TFBS commonalities. In the ant species, only the highly social ants' ToR yielded TFBS commonalities. These results support the hypothesis that highly social bee species only and highly social ant species only will yield the greatest amount of TFBS commonalities. The more socially complex an insect, the greater the number of TFBS, or genetic mechanisms, it needs to regulate its genome.

Using Stable Isotope Analysis to Estimate the Trophic Position of Atlantic Sharpnose Sharks (<u>Rhizoprionodon</u> <u>terraenovae</u>)

Adrianna P. Davis
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Mentors: Dr. Chad Lane, UNC at Wilmington and Dr. Joel Fodrie, UNC at Chapel Hill

Populations of sharks, apex predators who play an important role in ocean biodiversity, have been decreasing due to human activity. Studies on shark diet are often facilitated through stomach content analysis, which does not give an accurate representation of long-term feeding behaviors and requires a necropsy. The purpose of this study is to use stable isotope analysis to assess the feeding patterns of Atlantic sharpnose sharks (*Rhizoprionodon terraenovae*). Blood was sampled from sharks caught and released from the University of North Carolina at Chapel Hill's Institute of Marine Sciences' (UNC-CH IMS) boats. Approximately .7cc of blood was taken from the caudal vein of the sharks using 25 gauge 1-1.5" needles before being put into collection tubes with lithium heparin. Samples were centrifuged and freeze dried at the University of North Carolina at Wilmington's Center for Marine Science (UNCW CMS). Of the freeze dried samples, .5 mg were processed using a mass spectrometer. The resulting isotopic ratios ($^{13}C/^{12}C$ and $^{15}N/^{14}N$) expressed as δ values provide valuable information on the differences between the diets of juvenile and adult sharks. Two sample, two-tailed T-tests determined that there was little variability between the two age groups, and calculations of their trophic positions suggested they eat at the same trophic level. Overfishing is a great threat to sharks and in order for researchers to understand the evident importance of sharks in marine ecosystems, more studies need to be done on shark diet. A better understanding of shark feeding patterns will more successfully protect shark populations.

Nurture vs. Nature in Stressed Mice Pups
Aysa Dunne
Manchester High School, Manchester, CT
Mentor: Megan Rader

Children who grow up in extremely stressful environments often have undeveloped cognitive skills. For instance, a child who is very stressed will often have a much worse memory than a child who only has a healthy amount of stress. In addition, it has been proposed that when a nursing mother is stressed, the cortisol that passes through the milk may affect the brain development of her infants. So the children growing up in war areas are being put under immense stress from multiple factors, which is often very harmful long term. On the other side, it has been shown that when children are nurtured and cared for beyond the very basics of life often succeed more in life. So this raises the question, can nurturing offset the dangerous effects of cortisol? Using stressed mice to simulate mothers raising infants in war zones, I propose that the group of stressed mice who received a higher level of nurturing will have better cognitive skills later in life. By doing this, it is hoped that the chances of babies growing up in traumatizing environments can develop with unharmed memories and cognitive skills.

Racial Differences in Free Life Expectancy
Jacob Gross
Amity Regional High School, Woodbridge, CT
Mentor: Dr. Emily Wang

There are significant disparities between white and black males in the U.S. in both incarceration and life expectancy (LE). The purpose of this project was to create a new measure to analyze these differences. The measure is called free life expectancy (FLE), and represents the amount of time a person is expected to live while not incarcerated. Disparities in both LE and FLE were measured at the national and state level. It was hypothesized that African-American males would have a substantially shorter FLE than whites at the national level, and that FLE would vary across states. This project used data from the 2015 Bureau of Justice Statistics Bulletin, the 2010 National Vital Statistics Report, and *The Sentencing Project*'s online database of incarceration rates. FLE was found using a standard life-table approach. The total number of free years lived was found, and averaged to find the FLE. Eleven states with reliable life expectancy estimates were analyzed, as well as at the national level. Results indicate the veracity of both hypotheses. At the national level, black males spent 375% more time incarcerated than white males. The average disparity in LE was 6.36 years and the average disparity in FLE was 7.74 years. In nine out of the eleven states, there was a larger disparity in FLE than in LE. There exists no correlation between state LE and state FLE, indicating that FLE is not simply a function of LE. FLE is a novel measure that carries important implications towards disparities in our society.

Inhibiting the Formation of Methane Hydrates using Zeolite Minerals and Hydrophilic Polymers in Natural Gas Pipelines
Danny Jagoe
Bridgeport Regional Aquaculture Science & Technology Education Center, Bridgeport, CT
Mentor: Kirk Shadle

Methane hydrates pose a direct threat to the integrity of natural gas pipelines. Methane hydrates are formed within the high pressure and low temperature environments of the pipelines when water is present. Removing the water from the pipelines and creating a pure methane stream will eliminate the risk of methane hydrate formation. It is proposed that zeolites and hydrophilic polymers will provide a means to the absorption of water. The zeolites and hydrophilic polymers were tested using an inline gasification system. The mass differentials of the zeolites or hydrophilic polymers divided by the mass differential of the water along the gasification system calculate the efficiency of absorption for the zeolites and polymers. The zeolites and hydrophilic polymers had efficiencies of 42.57% and 4.88% respectively. Future research will be done on the porosity of the zeolites, along with the chemical structure of the hydrophilic polymers.

Archaeological Soil Samples Taken from Native Grave Sites may Allow Anthropologists to Further Understand Northeastern Native American Burial Culture and Ritual
Fiona Jones
Glastonbury High School, Glastonbury, CT
Mentor: Dr. Brian Jones, Connecticut State Archaeologist, University of Connecticut

By researching archaeological soil samples, my goal was to learn more about generally unknown topic- northeastern Native American grave rituals. I am using soil samples taken from the Morgan Site, a Native grave site in Rocky Hill, CT, that was dug

from the mid 1980's to early 1990's. I have sifted, organized, and statistically analyzed over 50 soil samples from one particular feature of the site, labelled Feature 68. This was the grave site of a Native American man who lived in the mid 1300's, and died when he was about 55 years old. Along with the notes and artifacts I have accessed, the compiled information is important for one main reason: increased cultural preservation for Native peoples. Research in this field could bring more attention to the mistreatment of cultural and burial preservation and make for more laws around this topic. An increased knowledge in this field of study, one that is mostly unknown, and further brought upon by my research, could make way for better laws surrounding Native American rights and grave repatriation.

Mean Platelet Volume as a Possible Diagnostic Marker for MPN Disorders

Tanmay Mehta
Darien High School, Darien, CT
Mentor: Dr. Anandi Krishnan

Myeloproliferative neoplasms (MPNs) are blood cancers in which the bone marrow produces an excessive amount of white blood cells, red blood cells, or platelets. If the diagnosis of this disorder is delayed, this blood cancer could lead to acute leukemia which lowers patient survival considerably as reflected in a 10-year study. Past research has indicated that a high Mean Platelet Volume (MPV) could be a possible diagnostic tool for this disease because a higher MPV signifies that there is an influx of young, immature platelets. To analyze the correlation between MPV and MPNs, this study analyzed 139 blood samples from 86 patients of the three MPN types: polycythemia vera (PV), essential thrombocythemia (ET), and primary myelofibrosis (PMF) with the Cell Dyn 1800 Hematology Analyzer. Using the TI-84 Plus calculator and Analysis Toolpak from Excel 2003, histograms and a T-test were conducted to determine if there was a statistically different MPV value between the MPN and healthy patients. This study also determined whether there were notable differences in the MPV between the three types of MPN patients. The results of this study indicate that the MPV value of PV patients are in the low to normal range (7-10 fL), ET patients in very low range (6-7 fL), and PMF patients in mostly normal range (6-9 fL). This study suggests an inverse correlation between platelet activity of MPN disorder and MPV (more platelets, lower MPV), indicating that MPV value could be a biomarker for MPNs quickening the diagnosis and treatment of them.

The Impact of Methoxy on the Nucleophilicity of Re(pyridine-oxazoline)$(CO)_3Cl$ and Its Rate of CO_2 Conversion

Nicole Nguyen
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Mentor: Alfredo Angeles-Boza, University of Connecticut

The amount of carbon dioxide in the atmosphere has been steadily increasing since at least the 1960's. This has led to a growing concern about its effects on global temperature which threaten to destabilize the earth's delicate biosphere. There has been extensive prior research into the capabilities of transition metal complexes as catalysts in the electrochemical reduction of CO_2 to CO, a compound with a variety of uses, especially in fuel. However, the rate of the reduction is not fast enough for it to be feasible to put to use on a global scale. I sought to synthesize a rhenium complex with improved CO_2 reduction capabilities than previous catalysts. A version of the bipyridine ligand was synthesized first with the addition of a functional methoxy group, and then the metal complex Re (pyridine-oxazoline)$(CO)_3C$ was synthesized with the ligand. The ligand synthesized was 2-(6-methoxypyridin-2-yl)-4,5-dihydrooxazole. The metal complex will be analyzed for its CO_2 reduction abilities using gas chromatography and cyclic voltammetry. I hypothesize that due to methoxy being an electron donating group, the ligand and therefore the rhenium complex will have an increased electron density, which will reduce the reduction potential and increase the rate of reaction. Data collection and analyzation is currently ongoing, and results can be valuable to the scientific community by helping researchers get a better understanding on methods and mechanisms that can be used to effectively reduce CO_2 to CO.

A Novel Heavy Metal Remediation Technique Utilizing a Photocatalyst Driven Graphene-Cupric Oxide Matrix

Catherine Odendahl
Bridgeport Regional Aquaculture Science & Technology Education Center, Bridgeport, CT
Mentor: Kirk Shadle

Heavy metals contaminate soil through mining, manufacturing, and the use of synthetic products within the proximity of the soil. Current methods of remediation are high temperature treatments and a washing process. Although these methods are effective, they require copious amounts of energy, time, and money. Both treatments require the soil to be transported from its source to a factory and be treated. It is proposed that using a photocatalyst driven graphene-cupric oxide matrix is needed. The matrix will capture and trap the metal ions by using the cupric oxide as a photocatalyst, therefore changing the properties of the metals to

be less harmful. Experimentation will be conducted using: a control (untreated), soil with the heavy metal contaminate, soil with the heavy metal contaminate and graphene-oxide, and soil with heavy metal contaminate, and the graphene-cupric oxide solution. Rye grass will then be grown in each environment and analyzed. Rye grass is known to uptake heavy metals if they are present in the soil. Infrared spectra will be performed before and after to determine the concentration of lead ions in each solution. The initial concentration of the heavy metals will also be compared to the final concentration, using atomic absorption. Atomic absorption uses a standard curve with known concentrations to determine the unknown concentrations. Future applications include fixation of heavy metals in soil to prevent movement in the soil system.

Design and Fabrication of a Smart, Medicated Gel Bandage to Deliver Antibiotics to a Draining Wound

Romano Orlando
Greenwich High School, Greenwich, CT
Mentor: Andew Bramante

For adhesives and wound dressings, consumer options are limited. Besides flexible Band-Aid strips, the only other inexpensive option for wound coverage is a liquid bandage. Although liquid bandages are better than their solid counterparts at covering an affected area, as their contact interface is more complete, they are still plagued by a common deficiency: the wound receives little to no assistance to fight initial-trauma bacterial infection, other than coverage from outside contamination. In this research, a *Smart*, medicated gel bandage was created that would release antibacterial agents into the wound while solidifying, then provide hardened protection, and subsequently release antibiotics only during additional periods of drainage, when it is needed most. To create the novel dressing, 65mg of tetracycline (Tc) was embedded into 210mg of HydroMed-D, an ether-based hydrophilic, biocompatible urethane, creating a gel-like formulation that is applied via a squeeze tube. When administered, the Smart bandage dries in 5 minutes, releasing Tc during that time of initial wound drainage. Once dry, it provides durable structural support for a cut/abrasion that is far improved relative to a stick-on cloth bandage. During the subsequent dry healing (scabbing), the Smart bandage retains significant Tc load, and can release it should drainage reoccur, further increasing the effective life and infection-fighting ability of the bandage. For a cut that is covered with a traditional Band-Aid, 210mg of the Smart bandage will deliver up to 42µg of tetracycline to the localized area as needed, as a function of (cut) bleeding, or drainage.

Controlled-Release Delivery of Ovarian Anticancer Paclitaxel via Vortex Ring, Donut-Shaped Hydrogels

Emily Philippides
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Mentor: Andrew Bramante, Greenwich High School

Ovarian cancer affects hundreds of thousands of women worldwide. Unfortunately, systemic chemotherapy for treatment of ovarian cancer necessitates one-time super dosing, leading to the onset of severe side effects, and like radiation therapy, causes the destruction of neighboring, healthy cells. A method where chemotherapy is temporarily implanted at the cancer site and subsequently time-released would be preferred, to both adhere the drug to the tumor and minimize side effects associated with immediate overdosing. Here, such a device is engineered, via donut-shaped hydrogel vortex rings that are formed and loaded with a chemotherapy agent. Specifically, 750µg of paclitaxel (PAC) is dissolved in 1ml aqueous 2% sodium alginate, a droplet of which is then injected into a 5mM $CaCl_2$ and 95mM $MgCl_2$ buffer to create a 1mm vortex ring hydrogel, with a 7.5µg drug load. Under simulated ovarian conditions, each sticky, PAC-loaded vortex ring steadily releases its chemotherapy load, so that 50% (3.8µg) is released in 4 hours, with up to 5.4µg delivered in a maximum of 20 hours (72% release), post-application. Simulation of pointed placement of the PL-VRH donuts, their adherence to a cancerous tumor in the ovarian cavity, resistance to movement due to aqueous conditions, and subsequent release of the paclitaxel to the targeted region, was carried out using a porcine intestine membrane model. For delivery of a localized PAC dosage that concurs current IP injection (342µg for a typical 57cm^2 ovary), it was determined that ~60 hydrogel vortex rings can be directly delivered to the ovarian site via 600µl injection of medicated precursor, ensuring direct and extended interaction of the chemotherapy agent with the targeted cancer cells.

Simulating the Structure of Polymeric Nanospheres using Molecular Dynamics Software

Abigail Slanski
Amity Regional High School, Woodbridge, CT
Mentor: Dequan Xiao

Recently, a new type of hollow nanosphere was fabricated using poly(acrylonitrile)-stat-poly(4-vinyl-pyridine) (PAN-stat-P4VP) bound with azobenzene complex metanil yellow (MY) through self-assembly. These have gained attention in the biomedical world for their use in drug delivery and unique photoresponsive properties. In order to use these nanospheres effectively, the

detailed chemical structure of the nanospheres must be known. However, an accurate, representative model has yet to be made. This project aimed to create a model of PAN-stat-P4VP/MY hollow nanospheres using Avogadro and molecular dynamics software. Avogadro was used to build polymer chains atom by atom and optimize their geometry. PACKMOL was then used to recreate the observed spherical structure. Finally, NAMD2 was used to relax the geometry of this structure and ensure the representation would be accurate to life like conditions. This simulation will be a useful tool in future development of these nanospheres and can be used in determining their best uses. This simulation is an important step in taking polymeric nanospheres to a level where they can be used to deliver lifesaving drugs.

Regulatory Mutations in the PAX6 Locus as Pathogenic Lesions in Aniridia

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Aniridia is a congenital eye disorder caused by mutation in the PAX6 gene region. Victims suffer from compromised vision and other complications. The PAX6 region has been important for understanding the control of gene expression. This research study investigated the roles specific mutations in PAX6-Cis-regulatory elements, which control and monitor genes, have in Aniridia and other disorders. In this study, zebrafish were used. The independent variable was the type of gene (SIMO, CRE1, CRE2, and CRE3) inserted. The dependent variable identified the cell-types and times during development where CRE function was altered by mutation. It was hypothesized that mutations would affect PAX6 expression. Each of the genes was crossed with a fluorescent protein to visually mark the mutation, and these genes were then inserted into the zebrafish through a dual color transgenesis strategy. Live imaging was then used to study the zebrafish from 18 hours to 5 day post fertilization. DNA of Aniridia patients was then synthesized to discover the actual locations of these genes in a human. The data, overall, served to uncover the location, characteristics, growth rate, and impact of the genes and their mutations. Results showed that all the genes are highly susceptible to mutation, and all characteristics of the genes and mutations were recorded successfully. They experienced live imaging from 18 hours to 5 days post fertilization. Implications of this include the assignment of pathogenicity to Aniridia-associated CRE mutations. The understanding of the genetics of Aniridia is also enhanced, which enables diagnosis and counselling for patients.

Pyroptotic Cell Death and NLRP3 Response to Infections in Hofbauer Cells

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Hofbauer cells (HBCs) are placental macrophages that are present in the villus throughout gestation. Recent studies have indicated that alterations in the number and gene expression of HBCs may play a role in cytokine-mediated inflammation in placenta. Pyroptosis is a form of rapid cell death mediated by NLRP3 inflammasome. It has been shown that pyroptotic cell death can be triggered by bacterial endotoxin lipopolysaccharide (LPS) and adenosine triphosphate (ATP), which has been primarily studied in peripheral macrophages. However, the potential role of LPS/ATP in pyroptotic cell death in HBCs is not clear. The aim of this study was to explore the response of HBCs to LPS/ATP in vitro and the mechanism of pyroptotic cell death and inflammasome function. HBCs were isolated from human term placentas with high yield and purity. The cells were treated with LPS and ATP, respectively and in combination, to examine their effect on the LPS/ATP-induced pyroptosis by microscopic examination, LDH assay, and Capases-1 Glo assay to measure morphological change, cell death, and caspase-1 enzyme activity, respectively. The synthesis and secretion of cytokine IL-1β were examined by Western blot and ELISA. Preincubation of HBCs for 4 h with NLRP3 silencing RNA suppressed the LPS/ATP mediated increase in IL-1β treatment approximately 85%, indicating that the NLRP3 inflammasone plays a central role in regulating before LPS/ATP-induced IL-1β secretion by HBCs. Collectively, our data indicate that LPS/ATP treatment stimulated NLRP3 inflammasome activation and pyroptosis in HBCs, highlighting the possibility of targeting therapies for inflammatory diseases of pregnancy involving inflammasome activation.

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