Fifty-Seventh Connecticut

JUNIOR SCIENCE
and
HUMANITIES SYMPOSIUM

at UConn Health, Farmington, Connecticut
March 7, 2020

THE NATIONAL SCIENCE TEACHING 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

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<td>9:30 – 9:45 a.m.</td>
<td>Break</td>
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<td>9:45 – 10:30 a.m.</td>
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<td>10:30 – 11:15 a.m.</td>
<td>Health &amp; Research Careers Panel</td>
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<td>Break Poster Viewing/ Snack</td>
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<td>11:30 a.m. – 12:15 p.m.</td>
<td>2nd Oral Session</td>
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<td>12:15 – 1:00 p.m.</td>
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<td>1:45 – 2:30 p.m.</td>
<td>3rd Oral Session</td>
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<td>2:30 – 3:15 p.m.</td>
<td>Lab Tour</td>
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<td>3:15 – 3:30 p.m.</td>
<td>Break Poster Viewing/ Snack</td>
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<td>3:30 – 4:50 p.m.</td>
<td>STEM Poster Exhibition</td>
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<td>3:30 – 4:50 p.m.</td>
<td>Peoples’ Choice Award Voting</td>
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<td>4:50 – 5:00 p.m.</td>
<td>Hartford Medical Society Library Research Activity</td>
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<td>5:00 – 5:30 p.m.</td>
<td>Data Analysis Demo</td>
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<td>5:00 – 5:30 p.m.</td>
<td>Evaluation and Raffles</td>
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<td>5:00 – 5:30 p.m.</td>
<td>Awards Ceremony</td>
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Fifty-Seventh Connecticut
JUNIOR SCIENCE and HUMANITIES SYMPOSIUM
at UConn Health

SATURDAY, MARCH 7, 2020

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
Kimberly Dodge-Kafka, PhD
Professor, Department of Cell Biology
Calhoun Center for Cardiology
Director, Biochemistry and Molecular Biology graduate program
Co-Director, MD/PhD Program
UConn Health
“Targeting protein-protein interactions for therapeutic treatment”
BREAK/TRANSITION
9:30 - 9:45 a.m. Refreshments Rotunda Hallway

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

2020 HUMANITIES ACTIVITY: Consumerism and Global Impacts

BLOCK #1
9:45 – 11:15 a.m.

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

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<tr>
<th>Activity</th>
<th>Group A: 1st Oral Session (names are below)</th>
<th>Group B: Health &amp; Research Careers Panel and Lab Tours</th>
<th>Group C: Humanities Activity</th>
<th>Competitive Poster Session (names are directly below)</th>
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<tbody>
<tr>
<td>Location</td>
<td>Rotunda</td>
<td>Massey Auditorium</td>
<td>Patterson or Friends Hall</td>
<td>Academic Lobby</td>
</tr>
</tbody>
</table>

Poster Presenters

**Eesha Acharya**
Amity Regional High School
Mentors: Lubna Pal and Dr. Vinitia Parkash
*Characterizing Chronic Endometritis in the Context of Menopausal Status*

**Ananya Aggarwal**
Glastonbury High School
Mentors: Jessica Rouge and Shraddha Sawant
*The Enzyme Triggered Degradation Studies of a Nucleus Targeting Nucleic Acid Nanocapsule*

**Halla Clausi**
Greenwich High School
Mentor: Andrew Bramante
*A Photonic Crystal-Based, Non-Invasive, Color-Changing Sensor for Detection of Salivary SOD2, for Diagnosis of Hepatocellular Carcinoma*

**Elizabeth Davis**
Bridgeport Regional Aquaculture Science & Technology Education Center
Mentor: Kirk Shadle
*Analysis of the Antimicrobial and Antiproliferative Effects of the Coelomic Fluid of Eisenia fetida on E. coli and Yeast*

**Shriya Desai**
Darien High School
Mentor: Premkumar Reddy
*Dual Targeting of ARK5 and CDK4 to Induce Cell Death in Triple-Negative Breast Cancer*

**Isabelle Garcia-Fischer**
Wooster School
Mentor: Braden Kuo and Evelyn Fetridge
*Auricular Vagal Nerve Stimulation in Brain and Gastric Outcomes in Functional Dyspepsia Patients*
Leyli Ghavami  
Joel Barlow High School  
Mentor: Katherine Nuzzo  
*The Utilization of Flavonoids for the Prevention of Paint Degradation via Exposure to Ultraviolet Radiation*

Hannah Goldenberg  
Greenwich High School  
Mentor: Andrew Bramante  
*Rapid Degradation of Water-Borne Microplastics via Magnetically-Functionalized Nanoplates, for Simple Adaptation in Current Water Treatment Plants*

Charlotte Hickey  
Bridgeport Regional Aquaculture Science & Technology Education Center  
Mentor: Kirk Shadle  
*Development of Vibrio sp. Detection in Crassostrea virginica for the Consumer Market*

Mina Kim  
Amity Regional High School  
Mentor: Adam Wisnewski  
*Impact of Diisocyanate on Lung Gene Expression in a Mouse Model of Occupational Asthma*

Jake Lambrech  
Joel Barlow High School  
Mentor: Katherine Nuzzo  
*Natural Enzyme Reduction of Saline Stress in Ocimum basilicum pilosum*

Ningxin Luo  
Amity Regional High School  
Mentor: Jenna Pappalardo  
*Investigating the Role of Astrocytes on Shaping T Cell Function in the Human Brain*

Kyle Xiong  
Greenwich High School  
Mentor: Andrew Bramante  
*Early Diagnosis and Tracking of Parkinson’s Disease via Supervised Machine Learning Algorithms*

Rushil Yerrabelli  
Conard High School  
Mentor: Djamel Nehar-Belaid  
*The Analysis of Childhood Lupus Disease Activity of Associated Immune Cell-Types at the Single-Cell Level*

David Zhou  
Hopkins School  
Mentor: Deva Chan  
*Effect of Region of Interest Segmentation on Regional Analyses of Trabecular Bone Morphology*
First Oral Session Presenters

Rachel Brooks  
Christian Heritage School  
Mentor: James Grady  
*Increased Prevalence of Gastrointestinal, Cardiovascular, and Immunologic Conditions in Hospitalized Patients with Ehlers-Danlos Syndrome: A Case-Control Study*

Kenneth Choi  
Ridgefield High School  
Mentor: Xiaodi Wang  
*Towards Privacy-Preserving Intelligence: Differential Privacy in Machine Learning*

Rhea Dey  
Amity Regional High School  
Mentor: Jason Karimy  
*Determining the Effect of Rapamycin on Ventricular Volume of Post Hemorrhagic and Post Infectious Hydrocephalus Wistar Rats*

Sam Florin  
Greenwich High School  
Mentor: Andrew Bramante  
*Decoding Algorithms for Correction of X-Z and Spatially Correlated Errors in Topological Quantum Computing*

Skylar Ford  
Darien High School  
Mentor: Ryan Chow  
*Single-Cell Transcriptomic Interrogation of Genetic Interactions through CRISPR-Cpf1*

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

BLOCK #2  
11:30 a.m. – 1:00 p.m.

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

<table>
<thead>
<tr>
<th>Activity</th>
<th>Group A: Humanities Activity</th>
<th>Group B: 2nd Oral Session (names are directly below)</th>
<th>Group C: Health &amp; Research Careers Panel and Lab Tours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Patterson or Friends Hall</td>
<td>Rotunda</td>
<td>Massey Auditorium</td>
</tr>
</tbody>
</table>
Second Oral Session Presenters

Ashley Granquist  
William H. Hall High School  
Mentors: Jay Strader, Laura Chomiuk, Laura Shishkovsky  
*Multiwavelength Identification of Black Hole Candidates in M13*

Jacob Krucinski  
Glastonbury High School  
Mentors: Krishna Pattipati and Adam Bienkowski  
*Determining the Efficiency of Machine Learning for Missile Detection and Tracking*

Jordan Macdonald  
Bridgeport Regional Aquaculture Science & Technology Education Center  
Mentor: Kirk Shadle  
*Determining the Efficacy of Dexamethasone Infused Polypropylene Mesh to Prevent Post Surgical Abdominal Adhesion*

Aurora Mu  
Ridgefield High School  
Mentor: Xiaodi Wang  
*A Hybrid Machine Learning Model with Cost-Function Based Outlier Removal and Its Application on Credit Rating*

Emily Ngo  
Academy of Aerospace and Engineering  
Mentor: Lia Tesfay  
*Role of Tumor Microenvironment on Glutathione-Driven Ferroptosis*

LUNCH/POSTER VIEWING

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

<table>
<thead>
<tr>
<th>Role</th>
<th>Judges</th>
<th>All Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seating location</td>
<td>Classrooms A1 and A8</td>
<td>Cafeteria (incl. Onyiuke Dining Room), Massey Auditorium, Rotunda, Patterson Hall, Friends Hall</td>
</tr>
</tbody>
</table>

BLOCK #3

1:45 – 3:15 p.m.

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

<table>
<thead>
<tr>
<th>Activity</th>
<th>Group A: Health &amp; Research Careers Panel and Lab Tours</th>
<th>Group B: Humanities Activity</th>
<th>Group C: 3rd Oral Session (names are directly below)</th>
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</thead>
<tbody>
<tr>
<td>Location</td>
<td>Massey Auditorium</td>
<td>Patterson or Friends Hall</td>
<td>Rotunda</td>
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</tbody>
</table>
Third Oral Session Presenters

Meghan Ogrinz  
Joel Barlow High School  
Mentor: Katherine Nuzzo  
Removal of Microplastics using Cornu aspersum Glycoconjugates

Shun Sakai  
Greenwich High School  
Mentor: Andrew Bramante  
Portable, Simple Filtration of V. cholerae Infected Water using Electrified, Silver-SWCNT Nanostructures within a Sari-Cloth Textile

Colin Speaker  
Greenwich High School  
Mentor: Andrew Bramante  
Enhancement of a Flow-Through Solar Water Disinfection (SODIS) System using Riboflavin as a Photocatalyst

Mingda Sun  
Farmington High School  
Mentor: Sherli Koshy Chenthittayil  
Agent Based Modeling of Biofilm Growth

Sienna Wang  
Amity Regional High School  
Mentor: Camrynn Fausey  
Modeling the Complexities of E. coli Transmission in Bangladeshi Children in Order to Calculate Risk of Early Childhood Diarrhea (ECD)

BREAK
3:15 - 3:30 p.m.  Refreshments STEM Poster Exhibition Areas  
(Rotunda Lower Hallway and Academic Mezzanine)

*“YOU CHOOSE” ADDITIONAL TOUR AND/OR DEMO
3:30 - 4:50 p.m.  Tour groups form in Academic Lobby  
- 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

MODERATORS’ AND JUDGES’ DELIBERATION
3:15 - 5:00 p.m.  Classroom A8
STEM POSTER EXHIBITION
3:30 - 4:50 p.m.   Rotunda Lower Hallway and Academic Mezzanine

To vote for the People’s Choice Award (your favorite poster):

- Locate your paper ballot in your conference folder.
- Place your completed ballot in the basket in the Rotunda Lower Hallway area between 3:00 and 4:50 p.m.
- Award will be announced in the Rotunda at 5:00 p.m.

PARTICIPATE IN “EXHIBIT QUEST” TO WIN THE GRAND PRIZE RAFFLE AT 5:00!

Rules for entry into the grand prize raffle in the Rotunda at 4:50:
1. You must obtain 2 colored cards from each exhibit zone for a total of 8 cards collected (at least)
   a. Zone 1 is colored green
   b. Zone 2 is colored blue
   c. Zone 3 is colored yellow
   d. Zone 4 is colored pink
2. Each exhibitor will hand you a card with a question that you must ask, and then write your answer on the card
   a. Your answer has to be a sentence or two only
3. If an exhibitor has no more cards, you are encouraged to stay for his/her presentation but it does NOT count for your entry, and you must obtain a card from another table
4. There are optional 20-minute demonstrations in the library that count as one wild card if you are missing a card
   a. Library scavenger hunt and data demo cards are colored ivory
   b. You may attend both but only ONE will count for your final card collection
5. Each poster exhibitor’s presentation lasts at least 5 minutes so budget your time accordingly!

STEM Poster Exhibitors

Aishatu Affini, Manchester High School  
*Sexing of Androgynous Animals by Neutrophil Morphology*

Priya Bhat, University High School of Science and Engineering  
*Human Engraftment in Humanized Mice by Multiparameter Flow Cytometry*

Avery Bonner, Darien High School  
*Auditory Processing Deficits in Children at Risk of Developmental Dyslexia*

Matthew Brander, Bridgeport Regional Aquaculture Science & Technology Education Center  
*The Use of Trehalose as an Additive to the Antimicrobial Tetracycline in Order to Increase Thermal Stability and Longevity*

Jennifer Brassington, Bridgeport Regional Aquaculture Science & Technology Education Center  
*Analysis of Toxins Derived from Conus geographus as a Method to Mitigate the Effects of Migraines*

Niharika Burugapalli, The Williams School  
*The Effectiveness of Guided Art Therapy on Mood in the Elderly*

Molly Dauk, Bridgeport Regional Aquaculture Science & Technology Education Center  
*A Novel Nootropic Therapy as a Functional Neuroprotective and Neurorestorative Stimulant to Hypocretin-Producing Neurons in Relation to Managing Narcolepsy*

Tageria Davis, Bridgeport Regional Aquaculture Science & Technology Education Center  
*Utilizing a Graphene Oxide/Copper and Reflective Aluminum Design to Improve Heating and Cooling Efficiency*
Richard Dube, Glastonbury High School
Reflective Photonic Limiters

Rebecca Fleischmann, Conard High School
An Analysis of the Impact of Mindfulness Meditation on Working Memory Capacity in Teens

Lyle Given, Bridgeport Regional Aquaculture Science & Technology Education Center
Allelopathic Effects of Invasive Red Macroalga (Grateloupia turuturu) for the Mitigation of Harmful Algal Blooms

Yuhao Han, Hamden Hall Country Day School
Improving Sunscreen Molecule Efficacy and Safety by Encapsulation and Molecular Cages

Dingkun Hong, Canterbury School
A Novel Computer-Aided Autism Spectrum Disorder Identification Method Based on Transfer Learning from
VoxResNet and Therapeutic Method Based on Embedded System

Laura Jeniski, Ridgefield High School
Studying the Evolution of People Pleading in the Canis lupus irremotus in Comparison to the Canis lupus familiaris

Isabella Jureller, Ridgefield High School
Effect of Extracurricular Activities on Student Stress

Srilekha Kadimi, Amity Regional High School
Analyzing the Efficacy of a New Method for Inserting Transgenes in Mice

Lila Karl, Darien High School
Concentration of Microplastics in Different Bodies of Water in Darien, Connecticut

Brendan Kelly, Bethel High School
Effect of Hair Derived Fertilizer on Plant Growth

Andrew Kim, Amity Regional High School
The Effect of Spoken Heritage and Second Languages on Memory Retention and Organization

Autumn Kim, Greenwich High School
Non-Invasive Diagnosis of Meningococcal Meningitis via Tattoo-Based Iontophoresis of Mannose-coated Tannic Acid
F-127 Nanoparticles

Juliet Lam, Joel Barlow High School
Impact of Ammonia Concentration on Arthrospira platensis Lead Absorption

Emily Larkin, Joel Barlow High School
The Effect of Various Enzymes on the Biofilm of Staphylococcus epidermidis

Ryan Lemone, Bethel High School
Effects of Swept Delta Fin Parameters on Model Rocket Performance

Guanshen Li, Xavier High School
A Novel Computer-Aided Cloud Type Classification Method Based on Convolutional Neural Network with Squeeze-and-Excitation
Leonard Liu, Glastonbury High School
Exploring a Novel Approach for Tackling Climate Change: Engineering Enzymes for Improved CO₂ Removal and H₂ Production

Ethan MacKenzie, Ridgefield High School
Utilizing Habitat Suitability Indices for the Discovery and Protection of Endangered or Threatened Herpetology Based Species

Rory McGrath, Ridgefield High School
Determining the Optimal Age for Gonadectomy in Dogs

Nicole Mongillo, Amity Regional High School
The Effect of Diet Composition on Juvenile American Horseshoe Crab (*Limulus polyphemus*) Survival in Culture

Kayla Morgan, Amity Regional High School
Degrees of Separation in Internet Personalities: Contributions of Fame and Fortune

Ana-Luisa Moura, Bridgeport Regional Aquaculture Science & Technology Education Center
Micronutrient Sourcing from Macroalgae *Chondrus crispus* in Application of Enhanced Neonatal Dietary Supplement

Aria Muchhal, Darien High School
The Impact of Targeted Modifications of SNPs rs265 and rs99 in iPSC Cells Using CRISPR/Cas9 on Obesogenic Gene Expression

Kyle Murray, Joel Barlow High School
Assessing the Efficacy of Bacteriophage Preservation in *Bacillus cereus* Endospores

Ethan Pernek, Bridgeport Regional Aquaculture Science & Technology Education Center
Utilization of Piezoelectric Elements within a Breakwater System for Situational Power Generation

Lucie Scura, Darien High School
The Effect of Nectar Distribution on Fecal Deposition in Bumble Bees: Implications for Disease Transmissions

Noah Simons, Joel Barlow High School
Electronic Sealants for Moisture Resistance in IPC-B-25A Boards

Christian Spallone, Ridgefield High School
Testing the Effectiveness of the Raspberry Pi Sense HAT in Comparison to a Traditional Weather Station

Mitchell Worthington, Joel Barlow High School
Use of Carbonic Anhydrase and Different Concentrations of Water for Carbon Dioxide Sequestration in Soil

Bowen Yao, South Kent School
Comorbidities of Mobility Impairment in Elders

Baasim Zafar, Amity Regional High School
Determining Difference in Growth and Developmental Rates of Amphibian Metapopulation Depending on Average Spring Temperature of the Larva’s Home Pond

Steven Zhang, Hamden Hall Country Day School
Sampling Microplastics in the New Haven Harbor Sand
EVALUATION AND RAFFLES
4:50 - 5:00 p.m.  Rotunda

Grand Prize Raffle: STEM Poster “Exhibit Quest”
✓ Submit set of at least 8 completed cards for a chance to win dinner for four at Barcelona Restaurant (locations throughout Connecticut)!

STEM Poster Exhibitor Raffle
✓ If you exhibited, you are automatically entered to win dinner for four at Bartaco Restaurant (locations throughout Connecticut)! (You were exhibiting while others were “questing”.)

Evaluation Raffles
✓ Submit completed activity card with evaluation form for a chance to win:
  ▪ A $25 gift card to Naples Pizza, Farmington!
  ▪ SweetFrog free frozen yogurt vouchers (locations throughout Connecticut)!
  ▪ One of 10 $10 Barnes & Noble gift cards for use in-store or online!

AWARDS CEREMONY
5:00 - 5:30 p.m.  Rotunda

Acknowledgments
Joy Erickson, MA
Director, CT-JSHS

Awards

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

CHAPERONES: PLEASE RETURN TO THE REGISTRATION AREA TO SIGN OUT YOUR STUDENT(S).
Participating High Schools/Programs

Academy of Aerospace and Engineering (CREC), Windsor
Academy of Science and Innovation (CREC), New Britain
Amity Regional High School, Woodbridge
Avon High School
Bethel High School
Bridgeport Regional Aquaculture Science & Technology Education Center
Bristol Eastern High School
Brookfield High School
Canterbury School, New Milford
Central AHEC’s Youth Health Service Corps, Hartford
Christian Heritage School, Trumbull
Conard High School, West Hartford
Daniel Hand High School, Madison
Darren High School
E. C. Goodwin Technical High School, New Britain
Enfield High School
Farmington High School
Francis T. Maloney High School, Meriden
Glastonbury High School
Greenwich High School
Hamden Hall Country Day School
Hopkins School, New Haven
Joel Barlow High School, Redding
Manchester High School
Mercy High School, Middletown
Middletown High School
Nathan Hale-Ray High School, Moodus
New Britain High School
Newtown High School
O.H. Platt High School, Meriden
Parish Hill Middle/High School, Chaplin
Portland High School
Ridgefield High School
Rocky Hill High School
South Kent School, Kent
Sport and Medical Sciences Academy, Hartford
The Williams School, New London
Thomaston High School
University High School of Science & Engineering, Hartford
Waterbury Arts Magnet School
Wesleyan University Upward Bound Math/Science, Middletown
Weston High School
William H. Hall High School, West Hartford
Wooster School, Danbury
Xavier High School, Middletown
SPONSORS

- Connecticut Academy of Science and Engineering
- Connecticut Science Supervisors Association
- Connecticut Science Teachers Association, Inc.
- The National Science Teachers Association 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 (raffle prizes)

- Barcelona Wine Bar and Restaurant, West Hartford
- Bartaco, West Hartford
- Barnes & Noble at UConn Health, Farmington
- Naples Pizza, Farmington
- SweetFrog, West Hartford

COOPERATING ORGANIZATIONS

- AmeriCorps HealthForward Program (CT AHEC Network)
- AmeriCorps Service to Improve Community Health (STICH) Program
- Connecticut Association of Secondary Schools
- CT AHEC Urban Service Track/AHEC Scholars Program
- EASTCONN Mobile STEM Lab
- Hartford Medical Society Library, UConn Health
- Lambda Kappa Sigma, Alpha Beta Chapter
- Lyman Maynard Stowe Library, UConn Health
- National Association of Secondary School Principals
- Talcott Mountain Science Center
- UConn College of Liberal Arts and Science
- UConn Graduate School
- UConn School of Dental Medicine
- 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, MA
- Joy Erickson, Director CT-JSHS
- Robert Erickson, Pratt & Whitney, United Technologies Corporation, East Hartford (retired)
- Barbara Fischler, U.S. Army Nurse Corps (veteran)
- Sandra Justin, CT Science Supervisors Association
- Brittany Knight, CT Convergence Institute for Translation in Regenerative Engineering, UConn Health
- Frank LaBanca, Westside Middle School Academy, Danbury
- John Listorti, Killingly High School, Danielson
- Dave Lopath, Connecticut Science Teachers Association and Connecticut Science Supervisors Association
- Diane Pintavalle, Glastonbury High School
- Jon Swanson, E.O. Smith High School, Storrs
- Ralph Yulo, Eastern Connecticut State University, Willimantic

STUDENT PRESENTATION MODERATORS

- Terri Clark, Executive Director, Connecticut Academy of Science and Engineering, Rocky Hill
- Robert Erickson, Pratt & Whitney, United Technologies Corporation, East Hartford (retired)

JUDGES, REVIEWERS, CAREER PANELISTS, TOUR AND DEMO GUIDES, AMERICORPS MEMBERS, URBAN HEALTH/AHEC SCHOLARS, LAMBDA KAPPA SIGMA, AND ALL OTHER VOLUNTEERS: THANK YOU!
Increased Prevalence of Gastrointestinal, Cardiovascular, and Immunologic Conditions in Hospitalized Patients with Ehlers-Danlos Syndrome: A Case-Control Study
Rachel Brooks
Christian Heritage School, Trumbull, CT
Mentor: Dr. James Grady, UConn Health, School of Medicine

This study investigated the prevalence of gastrointestinal, cardiovascular, and immunologic conditions in hospitalized patients with Ehlers-Danlos syndrome (EDS), a group of rare, inherited connective tissue disorders. Small studies have suggested a potential link between EDS and these conditions, but this is the first large case-control study to be performed to date. It was hypothesized that an EDS diagnosis would be associated with a higher prevalence of gastrointestinal symptoms, cardiovascular autonomic dysfunction, food allergies, and cardiovascular complications compared to the general population of hospitalized patients. It was also hypothesized that EDS patients would have higher odds of mortality and likelihood of having a longer than average length of hospital stay (> 4 days). Cases and controls (matched 1:2) were acquired from the 2016 Nationwide Inpatient Sample. The study population included 6021 individuals (n=2007 EDS). On multivariate logistic regression analysis adjusted for confounders, EDS patients had significantly higher odds of having GI symptoms (Odds Ratio [OR] = 3.53, Confidence Interval [CI]: 3.08-4.03, P < 0.0001), cardiovascular autonomic dysfunction (OR = 4.20, CI: 3.44-5.14, P < 0.0001), food allergies (OR = 3.92, CI: 2.57-5.98, P < 0.0001), and cardiovascular complications (OR = 5.76, CI: 4.17-7.96, P < 0.0001). EDS patients were also 76% more likely to have a longer than average length of hospital stay (OR = 1.76, CI: 1.54-2.02, P < 0.0001). These findings will enable physicians to exercise proper precautions in treating EDS patients and provide rationale for EDS to be considered in patients with unexplained GI, cardiovascular, and immunologic manifestations.

Towards Privacy-Preserving Intelligence: Differential Privacy in Machine Learning
Kenneth Choi
Ridgefield High School, Ridgefield, CT
Mentor: Dr. Xiaodi Wang, Western Connecticut State University

Although scary, data collection is inevitable. Our society needs data to improve. But, unlike popular opinion, data collection doesn't necessarily entail privacy loss. For decades, data-holding organizations have anonymized public datasets, removing identifying information such as names. However, as online data becomes more accessible, hackers can now link two public datasets containing the same person and find who that person is—thus compromising privacy. Differential privacy prevents these linkage attacks by using computer mechanisms to obscure data with randomized numbers (noise). Mechanisms preserve individual privacy adding just enough noise to datasets to make individuals undetectable. However, current mechanisms are not complex enough and neglect next-generation hacking techniques that use quantum computing. Overly-secure mechanisms, on the other hand, compromise the statistical integrity of the data, preventing analysts from learning from the data. To fix these issues, I create three differentially private mechanisms that use the discrete M-band wavelet transform, a secure linear transformation. The first two mechanisms (LS and LS+) use a “Laplace-Sigmoid” distribution that multiplies Laplace-distributed values with the sigmoid function, creating a doubly random, more secure distribution to draw noise from. The third mechanism utilizes pseudo-quantum steganography, a next-generation cryptographic technique, to embed noise into data. I then test the mechanisms in various machine learning environments. The mechanisms achieve more than 94% classification accuracy for all privacy values tested, proving that they successfully retain both differential privacy and statistical learnability. My research effectively connects differential privacy and quantum computing, and it illustrates the future of data privacy.
**Determining the Effect of Rapamycin on Ventricular Volume of Post Hemorrhagic and Post Infectious Hydrocephalus Wistar Rats**

Rhea Dey  
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Mentor: Jason Karimy, Yale University

Hydrocephalus is a neurological condition where an excess of cerebrospinal fluid (CSF) accumulates in the cerebral ventricles. The most common cause in infants is intraventricular hemorrhage (IVH), a brain bleed, or a bacterial infection (LPS). Standard treatment entails a ventricular-shunt which is invasive and often fails. Therefore, drug-related therapies are needed. In preliminary studies, the kinase mTOR, is significantly up-regulated following IVH and LPS. In this study, mTOR was inhibited using Rapamycin (RAPA). The purpose of this study was to determine if targeting this inflammatory pathway could treat hydrocephalus by limiting the flow of CSF. The groups were the control with no hydrocephalus, IVH, LPS, IVH+RAPA, and LPS+RAPA. The administration of the drug was the independent variable. The dependent variable was the ventricular volume. The tissue was sectioned using a cryostat. Then, ventricular volume was measured in each group using photoshop and the averages were compared to the control. Hematoxylin and eosin staining was performed to obtain better images of the brain. It was hypothesized the IVH+RAPA and LPS+RAPA would have significantly smaller ventricles because RAPA would control the CSF into the brain. This hypothesis was accepted. The average volume was smaller for IVH+RAPA and LPS+RAPA compared to IVH and LPS proving RAPA prevented the excess secretion of CSF. The next step would be to test RAPA after a longer time period of induced hydrocephalus. This new discovery would provide a noninvasive treatment and a better quality of life for patients with hydrocephalus.

**Decoding Algorithms for Correction of X-Z and Spatially Correlated Errors in Topological Quantum Computing**

Sam Florin  
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Mentor: Andrew Bramante, Greenwich High School

Topological quantum error correction uses the topology of surfaces like the plane or torus to correct quantum errors, helping quantum computing to be successful. However, topological quantum error correction assumes that all errors occur independently. In this project, both spatial correlation and X-Z correlation are considered. In the error model used, staircase-shaped errors of fixed unknown length are considered, providing the spatial correlation. Also, instead of treating Pauli Y errors as a combination of X and Z errors, they are considered separately by having X, Y, and Z chains occur with equal probability. This forces the decoder to consider X-Z correlation. The decoder is a variation of the minimum-weight perfect matching algorithm. However, instead of using the taxicab distance on the lattice as the weight of an edge, weight is defined using a combination of functions on distance and the overlap of chains. The distance function has a minimum spike at the predicted staircase distance. The overlap function peaks at no overlap and maximum overlap to account for Y errors. This algorithm is applied twice; once for X syndromes and once for Z syndromes. This information is combined to give the most likely error chains and more accurately corrects error.

**Single-Cell Transcriptomic Interrogation of Genetic Interactions through CRISPR-Cpf1**

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Mentor: Ryan Chow, Yale University Sidi Chen Lab

Genetic screens are revolutionary in their ability to analyze the comprehensive transcriptome of a cell; however, traditional screens are limited to relatively simple read-outs. CRISPR-driven transcriptomics and CRISPR screens are effective and economical methods for analyzing complex cell populations and systems, and provide for more diverse and thorough read-outs. Current methods of CRISPR screening coupled with transcriptomic profiling, such as Perturb-seq, MOSAIC-seq, CRISP-seq, and CROP-seq, are restricted to targeting only one gene for perturbation or are subject to issues involving lentiviral reproduction. Their use of a genetic “barcode” to associate guide RNAs with the construct causes mispairing and loss of viable constructs during lentiviral reproduction. To improve sensitivity and allow for multiple perturbations, we designed a construct without a “barcode” that utilizes the CRISPR-associated protein Cpf1, rather than traditional Cas9, because Cpf1 allows for multiple perturbations with the use of a single promoter, creating a less complicated and more viable construct. Our construct, termed RC128, successfully cut two genetic targets in the genes Nf2 and Cd43, and underwent reverse-transcriptase PCR, a transcriptomic profiling technique. Our high-throughput method of analyzing complex transcriptomes may help identify innumerable gene signatures, targets, processes, and interactions associated with individual or multiple perturbations in future research.
Multiwavelength Identification of Black Hole Candidates in M13
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Mentors: Dr. Jay Strader, Dr. Laura Chomiuk, Ms. Laura Shishkovsky, Michigan State University Department of Physics and Astronomy

I present the identification of the most promising black hole candidates in the Milky Way globular cluster M13. Source-finding programs were utilized in conjunction with X-ray catalogs and radio data from the Karl G. Jansky Very Large Array (VLA), as well as a Hubble Space Telescope image of M13, to identify candidates and determine the likelihood of each being a black hole. The sources identified most closely match the $L_r/L_x$ (radio luminosity/X-ray luminosity) correlation of black holes, and the most likely sources also have optical counterparts (which would signify the presence of a companion star in an X-ray binary, indicating the likelihood of the radio/X-ray source being a black hole). These sources have radio luminosities between $5.3 \times 10^{27}$ and $1.3 \times 10^{28}$ erg s$^{-1}$, and have X-ray luminosities between $4.4 \times 10^{30}$ and $2.6 \times 10^{32}$ erg s$^{-1}$, rendering the candidates too X-ray-faint to be neutron stars and too radio-bright to be white dwarfs. Several radio sources without X-ray matches were observed in both the 5 GHz and 7.4 GHz basebands of the VLA observation; their spectral indices close to zero indicate the possibility of them being black holes. Finding black holes in globular clusters helps fine-tune models for the causes of gravitational wave events which have been recently detected by the Laser-Interferometer Gravitational-Wave Observatory (LIGO) and helps predict the abundance of black holes in globular clusters.

Determining the Efficiency of Machine Learning for Missile Detection and Tracking
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Mentor: Dr. Krishna Pattipati, University of Connecticut, Storrs
Graduate Student Mentor: Adam Bienkowski, University of Connecticut, Storrs

In today’s world, missile detection and tracking plays a key role in national security. It is vital that nations intercept any missiles before they strike assets or civilians. My research is focused on one aspect of missile defense in the form of streaks in images, which are distinct signatures that have an elongated or extended spread across several pixels. Current approaches to this task involve physics-based analytical and probabilistic models, however, Machine Learning is yet to be applied. Therefore, the question I am trying to answer is: Can Machine Learning techniques perform missile detection and tracking more efficiently, with fewer computations, and faster than current methods? If so, this research could make significant contributions to the global missile defense industry and potentially save many lives and assets. To address this question, I have used generated image data with and without streaks for training a streak detector neural network (NN) as well as a streak/missile locator NN. To initially simplify the problem, I will work with less and/or smaller image data that I normalize and preprocess using autoencoding, a denoising tool. This will help me find promising neural network models, as there are many parameters to adjust and lots of data to train on. After finding such models, I will expand to larger datasets and compare various metrics of performance to current methods. Currently, I have trained the detector NN to work on the small images and will use this capability on large images and in the localization task.

Determining the Efficacy of Dexamethasone Infused Polypropylene Mesh to Prevent Post Surgical Abdominal Adhesion
Jordan Macdonald
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Mentor: Kirk Shadle, Bridgeport Regional Aquaculture Science & Technology Education Center

After surgery, scar tissue may connect parts of organs, causing severe abdominal pain, bowel blockage, or even organ strangulation. Currently, doctors have no way to prevent these adhesions from occurring, and the only way to resolve these issues is through more surgery, making this a recurring issue in patients. Presently, doctors use polypropylene hernia meshes to reduce strain and pressure on damaged tissue after surgery. If these meshes were enhanced to include anti-adhesive properties, it would significantly decrease the chances for post-surgical adhesion. The glucocorticoid, Dexamethasone, has previously been proven to have anti-adhesive properties in the body. In this experiment, multiple Dexamethasone solutions will be created using methanol, and polypropylene meshes will be placed in each solution for varying amounts of time. The meshes will be rinsed and dried, and then placed in distilled water. Samples of the water will be taken over time and tested using UV spectroscopy for the presence of Dexamethasone, and the elution time of the Dexamethasone. It was found that this soaking method was not effective in infusing the mesh with the Dexamethasone, due to the very low absorption values when samples were tested using UV spectroscopy. This being, a plasma treatment will be tried in order to attempt to strengthen the coating on the mesh. It is
anticipated that this treatment will allow the Dexamethasone to properly adhere to the mesh surface, and that the Dexamethasone will then elute from the mesh over time, rather than all at once.

**A Hybrid Machine Learning Model with Cost-Function Based Outlier Removal and Its Application on Credit Rating**

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Mentor: Dr. Xiaodi Wang, Western Connecticut State University, Danbury

The ability to allocate capital efficiently and profitably is of great significance to financial institutions. Banks and credit companies often have sizable loan portfolios, making it necessary to develop accurate credit scoring models. Slight improvement in credit scoring accuracy can reduce lenders’ risk and translate to significant future savings. The release of the Basel Accords has prompted further development into credit scoring models. Machine learning techniques such as support vector machines, neural networks, and logistic regression learning, are widely explored and utilized. This paper establishes a methodology to build hybrid machine learning models, aiming to combine the power of different machine learning algorithms on different types of features and hypothesis. In particular, the methodology is tested for a crediting problem. After a logistic regression-based feature treatment is introduced in the preprocessing of training data, a generic cost-based outlier removal was utilized in the hybrid machine learning model. Together with the combination of three types of machine learning algorithms (support vector machine, decision tree, and logistic regression), the new hybrid models showed improvement in performance compared with benchmark models of SVM, DT, and LR. This new methodology can be further explored with other algorithms and applications.

**Role of Tumor Microenvironment on Glutathione-Driven Ferroptosis**

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Mentor: Lia Tesfay, University of Connecticut

Cancer cells naturally have higher retention of iron. Thus, ferroptosis—the iron-dependent and peroxidation-driven form of cell death—opens avenues to target cancer cells more effectively. The effectiveness of the treatment further depends on the tumor microenvironment, which is characterized by cell-signaling secretions. One such secretion is glutathione (GSH), an antioxidant that inhibits ferroptosis by repressing lipid peroxidation. Recent literature provides evidence that fibroblasts release GSH into the tumor microenvironment (TME), suggesting that other cells of the TME may also secrete inhibiting molecules. This experiment sought to test the effect of conditioned media from various cells on the ferroptosis of ovarian cancer (OVCAR4) cells. Non-contact co-culture procedures were used in this experiment—transferring conditioned media from pre-adipocytes, adipocytes, and fibroblasts to OVCAR4 cells were used to simulate interactions in the TME. It was observed that, in addition to the fibroblasts, pre-adipocytes and adipocytes secrete GSH. After the treatment of the conditioned media, OVCAR4 cells demonstrated higher resistance to ferroptotic cell death. A similar analysis showed that intracellular GSH levels of the ovarian cancer cells increased when exposed to exogenous GSH, suggesting that the OVCAR4 cells uptook secretions from conditioned media.

**Removal of Microplastics using Cornu aspersum Glycoconjugates**

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Mentor: Dr. Katherine Nuzzo, Joel Barlow High School

The research investigated whether the glycoconjugates from *Cornu aspersum* were able to collect microplastics (polyethylene terephthalate) in the size range of 0.25 to 0.30 mm in diameter. Hematoxylin dye, which colors inorganic material, was added to a mixture of glycoconjugates and water collected from Long Island Sound (LIS). Another mixture was created which consisted of distilled water and dye. Slides of both mixtures were created and viewed at the same magnification under a microscope before and after adding the microplastics. After the microplastics were added the mixtures were then stirred for 30 seconds and left to sit for 2 minutes. Dark red-purple objects were only observed in the glycoconjugate-LIS mixture, which supports the presence of the microplastics. However, colored objects did not appear in the mixture of dye and distilled water. These observations support the feasibility of the use of glycoconjugates in developing a safer, organic alternative to toxic dispersants released at oil spill sites.
Portable, Simple Filtration of V. cholerae Infected Water Using Electrified, Silver-SWCNT Nanostructures within a Sari-Cloth Textile
Shun Sakai
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Mentor: Andrew Bramante, Greenwich High School

Cholera is an acute illness caused by Vibrio cholerae (Vc) intestinal infection. If left untreated, cholera can lead to death within a few hours, due to rapid dehydration and shock. Since it is transmitted through water sources by fecal contamination, the spread of cholera is easily prevented with advanced water filtration systems in developed regions. For at-risk, underdeveloped regions, however, a simple, portable, and effective water filtration device is highly desirable. In this research, such a device was created, using a sari-cloth textile filtration medium, with embedded antibacterial silver nanoparticles (AgNPs). To construct the filter, 500nm AgNPs were first synthesized and verified with SEM and EDS. Silk-polyester sari cloth textiles were then coated with 4mg/ml SWCNT ink, to provide 200 Ω/cm2 conductivity. Previously synthesized AgNP’s were dispersed in solution and evenly loaded onto the conductive textiles (as supported by SEM). A 2.5cm2 AgNP-SWCNT-Sari filtration textile was loaded into a custom funnel-holder, so that 0, 5, 9, & 12 V could be applied across the conductive filter, as known concentrations of V. porteresiae (BSL1 model-bacteria) were filtered. Organism filtering capacity was determined via filtrate OD600nm; the treated textile exhibited 97% inactivation at 12V, with 95% being inactivated using a typical 9V battery. SEM images of the post-run filtration textile confirm the stability of the AgNP/SWCNT/Sari matrix. Additionally, traces of dead V. porteresiae atop the textile suggest that bacteria inactivation occurs at the point of contact between the organism and the electrified textile.

Enhancement of a Flow-Through Solar Water Disinfection (SODIS) System Using Riboflavin as a Photocatalyst
Colin Speaker
Greenwich High School, Greenwich, CT
Mentor: Andrew Bramante, Greenwich High School

An improved solar water disinfection (SODIS) system was developed using riboflavin as a photocatalyst to enhance the antimicrobial efficacy of ultraviolet radiation. Greater efficiency is critical to the 2 million people in the developing world who depend on SODIS systems and are deprived of clean water when UV radiation is blocked by atmospheric conditions. The ability of 0.1% riboflavin to enhance the bactericidal effect of UV on Escherichia coli was investigated in a PET plastic bottle system containing 105 CFU/ml of E. coli at an illumination distance of 12 inches. Addition of riboflavin 0.1% to the water prior to UV irradiation produced a measurable increase in purification: 5-minutes of UV treatment alone reduced viable E. coli by 0.5 log units, while combined UV-riboflavin treatment reduced bacterial content by 2 log units. In the second phase of the investigation, a prototype flow-through SODIS system with a compound-parabolic solar collector was constructed to evaluate the feasibility of a practical, high-output water disinfection system employing riboflavin as a photocatalyst. Results from previous experiments were confirmed by tests conducted in the flow-through system, where a similarly time-dependent bactericidal effect with UV treatment alone was significantly enhanced when riboflavin was added to the water. Investigations into fluence, time, and flow rate are now underway to determine optimal conditions for this flow-through SODIS system, which is made from inexpensive and readily available building materials and can thus be easily constructed in regions of the world where water purification is most needed.

Agent Based Modeling of Biofilm Growth
Mingda Sun
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Mentor: Dr. Sherli Koshy Chenttitayal, UConn Health

Biofilms are microbial communities that adhere to the surface of the oral cavity and medical implants through excreting self-produced proteins. Candida albicans biofilms become highly virulent when they branch off from yeast form into hyphal form, presenting an important cause of fungal infections in humans, especially nosocomial infections in patients via medical implants. Researchers have recently discovered that varying the composition of co-existing bacteria in C. albicans biofilms might serve to strengthen or limit the virulence of the fungus itself. The two main species of bacteria that we studied in this project were streptococcus gordonii and lactobacillus casei. Streptococci is found to promote fungal virulence and pathogenicity while Lactobacilli inhibits the Candida transition. Our study aims to better understand the interactions that C. albicans has developed with these bacterial species in biofilms in order to control and inhibit the ability of C. albicans to form pathogenic biofilms. We observed and analyzed the growth and mechanism of these two important species of bacteria by developing and validating an agent based model based upon experimental observations. We modeled the growth of bacterial biofilms through running simulations in a computerized agent based modeling software, iDynoMics. Using parameters from literature, we were able to
analyze the results of these computer simulations and compare them to experimental trends as part of a process of determining their effectiveness in modeling real bacterial growth. After designing various different simulations with customized conditions of bacteria growth, and analyzing the software’s response to each programmed task, our study has demonstrated that iDynoMiCS is a software capable of faithfully reproducing results from literature, and therefore can be used to further understand the interactions between *Streptococcus* and *Lactobacillus* bacteria in *C. albicans* biofilms in a more efficient and quantitatively driven matter. This was part of a wider initiative to discover ways to better control and limit the virulence of certain biofilms that grow in the human body, and on medical implants.

**Modeling the Complexities of *E. coli* Transmission in Bangladeshi Children in Order to Calculate Risk of Early Childhood Diarrhea (ECD)**
Sienna Wang
Amity Regional High School, Woodbridge, CT
Mentor: Camrynn Fausey, Yale Zimmerman Laboratory

Growth stunting affects 26% of children in South Asian countries. A primary cause of growth stunting is early childhood diarrhea (ECD). The knowledge of *E. coli* ingestion pathways through agent-based modeling can inform more successful interventions than current ones. The objective of this project was to design and program a model to understand the fecal-oral pathways of pathogenic transmission, serving as a risk prediction model for ECD. Data from a WASH Benefits Trial in Bangladesh was inputted into the model, run in the software NetLogo. The data consisted of diarrheal occurrences in children, *E. coli* amounts found in household vectors (food, hands, soil, and stored water), season, rainfall, and geospatial location. Hazard variables of animal presence and sanitation infrastructure, among others, were incorporated into the modeling framework. Exposure to *E. coli* was calculated across four different pathways: mouthing hands, ingesting soil (geophagia), drinking water, and consuming food. The combination of the hazard and exposure variables was used to calculate a risk of ECD. BehaviorSpace, a function of NetLogo, was used to validate the model; experiments provided for the prevalence (% with ECD), incidence (ECD/child-year), and amount of *E. coli* ingested from each exposure pathway as a function of age. *E. coli* ingestion model data with raw data, indicating the viability of the model for accurate, realistic predictions involving the modeled community.

**Poster Presenters**

**Characterizing Chronic Endometritis in the Context of Menopausal Status**
Eesha Acharya
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Mentors: Dr. Lubna Pal and Dr. Vinitia Parkash, Yale School of Medicine

Chronic endometritis (CE) is a distinct type of inflammation of the uterine endometrium. The presence of tissue plasma cells is considered a histological hallmark of CE. The clinical presentation of CE can be variable. Hypothesized mechanisms for CE are many, yet poorly understood. CE is described in reproductive-aged as well as in postmenopausal women; literature on postmenopausal CE, however, is almost non-existent. We hypothesized that histological features of CE differ by menopausal status, postmenopausal CE has more plasma cells and acute inflammation than premenopausal CE. Our overarching goal is to gain clarity on the diagnostic criteria that can help pathologists in identifying CE in tissue specimens and to enhance our understanding of underlying and coexisting mechanisms that can guide clinicians in making informed clinical management decisions. Cases of CE were identified from histopathology database and histological fixed specimen slides were requested for review. Slides were categorized by menopausal status (pre and post). Using light microscopy, histopathological features were examined with particular attention to the number, the distribution pattern of plasma cells, presence and density of other inflammatory cells (neutrophils, eosinophils, macrophages). Differences in histological features were compared between pre and postmenopausal samples. Our preliminary analyses identify differences in histological presentation of CE by menopausal status. Postmenopausal CE differs from premenopausal CE in significantly higher numbers, and clustering patterns of plasma cells compared to premenopausal CE. Also, evidence of coexisting neutrophils and macrophages was significantly higher in postmenopausal women, but the prevalence of eosinophils was comparable between the two groups. Interestingly, the proportion of “granulated macrophages” was also significantly higher in postmenopausal compared to premenopausal CE samples. Our preliminary data suggest that postmenopausal CE and premenopausal CE are distinct entities with unique pathophysiological underpinnings. We anticipate that this ongoing study will clarify if the choice of treatment modality for CE should differ based on the menopausal status of the patient.
The Enzyme Triggered Degradation Studies of a Nucleus Targeting Nucleic Acid Nanocapsule
Ananya Aggarwal
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Mentor: Dr. Jessica Rouge, Department of Chemistry, University of Connecticut
Graduate Mentor: Ms. Shraddha Sawant, Department of Chemistry, University of Connecticut

In this study, a nucleus targeted nucleic acid nanocapsule (NAN) was designed to create a less toxic and more targeted delivery method for therapeutic splice switching antisense oligonucleotides (SSOs) needed to treat genetic diseases. Spinal muscular atrophy, the leading genetic cause of infant mortality, and atypical cystic fibrosis, affecting ⅓ of the US, are just some of the diseases caused by mutations in pre-mRNA splicing. SSOs are a promising treatment to correct pre-mRNA splicing, but while effective, current delivery methods require chemical modifications and are not targeted, resulting in large, toxic doses. A significantly less toxic and more cellular targeted method of delivering SSOs includes using self-transfecting NANs; however, there is no method for the NANs to target the nucleus. This study aimed to design NANs with a nuclear localization signal (NLS) embedded into an enzyme responsive substrate to target the nucleus. Using an NLS in the crosslinker allows the NANs to reach the nucleus using the nuclear import pathway. The crosslinker is designed with an NLS peptide on either end of a cathepsin B substrate to maximize the NANs that reach the nucleus. The NANs were successfully synthesized with the crosslinker and characterized for charge and size using dynamic light scattering, zeta potential, transmission electron microscopy, and gel electrophoresis. Furthermore, in vitro toxicity tests prove the NANs are non-toxic in 80 μM concentration. Future studies include testing the NANs’ nucleus targeting ability using confocal microscopy. If successful, this NAN will be a fundamental step towards treating patients with genetic diseases.

A Photonic Crystal-Based, Non-Invasive, Color-Changing Sensor for Detection of Salivary SOD2, for Diagnosis of Hepatocellular Carcinoma
Halla Clausi
Greenwich High School, Greenwich, CT
Mentor: Andrew Bramante, Greenwich High School

Hepatocellular carcinoma (HCC) is the most common type of liver cancer and is regarded as one of the most aggressive cancers. Over 800,000 people contract HCC each year and around 700,000 die, making HCC the 3rd leading cause of cancer death in the world despite only being the 6th most common. Currently, the most common means of diagnosing HCC are through costly imaging tests, such as CT and MRI, as well as potentially traumatizing and invasive blood tests and liver biopsies, all which require trained personnel. As such, an easily readable sensor that could measure superoxide dismutase 2 (SOD2) levels in saliva in a low-cost, noninvasive way is highly desirable, and is the focus of this research. To begin, a photonic crystal microchip with opal structure was created through the spin-coating of monodispersed latex spheres (P-(St-MMA-AA)) onto a PDMS glass substrate. This microchip was then dipped in an aqueous prepolymer solution containing the salivary biomarker, SOD2, pulled out, and cleansed under 100 W UV, acetic acid, sodium dodecyl sulfate solution, and deionized water. It has been found that the PC microchips exhibit a change in intensity when exposed to SOD2, which was measured through a PerkinElmer Lambda 18 UV-Vis spectrometer and SEM.

Analysis of the Antimicrobial and Antiproliferative Effects of the Coelomic Fluid of Eisenia fetida on E. coli and Yeast.
Elizabeth Davis
Bridgeport Regional Aquaculture Science & Technology Education Center, Bridgeport, CT
Mentor: Kirk Shadle, Bridgeport Regional Aquaculture Science & Technology Education Center

Novel sources of antibiotics and cancer treatments are crucial to combat the rise of microbes and cancers resistant to antibiotics and chemotherapy. The innate immunity of a worm is a potentially rich source of novel antibiotics and cancer treatments because of its unique composition and broad antimicrobial activity. The purpose of the project is to analyze the antimicrobial and antiproliferative effects of the coelomic fluid of Eisenia fetida. Coelomic fluid is the fluid within the coelom of the worm and functions in the respiratory system and innate immunity of the worm. During the study, the activity of coelomic fluid was evaluated by introducing coelomic fluid to two model organisms. E. Coli is the first model organism. An antibiotic disk is saturated with coelomic fluid and placed on a culture of E. coli. The zone of inhibition is measured to analyze the antimicrobial activity. Yeast is the second model organism. The coelomic fluid is introduced to yeast cultured in broth. A cell count is obtained periodically to measure the suppression of the yeast caused by the coelomic fluid. The suppression indicates antiproliferative activity of the coelomic fluid. The coelomic fluid of Lumbricus terrestris is hypothesized to demonstrate activity against E. coli and yeast.
Dual Targeting of ARK5 and CDK4 to Induce Cell Death in Triple-Negative Breast Cancer
Shriya Desai
Darien High School, Darien, CT
Mentor: Premkumar Reddy, PhD, Icahn School of Medicine

Triple-Negative Breast Cancer is a form of breast cancer that tests negative for estrogen, progesterone, and HER2 receptors, and accounts for over 7,500 deaths in the United States annually. There are limited therapies available, as hormone treatment is ineffective since the tumor lacks hormone receptors, which leads to more patients succumbing to the disease in relation to the number of diagnoses. There has been a modest response to selective CDK4/6 inhibitors, which are currently available as chemotherapeutic agents, however, the partial response could be the result of an incomplete targeting of kinases. AMPK-related protein kinase 5 (ARK5), is expressed in Triple-Negative Breast Cancer lines and is associated with both tumor proliferation and metastasis. In this study, we examined whether the dual targeting and inhibition of CDK4 and ARK5 using the drug ON123300 would result in a better therapeutic outcome in comparison with single CDK4 inhibitors. The treatment of the Triple-Negative Breast Cancer cell lines with ON123300 in vitro resulted in cell-cycle arrest closely followed by apoptosis. ARK5 inhibition led to the inhibition of the mTOR/S6K pathway along with the upregulation of the AMPK cascade, which resulted in the destabilization of the steady-state MYC protein and increased levels of SIRT1. This research provides preclinical evidence that ON123300 is unique from other drugs in inhibiting oncogenic pathways in Triple-Negative Breast Cancer and supports the development of dual CDK4 and ARK5 inhibition as a therapeutic approach to Triple-Negative Breast Cancer.

Auricular Vagal Nerve Stimulation in Brain and Gastric Outcomes in Functional Dyspepsia Patients
Isabelle Garcia-Fischer
Wooster School, Danbury, CT
Mentors: Dr. Braden Kuo, Massachusetts General Hospital and Dr. Evelyn Fetridge, Wooster School

Roughly 60-70 million people are affected by gastrointestinal (GI) disorders in the United States alone. Functional Dyspepsia (FD) affects 20% of this population and costs over $8 billion in health care expenditures in the United States. FD patients are mainly affected by the symptoms of early satiation, bloating, nausea, belching, and abdominal pain, which are exacerbated by the consumption of meals. The goal of this study was to evaluate the ability of transcutaneous vagus nerve stimulation (tVNS) to attenuate FD symptoms, thus creating a better quality of life. tVNS is a noninvasive medical treatment that delivers electrical impulses to the auricular branch of the vagus nerve to attenuate medical symptoms. Healthy controls (HC) and functional dyspepsia (FD) patients were recruited and completed a screening visit, two behavioral visits, and two Magnetic Resonance Imaging (MRI) visits. The behavioral visits consisted of multiple questionnaires, a nutrient drink test (NDT), and a visual analog scale (VAS). Sham or active tVNS was applied during the behavioral and MRI visits. Currently, the population size for this study is small. However, there are trends suggesting that tVNS attenuates the symptoms of FD patients by increasing parasympathetic nervous system activity, creating more balance within the autonomic nervous system. This study suggests that tVNS may increase parasympathetic activity and therefore reduce symptoms in FD patients. Continued research into this question may confirm this result and indicate whether tVNS represents a non-invasive means to increase the quality of life of patients.

The Utilization of Flavonoids for the Prevention of Paint Degradation via Exposure to Ultraviolet Radiation
Leyli Ghavami
Joel Barlow High School, Redding, CT
Mentor: Dr. Katherine Nuzzo, Joel Barlow High School

Paint degradation is the process in which the binder and pigments of a coating deteriorate and react with one another, resulting in the alteration of color, and oftentimes the peeling or blistering of paint. This experiment will demonstrate the use of the flavonoids rutin and quercetin dihydrate suspended in acrylic binder as an environmentally friendly and plant based avenue for UV protection. During experimentation, varying concentrations of rutin and quercetin dihydrate powders will be mixed with acrylic binder. The absorbance and reflectance spectra of these samples will then be measured via UV-Vis spectrophotometry. Using the Beer-Lambert law, the molar absorptivity of these samples will be calculated and compared. Then, dispersions with progressively higher concentrations will be prepared and coated over samples of ECOS house paint, so as to determine the highest concentrations of rutin or quercetin dihydrate that can be used without significant change to the color and quality of the paint. The results of this experiment will demonstrate the prospective use of a sustainable and readily available source of UV protection.
**Rapid Degradation of Water-Borne Microplastics via Magnetically-Functionalized Nanoplates, for Simple Adaptation in Current Water Treatment Plants**
Hannah Goldenberg
Greenwich High School, Greenwich, CT
Mentor: Mr. Andrew Bramante, Greenwich High School

Microplastics (MPs), which are contained in consumer cosmetic products to provide a skin cleansing mechanism through subtle abrasion, have become micro-contaminants due to their prevalence in aquatic environments. Ingestion of microbeads will damage the digestive tract of aquatic organisms, accumulate in the gut, leading to malnutrition, and act as a carrier for pesticide-pollutants in water. Further, their prolonged degradation in water can release carcinogenic by-products. Recent research has highlighted the use of carbon-nanocoils to catalyze the rapid degradation of MPs in water. While novel, the current technology lacks both efficiency and adaptability into a water treatment scheme, requiring pressurized heating of the catalyzed-water to ~160°C. A simple and efficient nanoplate-catalyzed MP degradation model is needed, that can easily be incorporated within current water treatment models. In this research, magnetically-responsive manganese-nanoplates (MnNPs) were fabricated from MnCl2 and melamine, and heated to 500°C under nitrogen. Analysis of these MnNPs via scanning electron microscopy (SEM) and energy dispersive spectroscopy (EDS) highlight the plate-like structure of the carbon strands, with integrated manganese, which provides the magnetic properties for the catalyst. Microplastics used in this study were first separated from currently available skin cleansers, and later characterized for size, morphology, and molecular structure using SEM and ATR-FTIR. MnNPs were then used to degrade MPs in water, using techniques that are easily incorporated into, or are already found in water treatment plants (ultrasonic mixing and UV-light irradiation), to hasten the process. SEM, EDS, and ATR-FTIR analysis were used to quantify MP degradation and identify decomposition products.

**Development of Vibrio sp. Detection in Crassostrea virginica for the Consumer Market**
Charlotte Hickey
Bridgeport Regional Aquaculture Science & Technology Education Center, Bridgeport, CT
Mentor: Kirk Shadle, Bridgeport Regional Aquaculture Science & Technology Education Center

The consumption of raw shellfish is a popular activity in the United States and continues to grow every year. Due to the changing climate, sustainable foods such as shellfish become more incorporated in the American diet in particular. According to a study conducted by the National Oceanic and Atmospheric Association (NOAA) Fisheries, Americans consumed “4.8 billion pounds of seafood in 2016” (California Aquaculture Association Staff et.al, 2017). With any food product comes the potential for contamination by food-borne diseases, especially the consumption of raw seafood. Usually when food is unsafe for consumption, there is a telltale indication such as a foul scent, discoloration or visible damage to the tissues. In the case of *Vibrio*, a problematic pathogen that infamously affects shellfish such as oysters, there is no indication of its contamination status on a consumer level. The goal of this project would be to use a test strip impregnated with an esculin bile agar and iron (II) chloride mixture. Exposure to contaminated shellfish meat would trigger a positive test reading indicated by color change of the test strip from white to dark gray/black.

**Impact of Diisocyanate on Lung Gene Expression in a Mouse Model of Occupational Asthma**
Mina Kim
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Mentor: Adam Wisnewski, PhD, Yale University

Diisocyanates, chemicals to make polyurethane which is widely used in industry, are able to sensitize immune systems, causing asthma. Differences between diisocyanate and environmental asthma prompt the hypothesis that it involves distinct mechanisms of pathogenesis. One difference is lack of immunoglobulins (Ig) of the epsilon subclass (IgE) that bind diisocyanate in blood, as allergen-specific IgE plays a primary role in allergic reactions. Diisocyanate asthma likely occurs through IgE-independent mechanisms that remain unclear, hampering screening, diagnosis, and therapy. The purpose of this experiment was to determine key gene expression differences in diisocyanate induced asthma. The independent variable was skin and/or respiratory tract exposure. The dependent variables were levels of gene expression, percent of airway fluid eosinophilia and mucus, and enrichment of specific biological pathways. The control was mice with mock solvent and mock respiratory tract exposure. Experimental groups included: sensitized mice with an exposed respiratory tract; mice with an exposed respiratory tract without prior skin exposure; mice with B-cell knockout; mice with IL-12β knockout. Student used bioinformatics software programs to analyze gene expression and determine significantly altered biological pathways. The implications of this project include developing a better understanding of the pathogenic mechanisms of diisocyanate induced asthma.
Natural Enzyme Reduction of Saline Stress in Ocimum basilicum pilosum
Jake Lambrecht
Joel Barlow High School, Redding, CT
Mentor: Dr. Katherine Nuzzo, Joel Barlow High School

A growing problem in today’s word is world hunger, not being able to feed the humans living today. It has many causes, one of them, being excess saline soil. The excess dissolved salts absorbed from the water increases ethylene production, a growth suppression in plants. A potential solution I’m studying are Pseudomonas fluorescens, a biosafety level 1 halophile – bacteria able to survive saline environments. They’re able to lower ethylene levels through production of ACC-Deaminase, which disrupts the ethylene formation process once absorbed into the plant. 2 suspensions were created from cultured bacteria, each with 5mL of water added to the 1.25g of bacteria each and shaken. 5 groups of basil plants are being used at Joel Barlow High School for this experiment, differing by their watering: 1 with deionized water, which has seen the most growth up to this point; 1 with 50mM NaCl, around the benchmark for water classified as saline; 1 with 90mM NaCl + 30mM NaCl2 * 2H2O, matching concentrations affected by rock salts; and the final 2 being the previous 2, but with bacterial suspensions. All five will be measured at the end by dry weight, internal water salinity, height, % germination, and number of leaves.

Investigating the Role of Astrocytes on Shaping T Cell Function in the Human Brain
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Mentor: Jenna Pappalardo, Yale University, Department of Immunobiology

Tissue-resident T cells are responsible for immune surveillance but can differ in behavior depending on the tissue’s unique, homeostatic immune state. In the absence of disease, many peripheral cells in the CNS are suppressed, preventing damaging inflammation. Astrocytes perform many tasks, such as axon guidance and synaptic support. Therefore, factors produced by astrocytes may impact T cells that enter the brain, resulting in a tissue-specific T cell state. The project’s purpose is to understand the physiological impact of astrocytes by examining how astrocyte conditioned media (ACM) affects T cell function in the absence of disease. Because astrocytes play an important role in brain homeostasis, it was hypothesized that their presence will induce co-inhibitory expression in CD4+ and CD8+ T cell receptors to prevent inflammation. Using IRB approved blood donations from healthy donors, T cells were isolated from whole blond. Astrocytes were cultured in media to yield the ACM. Isolated T cells were cultured without or without ACM to yield the experimental groups. qPCR measured relative gene expression. The results were insignificant. Limitations include the insufficient number and genetic variation of participants. By examining what factors affect immune surveillance in the absence of disease, this project can provide a greater understanding of processes in neuroinflammatory diseases and determine what types of metabolic environments and cytokines exist to better model T cells in vitro.

Early Diagnosis and Tracking of Parkinson’s Disease via Supervised Machine Learning Algorithms
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Mentor: Mr. Andrew Bramante, Greenwich High School

Current diagnosis of Parkinson’s disease is unreliable and time-consuming, relying on qualitative rather than quantitative data. Furthermore, current diagnostic procedures ignore the presence of a prodromal stage, a stage marked by non-motor symptoms. By the time motor symptoms appear, over 60% of dopaminergic neurons are already damaged. In this project, a machine learning model was created to diagnose and track the progression of Parkinson’s disease. Data from 730 patients (489 PD and 241 control) was analyzed from the Parkinson’s Progression Markers Initiative. After preprocessing the data, a two-sample Kolmogorov–Smirnov test and Pearson correlation test filtered unimportant and redundant features. After testing different classification algorithms, a Random Forest model was developed with an ROC accuracy of 99.09%. Next, a regression model was developed that could track the progression of Parkinson’s disease after the diagnosis has been made. The MDS-UPDRS rating scale is the standard scale to track progression of Parkinson’s disease. A Stochastic Gradient Boosting model based on numerical inputs was created that can predict the MDS-UPDRS rating with an R² of 0.67. These results show that the use of ensemble machine learning methods can help doctors diagnose and treat Parkinson’s disease based on easily-obtainable data.
The Analysis of Childhood Lupus Disease Activity of Associated Immune Cell-Types at the Single-Cell Level
Rushil Yerrabelli
Conard High School, West Hartford, CT
Mentor: Dr. Djamel Nehar-Belaid, Banchereau Lab at The Jackson Laboratory

Systemic Lupus Erythematosus (SLE) is a long-term autoimmune disease, where the immune system mistakenly attacks the body. SLE is a clinically and molecularly heterogeneous disease, whose course is unpredictable with remissions and flares that lead to cumulative organ damage. The disease is notably aggressive in children who suffer from a high incidence of nephritis. SLE's diverse clinical manifestations present challenges to clinicians and hamper the design of clinical trials. Numerous studies have identified distinctive blood gene-expression signatures in an SLE patient’s blood. However, the precise cellular origin of these signatures and how they may vary as a function of clinical disease heterogeneity remain mostly unknown. Single-cell RNA-seq (scRNA-seq) technology provides an unbiased approach to define cell types based on their individual gene-expression patterns. My project uses scRNA-seq to identify immune cell types associated with SLE disease activity. I have analyzed scRNA-seq data of 53,309 blood cells from three patients at three visits, with each patient visit defined by a SLE disease activity index number, and I have compared them to the scRNA-seq data of three healthy childhood donors. The scRNA-seq data was first cleaned, processed, and analyzed through Python based pipelines. By analyzing the genes of each cell and using a graph-based clustering method, I have generated visual representations to illustrate the cellular modulations occurring in SLE patients. While a detailed analysis is ongoing, preliminary results have revealed the presence of disease-related cell types. These findings lay the groundwork for resolving the heterogeneity of SLE towards precision medicine applications.

Effect of Region of Interest Segmentation on Regional Analyses of Trabecular Bone Morphology
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Hopkins School, New Haven, CT
Mentor: Prof. Deva Chan, Biomedical Engineering Department, Rensselaer Polytechnic Institute

Osteoarthritis is a common joint disease, affecting millions of people worldwide. In osteoarthritis research, micro-computed tomography (μCT) imaging has been established as the gold standard in assessing bone morphology such as trabecular and cortical bone. However, current assessments of bone morphology using μCT imaging largely ignored differences in measurement when comparing different types and sizes of region of interest (ROI), often leading to inaccuracy and inconsistency in measurements and assessments. My project aims to determine the differences in trabecular bone measurements among various ROIs using μCT images of mice tibias. In my research, three different types of ROIs were used: whole medial compartment, 1 mm circle, and 0.6 mm circle. Four key measurements were analyzed for the three ROIs using BoneJ: trabecular thickness, trabecular number, trabecular spacing, and bone volume fraction. Data was analyzed for significance with one-way ANOVA test and Tukey Kramer post-hoc test. My research found that three of the four measurements changed significantly when the size of ROI changed, and only one measurement did not. My results indicated that when the size of ROI increased, both trabecular number and bone volume fraction increased significantly; trabecular spacing decreased as ROI increased. Only the measurements in trabecular thickness remained largely the same. My findings could further the study in this area and potentially help refine and improve the accuracy of measurement and assessments of bone morphology with μCT imaging, leading to more accurate and precise evaluation and diagnosis of osteoarthritis in humans.