

Fifty-Fourth Connecticut

**JUNIOR SCIENCE
and
HUMANITIES SYMPOSIUM**

**at UConn Health, Farmington, Connecticut
March 11, 2017**



**UCONN
HEALTH**

**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

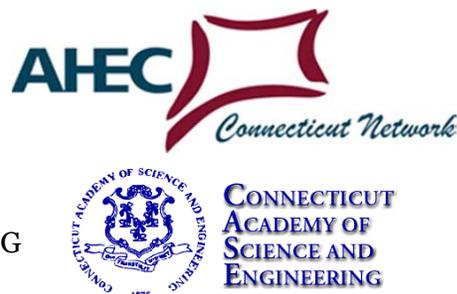
THE U.S. ARMY/NAVY/AIR FORCE JUNIOR SCIENCE AND HUMANITIES SYMPOSIA PROGRAM

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		
9:40 – 11:00 a.m. <i>(Block 1)</i>	Competitive Poster Judging	Group A’s Health Careers Panel and Lab Tours	First Oral Presentation Session
11:00 – 11:15 a.m.	Refreshment Break/Poster Viewing		
11:15 a.m. – 12:45 p.m. <i>(Block 2)</i>	Teacher Workshop A	Group B’s Health Careers Panel and Lab Tours	Second Oral Presentation Session
12:45 – 1:30 p.m.	Lunch		
1:30 – 3:00 p.m. <i>(Block 3)</i>	Teacher Workshop B	Group C’s Health Careers Panel and Lab Tours	Third Oral Presentation Session
3:00 – 4:30 p.m.	Moderators’ and Judges’ Meeting	STEM Poster Exhibition & People’s Choice Award Voting	
4:30 – 5:00 p.m.	Evaluation & Raffle		
5:00 – 6:30 p.m.	Banquet & Awards Ceremony (and Final Raffle)		

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

SATURDAY, MARCH 11, 2017

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 **Julia Oh, PhD**

Assistant Professor, The Jackson Laboratory
“The Microbiome in Human Health and Disease”



BREAK

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

BLOCK #1

9:40 – 11:00 a.m.

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

Activity	<i>Competitive Poster Judging (names are directly below)</i>	<i>Group A's Health Careers Panel and Lab Tours</i>	<i>First Oral Presentation Session (presenter names follow poster presenters below)</i>
Location	Academic Lobby	Massey Auditorium	Rotunda

Poster Presenters

Luca Barcelo

Greenwich High School

Mentor: Paulina Larrauri

Crowd-Sourced Detection and Mapping of Nitrate Water Pollutants via a Mobile Web-Based Image Analysis System

Andrew Benz

Darien High School

Mentor: Mariana Raykova

Determining the Optimal Implementation for Secure Multiparty Computation of the Logistic Function

Claire Borecki

Darien High School

Mentor: Lauren Pepa

Least Positive Outcome: Health Service Use in a Longitudinal Study of Autism Spectrum Disorders

Cassidy Fawcett

Bridgeport Regional Aquaculture Science & Technology Education Center

Mentor: Kirk Shadle

The Efficacy of Topical Ascorbic Acid as an Inhibitor to Mold and Microbial Growth

Marissa Guzzo

Greater Hartford Academy of Mathematics & Science

Mentor: Lili Aramli

The Effect of Collect Nutrient Powder on Mus Musculus Lewis Lung Carcinoma Cell Confluence, Viability and Growth Rate

Amanda Hernandez

Bridgeport Regional Aquaculture Science & Technology Education Center

Mentor: Kirk Shadle

Predicting the Genomic Pathways of Adaptation in Spartina alterniflora Salt Tolerance Protein LSD1 in Response to Sea Level Rises Via Phylogenetic Trees

Niyati Hora

Glastonbury High School

Mentor: Jessica Costa

Whole Exome Sequence Analysis of Sporadic Ossifying Fibroma

Anish Kosanam

Greens Farms Academy

Mentor: Mathieu Freeman

Anticorrosive Barrier Microwave-Assisted Coatings on AZ31 Magnesium Alloy to Reduce Degradation Rate for Metallic Medical Implants

Ronak Mahatme

Glastonbury High School

Mentor: Jenna Bartley

Flu Induced Alterations In Muscle Cytokine Expression Due To Aging

Jasmine Moon

Amity Regional High School

Mentor: Songye Li

Synthesis and in vivo Evaluation of an Aromatase Inhibitor as a PET Radiotracer

Caleigh Morr

Darien High School

Mentor: Daniel Moore

IgM Expands Regulatory T Cells and Demonstrates Therapeutic Potential for Type 1 Diabetes

Julia Nadelmann

Amity Regional High School

Mentor: George Iosifidis

Investigating the Cooperation in the Sharing Economy using the Wifi Sharing Game

Taryn Rahman

Manchester High School

Mentor: Golam Chowdhury

How Does the Type of Attention During the Imprinting Period Affect Memory Development?

Hannah Rappaport

Amity Regional High School

Mentor: Tracy Johnson

Designing a Canine (Canis familiaris) Facial Recognition System of Emotions

Neal Soni

Staples High School

Mentor: Miriam Rafailovich

Characterization of Pluronic F127 Degradation Patterns and Drug Release Under Laminar Flow for a Preventative Measure Against Failed Back Surgery Syndrome

Rahul Subramaniam

Greenwich High School

Mentor: Prem Subramaniam

Rapid Colorimetric Field Monitoring System for Zika Virus in Mosquito Populations via DNAzyme-Functionalized Gold Nanoparticles

Melani Zuckerman

Joel Barlow High School

Mentor: Katherine Nuzzo

The Role of Acidity in Phosphorus Fixation of Brassica rapa through Induced Systemic Resistance by Inoculation of Azospirillum brasilense

First Oral Session Presenters

Aakshi Agarwal

Hamden High School

Mentor: Priti Kumar

Permanent Inactivation of the HIV Provirus via CRISPR Gene-Editing

Akshar Agarwal

Hamden High School

Mentor: Danny Martins

PAD4 Inhibition: A Novel Treatment for Rheumatoid Arthritis

Danielle Cai

Glastonbury High School

Mentor: Jing Zhao

Functionalization of Gold Nanoparticles with various Amino Acids under Different pH Environment

Katherine Cunningham

Darien High School

Mentor: Juri Miyamae

Sexual Dimorphism in the Foramen Magnum and Implications for Dinosaurs

Virginia Gerig

Staples High School

Mentor: Flavio Tinoco

Cilantro and Plants with Ester Functional Groups Purify Copper (II) From Water

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	Teacher Workshop A	Group B's Health Careers Panel and Lab Tours	Second Oral Presentation Session (names are directly below)
Location	Classroom C3/C5	Massey Auditorium	Rotunda

Teacher Workshop:

Facilitator Frank LaBanca, EdD: *Research and Authentic Inquiry*

Second Oral Session Presenters

Katherine Handler

Amity Regional High School
 Mentors: David Post and Amanda Subalusky
The Influence of Wildebeest Carcass Inputs on the Diet of Fish in the Mara River

James He

Amity Regional High School
 Mentor: Airey Lau
The Relationship Between Intelligence Quotient, Phonological Awareness, and Reading Cognition: A Behavioral and Neuroimaging Analysis

Reshana Homma

Glastonbury High School
 Mentor: Marc Hansen
The Effect of Regulation of Autophagy on the Hedgehog Signaling Pathway in Paget's Disease of the Bone

Haya Jarad

Amity Regional High School
 Mentor: Garth Thompson
Identifying Quasi Periodic Patterns in fmri Versus CBF Data

Mahdeen Khan

James Hillhouse High School
 Mentor: Victor Wong & Kathryn Miller-Jensen
The Stimulation of the TNF Pathway in Jurkat Cells to Reverse HIV Latency

LUNCH

12:45 - 1:30 p.m.

Pick up boxed lunch in cafeteria and make way to designated seating locations:

<i>Role</i>	<i>Judges</i>	<i>All Others</i>
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

<i>Activity</i>	<i>Teacher Workshop B</i>	<i>Group C's Health Careers Panel and Lab Tours</i>	<i>Third Oral Presentation Session (names are directly below)</i>
Location	Classroom C3/C5	Massey Auditorium	Rotunda

Teacher Workshop:

Facilitator Frank LaBanca, EdD: *Research and Authentic Inquiry*

Third Oral Session Presenters

Connor Li

Greenwich High School

Mentor: Andrew Bramante

Fabrication of a Magnetically Vertical-Aligned Boron Nitride Nanotube Membrane in a Lyotropic Precursor for Water Transport Applications

Lauren Low

Engineering & Science University Magnet School

Mentor: Randolph Callender

A Novel Rapid Diagnostic Test for Zika Virus NS1 Protein using Nanoribbon Microfluidics

Samarth Menta

Glastonbury High School

Mentor: Marc F. Hansen

Genomic Analysis of Osteosarcoma to Identify Novel Key Regulatory Pathways in Tumorigenesis

Gabrielle Stonoha

Manchester High School

Mentor: Sara Sullivan

Growth and Sustainability of Metarhizium on Low-nutrient Substrates

Shobhita Sundaram

Greenwich High School

Mentor: Andrew Bramante

Detection of Premalignant Pancreatic Cancer via Computational Analysis of Serum Proteomic Profiles

William Yin

Greenwich High School

Mentor: Andrew Bramante

Portable, Low-Cost Tattoo-Based Biosensor for the Non-Invasive Self-Diagnosis and Quantification of Atherosclerosis

MODERATORS' AND JUDGES' MEETING

3:00 - 4:30 p.m.

Classroom A1

STEM POSTER EXHIBITION (vote for the People's Choice Award!)

3:00 - 4:30 p.m.

Cafeteria

STEM Poster Exhibitors

Patricia Athens Acorda, Engineering & Science University Magnet School
Arfan Ali, Manchester High School
Connor Anderson, Bridgeport Regional Aquaculture Science & Technology Education Center
Samuel Applegate, Hamden Hall Country Day School
Arya Bairat, Engineering & Science University Magnet School
Samantha Ballas, Joel Barlow High School
Lucy Briody, Ridgefield High School
Escher Campanella, Darien High School
Katrina Cirilli, Simsbury High School
Sabrina Dibble, Manchester High School
Luke Duffy, Greens Farms Academy
Thomas Ersevum, Glastonbury High School
Catherine Gorey, Darien High School
Sumudu Gunawadana, Joel Barlow High School
Elizabeth Hayman, Joel Barlow High School
Tamashi Hettiarachchi, Glastonbury High School
Mitchell Johnson, Glastonbury High School
Colleen Keenan, Ridgefield High School
Brianna Mailloux, Greater Hartford Academy of Mathematics & Science
Robert Marcus, Greens Farms Academy
Srihita Mediboina, Fairfield Ludlowe High School
Prastik Mohanraj, Engineering & Science University Magnet School
Neha Pashankar, Amity Regional High School
Tingwei Pu, Hamden Hall Country Day School
Kevin Santoro, Ridgefield High School
Daniel Schaefer, Bridgeport Regional Aquaculture Science & Technology Education Center
Emily Shaw, Joel Barlow High School
Cole Stearns, Bridgeport Regional Aquaculture Science & Technology Education Center
Charles Thompson, Greens Farms Academy
Brian Tormey, Bridgeport Regional Aquaculture Science & Technology Education Center
Joshua Verdejo, Ridgefield High School
Kyle Young, Shelton High School
Lillian Zhang, Amity Regional High School
Yuqi Zhou, Amity Regional High School

SUBMIT EVALUATION FORMS AND ACTIVITY CARDS

RAFFLE PRIZES DRAWN EVERY 10 MINUTES!

3:30 - 5:00 p.m.

Cafeteria

IF STAYING FOR THE BANQUET & AWARDS CEREMONY, SUBMIT YOUR RAFFLE CARD AND EVALUATION AFTERWARD (FOR FINAL RAFFLES).

BANQUET & AWARDS CEREMONY

5:00 - 6:30 p.m.

Cafeteria

Welcome

Barbara Kream, PhD

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



Sheldon Apsell, PhD

Chairman of the Board and CEO,
Academy of Applied Science

Mei Wei, PhD

Associate Dean and Professor,
UConn School of Engineering

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

Participating High Schools

Academy of Aerospace & Engineering
Academy of Information Technology & Engineering
Amity Regional High School
Bridgeport Regional Aquaculture Science & Technology Education Center
Bristol Central High School
Coginchaug Regional High School
Common Ground High School
Conard High School
Darien High School
East Hartford High School
Engineering & Science University Magnet School
Fairfield Ludlowe High School
E. O. Smith High School
Glastonbury High School
Greater Hartford Academy of Mathematics & Science
Greens Farms Academy
Greenwich High School
Haddam-Killingworth High School
Hall High School
Hamden Hall Country Day School
Hamden High School
Highville Change Academy
James Hillhouse High School
Joel Barlow High School
Jonathan Law High School
Killingly High School
Manchester High School
Mercy High School
Newington High School
Old Saybrook High School
Evolutions Program at Yale Peabody Museum of Natural History
RHAM High School
Ridgefield High School
Shelton High School
Simsbury High School
South Windsor High School
Staples High School
Tourtellotte Memorial High School
University High School of Science and Engineering
Wamogo Regional High School
Wethersfield High School
Wilbur Cross High School

SPONSORS

- Connecticut Academy of Science and Engineering
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- Talcott Mountain Science Center
- The Academy of Applied Science under contract with the U.S. Army, Navy, Air Force
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- UConn Office of Undergraduate Admissions

DONORS

- Barnes & Noble at UConn Health (coupons, raffle prizes)
- Sweet Frog Frozen Yogurt, West Hartford (raffle prizes)

COOPERATING ORGANIZATIONS

- AmeriCorps State Program
- Connecticut Association of Independent Schools, Inc.
- Connecticut Association of Secondary Schools
- CT AHEC Urban Service Track
- Educators for Responsible Science
- 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 Office of Public Engagement
- 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, Middletown
- Jonathan Craig, Talcott Mountain Science Center, Avon
- Deborah Day, Amity High School, Woodbridge
- Joy Erickson, Director, CT-JSHS
- Robert Erickson, Pratt & Whitney, East Hartford
- Barbara Fischler, U.S. Army Nurse Corps (retired)
- Sandra Justin, Neag School of Education, UConn
- 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, CT
- Robert Erickson, Manufacturing Engineer, Pratt & Whitney, United Technologies Corporation, East Hartford, CT

**JUDGES, REVIEWERS, CAREER PANELISTS, TOUR GUIDES,
AMERICORPS MEMBERS AND ALL OTHER VOLUNTEERS:
THANK YOU !**

ABSTRACTS

Oral Presenters

Permanent Inactivation of the HIV Provirus via CRISPR Gene-Editing

Aakshi Agarwal

Hamden High School, Hamden, CT

Mentor: Priti Kumar

Current HIV therapies fail to target the latent viral reservoir, the location of persistent, dormant HIV which often restarts producing virus. However, prior viral reservoir eradication attempts have been largely unsuccessful. This project aims to interrupt the replication machinery of HIV by making multiple cuts within HIV's highly conserved Long Terminal Repeats (LTRs) via the CRISPR (clustered regularly interspaced palindromic repeats) gene-editing system. Since they contain promoters, enhancers, and transcription machinery that are necessary to the viral replication cycle, LTRs are the "control centers" of gene expression. First, available HIV sequences were computationally analyzed to design and synthesize LTR-specific gRNAs. Now, the synthesized gRNAs are being molecularly cloned into a lentiviral vector. Next, surface-modified lentiviral particles that specifically target human T cells will be generated and transduced into a cell line carrying latent HIV with a fluorescent protein as reporter. A reduction in fluorescence after induction with activating agents will indicate damage to the integrated HIV and thus inactivation of the viral genome. In conclusion, CRISPR gene-editing of the HIV genome represents a potential cure/therapeutic for inactivating the latent viral reservoir. The data presented demonstrates successful production of HIV genome-specific gRNAs and ongoing testing will determine HIV-targeting efficacy.

PAD4 Inhibition: A Novel Treatment for Rheumatoid Arthritis

Akshar Agarwal

Hamden High School, Hamden, CT

Mentor: Danny Martins

Rheumatoid Arthritis (RA) is a disabling autoimmune disorder which affects millions of people. RA is characterized by painful systemic inflammation and synovium destruction. While therapy and timely treatment may reduce the effects of RA, no cure exists. Current approaches introduce serious toxicities such as tumors, cancer, etc. Peptidylarginine Deiminase 4 (PAD4) catalyzes citrullination, the deimination of arginine side chains, a process required for many human molecular mechanisms. In RA, this citrullination triggers an autoimmune response which leads to severe bone damage. This project aims to treat RA through the inhibition of PAD4. Mathematical and molecular modeling techniques were used to identify PAD4 inhibitors. Ten million available drug-like compounds were screened and their potencies were calculated. Docking scores that approximate the receptor:drug binding energy were computed and the top 100 compounds were selected. Docking calculations include polar and non-polar interaction terms. The empirical function was used to evaluate the ligands' ability to bind to PAD4's active site, and 20 structurally diverse inhibitors were identified. Their binding energies ranged from -34 to -148 (more negative is better). Through conformational shape analyses and the calculation of docking scores, drug-like compounds with unique shapes and the highest affinities for PAD4 were successfully identified.

Functionalization of Gold Nanoparticles with various Amino Acids under Different pH Environment

Danielle Cai

Glastonbury High School, Glastonbury, CT

Mentor: Jing Zhao

Gold nanoparticles (AuNPs) functionalized with organic compounds containing various functional groups have attracted a great deal of interest due to their unique size-dependent optical properties. These properties can be chemically designed with specific organic compounds to promote highly selective and sensitive target-detection and target-binding properties. The unique properties of the functionalized AuNPs together with their small size, large surface area-to-volume ratio and low toxicity have made AuNPs an excellent choice in biomedical applications such as bio-imaging, gene delivery and drug delivery. In this research, the functionalization of AuNPs with amino acids containing different functional groups are studied systematically under different pH environment. Three amino acids were selected: L-cysteine containing a thiol group, L-Lysine containing an additional amino group and L- Glutamic Acid containing an additional carboxyl group. The interaction between the AuNP solution and the amino acids with different concentrations and mixing ratios, under different pH environment, were monitored using UV-Vis spectra as well as by means of colorimetry. The results showed that, both the AuNP functionalization and the AuNP aggregation rate are dependent on the ligand concentration and the pH environment, which can be designed for desired repulsive forces between the negatively charged AuNP surfaces to control AuNP aggregation.

Sexual Dimorphism in the Foramen Magnum and Implications for Dinosaurs

Katherine Cunningham
Darien High School, Darien, CT
Mentor: Juri Miyamae

One of the most puzzling questions of paleontology is that of sexual dimorphism. Currently, the only way to determine the sex of a dinosaur is via presence of medullary bone. The issue with testing for medullary bone is that it requires using precision tools to take a cross-section of the fossil, which destroys the integrity of the specimen. The aim of this research was to find an alternative to destructive sampling methods. The focal point of this study was the foramen magnum, which has been shown to be dimorphic in human specimens, as it is typically larger in males than females. Prior to this experiment, the accuracy of the foramen magnum in sex determination had not been tested outside of humans. This study looked at the paleognathous bird *Struthio camelus*, since they are some of the closest living relatives to the dinosaurs. Linear discriminant analyses (LDA) of the data showed high accuracy levels in using the foramen magnum for sex determination, although the small sample size in most cases did not allow for statistically significant results. Most LDA tests predicted with 88.89% accuracy the specimen's sex, though there were results as high and low as 100% and 55.56% respectively. Only one test, which utilized only the anteroposterior foramen magnum diameter, was found to be statistically significant. Nevertheless, this study offers a promising new alternative to destructive sampling and opens the doors to analyzing a wide variety of species in regards to sexual dimorphism through the foramen magnum.

Cilantro and Plants with Ester Functional Groups Purify Copper (II) From Water

Virginia Gerig
Staples High School, Westport, CT
Mentor: Flavio Tinoco

Today, the heavy metal contamination of drinking water poses a threat to several countries' safety. In many third world countries people do not have access to water filtration systems because of expense and availability. In this study, plants were tested to see if they were capable of removing copper from water. Several plants that had similar chemical structures were tested. These plants were: celery, broccoli, cabbage, basil, black tea, kale, parsley, pineapple, apple, pear, banana, peach, strawberry, grape, blueberry, lemon, watermelon, tomato, mango, and orange. Overall, 20 mg samples removed 20-60% of a 20 ppm, 10 ml copper solution that was shook for 20 minutes. Through studying cilantro it was found that: amount of plant used, shaking time, and surface area of cilantro all had significant effects on the removal percentage of copper. In regions where plants grow abundantly, this way of purifying water is affordable and easily accessible. This idea could be useful in third world countries as an alternative way to purify water.

The Influence of Wildebeest Carcass Inputs on the Diet of Fish in the Mara River

Katherine Handler
Amity Regional High School, Woodbridge, CT
Mentors: David Post and Amanda Subalusky

The Mara River is a vital component of the Serengeti Mara Ecosystem. Frequent wildebeest mass drowning events provide an abundant source of organic matter for fish to consume directly or indirectly. The purpose of this research is to determine wildebeest carcass influence on fish diet. I hypothesize that the closer to the wildebeest inputs the fish are, the more the gut contents will relate to the carcasses. I analyzed the fish gut contents from two sites: above and within the region influenced by wildebeests. Fish collected in field research were stored in ethanol. We removed the gut track, emptied the gut contents, and analyzed them. The data was analyzed in a volumetric method by comparing the percentages of area each gut content group (insects, hippo excrement, other detritus). Results thus far show that fish without wildebeest carcasses present are not eating invertebrates, but the diet of fish with wildebeest carcasses in the area is 29% invertebrates. The results will help to chart a food web of the Mara river ecosystem, allowing us to determine the intricate relationships between aquatic and terrestrial ecosystems. They will also help to predict the effects should one species population decrease (or increase).

The Relationship Between Intelligence Quotient, Phonological Awareness, and Reading Cognition: A Behavioral and Neuroimaging Analysis

James He
Amity Regional High School, Woodbridge, CT
Mentor: Airey Lau

Reading serves as a fundamental aspect of education, but is a very complex cognitive process. Reading disabled individuals are left at a disadvantage in life, so this study investigated the relationship between IQ; phonological awareness (PA), the ability to manipulate phonemes; and reading cognition (RC), an individual's reading ability, to better understand and enhance reading development. It was hypothesized that IQ is positively correlated with a child's PA and RC, and that children with above average and average IQs exhibit less activity in the temporal lobe during phonological decoding while children with below average IQs exhibit the opposite trend. To investigate, forty-two participants aged 4-7 were randomly recruited from New Haven and given standardized assessments to determine their PA, IQ, and RC. Correlation analysis indicated higher positive correlations between IQ and PA as well as between IQ and RC as children gained reading proficiency. Also, a child with a below average IQ and PA exhibits less bilateral temporal lobe activation when decoding pseudowords rather than real words, suggesting the absence of an automated phonological decoding ability, a vital factor for a positive reading outcome. In addition, a child with a below average IQ and PA depends heavily on the right temporal gyrus while reading real words and pseudowords, an indicator of a future reading disability.

The data illustrates that IQ can potentially predict future reading outcome at the onset of reading instruction, and that children with low IQs are at risk for developing a reading disability. For children with low IQs, a phonological awareness intervention can potentially enhance reading development.

The Effect of Regulation of Autophagy on the Hedgehog Signaling Pathway in Paget's Disease of the Bone

Reshana Homma
Glastonbury High School, Glastonbury, CT
Mentor: Marc Hansen

Paget's disease of the bone (PDB) involves an imbalance in bone remodeling, a process in which bone tissue is broken down and replaced with newly synthesized tissue. This forms disorganized bone tissue which causes deformed skeletal structure and the potential development of bone cancers. Current understanding of the disease's pathogenesis is limited; however, studies have identified a mutation in the sequestosome-1 (SQSTM1) gene that is prevalent in PDB patients. This mutation is also correlated with defective autophagy in PDB, a mechanism that recycles organelles in response to oxidative stress. Furthermore, the Hedgehog (Hh) signaling pathway, which is involved in the activation of osteoclasts in bone turnover, is upregulated in mutant pagetic cells. Thus, it was hypothesized that a correlation between autophagy and Hh signaling exists. In order to confirm this, the expression of Hh signaling genes Sonic Hedgehog (sHH), GLI-4, and GLI-1 were analyzed in pagetic cells versus normal bone cells that were cultured and treated in different drugs that affect autophagy regulation: simvastatin, vitamin D, and LPS. Quantitative Polymerase Chain Reaction (qPCR) was used to quantify gene expression. Analysis of the qPCR data revealed differentiation in sHH expression in pagetic cells versus normal bone cells and upregulation of sHH expression in pagetic cells treated in simvastatin. This concludes that upregulation of autophagy amplifies sHH signaling in pagetic cells. GLI-4 was observed to be under expressed in pagetic cells, whereas GLI-1 and GLI-4 signaling were not affected by autophagy regulation. However, the difference in expression of GLI-1 and GLI-4 homologs shows promise for future research on their specific functions in Hh signaling in PDB.

Identifying Quasi Periodic Patterns in fmri Versus CBF Data

Haya Jarad
Amity Regional High School, Woodbridge, CT
Mentor: Garth Thompson

Blood Oxygen Level Dependent, or BOLD imaging, tracks metabolism of brain cells and over time depicts brain activity. These images can then be analyzed in order to better understand brain function. Cerebral Blood Flow (CBF) is a measure of the volume of blood pumped into the brain at any given time. It is obtained by taking one measurement of brain blood volume at the beginning of the time frame and another at the end. These two measurements are converted to images that look very similar to those of BOLD imaging. Because BOLD is a measurement of hemoglobin, which is found in red blood cells, and CBF is a measure of the volume of blood, which contains the red blood cells, it is assumed that BOLD images should correlate strongly with CBF images. In last year's study, an algorithm was refined and developed to detect semi-periodic patterns (called QPPs) in brain activity using BOLD data. That same algorithm, designed and run in MATLAB, will be run on the CBF data as well. It will have to be adjusted along the way to accommodate to the new data set. It will be my job to figure out what that entails as well as how to analyze the correlation between BOLD and CBF QPPs. The purpose of comparing CBF and BOLD is to determine how reliable the algorithm is. Research will be conducted in the Anlyan center at Yale University.

The Stimulation of the TNF Pathway in Jurkat Cells to Reverse HIV Latency

Mahdeen Khan
James Hillhouse High School, New Haven, CT
Mentor: Victor Wong & Kathryn Miller-Jensen

Many therapies for treating HIV are focused on activating latent HIV in immune cells. By activating HIV, therapies and drugs can focus on identifying infected cells and destroy them before they proliferate. However, because of heterogeneity, infected cells behave differently, producing different proteins, secreting different cytokines, and even causing HIV to become latent. TNF was used to stimulate immune cells to see if they activate HIV. From the data gathered, nearly 70% of cells in the TNF group were activated, while less than 5% in the control group were activated. This is evident of a correlation between TNF and HIV activation. TNF stimulation leads to a higher HIV activation rate, making it an effective practice for HIV therapy.

Fabrication of a Magnetically Vertical-Aligned Boron Nitride Nanotube Membrane in a Lyotropic Precursor for Water Transport Applications

Connor Li
Greenwich High School, Greenwich, CT
Mentor: Andrew Bramante

Boron nitride nanotubes (BNNTs) have significant potential in water transport applications, possessing a water flux greater than that of carbon nanotubes and 5x higher than contemporary reverse osmosis membranes. Larger-diameter BNNTs are also capable of harvesting osmotic power with efficiencies exceeding 1000x that of its pressure-driven counterpart. The factors limiting the application of these properties, however, are the lack of research dedicated to BNNTs and the difficulties associated with performing widespread characterization of BNNTs within a nanocomposite. This research investigates differences between BNNT chiralities via molecular dynamics (MD) simulations and develops a facile, scalable method for fabricating polymer nanocomposites with embedded vertically-aligned BNNTs by exploiting the diamagnetic, self-assembling properties of cylindrical micelles containing

BNNTs in a lyotropic liquid crystalline (LLC) precursor. The micelles orient with their long axes parallel to an applied magnetic field, templating the alignment of sequestered BNNTs. To begin, 2 g/L raw BNNTs were purified and dispersed in deionized water through sonication and then centrifugation. Following centrifugation, the supernatant was collected and incorporated into a LLC precursor in thin (<1 mm) and bulk (1 mm) film geometries with polarized optical microscopy ensuring phase stability. The films were heated to 65°C in a 1.4 T magnetic field, cooled 0.5°C/min to 35°C, and held there for 2 hours to improve orientation. They were then polymerized with 365 nm UV light, with scanning electron microscopy demonstrating the formation of aligned micelles. Polarized Raman spectroscopy at sample orientations of 0°/90°/180° demonstrates an additional Raman mode at 90°, indicating the alignment of the BNNTs due to increased intensity along the tube axis of the nanotube. MD simulations of pressurized water traveling through (9, 0) zigzag, (6, 4) chiral, and (5, 5) armchair BNNTs demonstrated that the (9, 0) zigzag BNNT transmits water faster than the other tested BNNT chiralities.

A Novel Rapid Diagnostic Test for Zika Virus NS1 Protein Using Nanoribbon Microfluidics

Lauren Low

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Mentor: Randolph Callender

As the Zika virus (ZIKV) global health epidemic continues to emerge, the necessity for rapid and sensitive viral detection methods is critical in advancing diagnosis. Current methods of ZIKV detection, which use ELISAs coupled to colorimetric readouts, are available but require large sample volumes and are time consuming. The integration of microfluidics and silicon nanoribbon technology (narrow strips of highly sensitive, low electrical noise transistors) provide potential advantages over current systems, including sensitive, low volume, and time efficient readouts. The objective is to compare the nanoribbon, pH meter, and optical detection systems of Zika virus Non-Structural Protein 1 (ZK NS1) at various concentrations ranging from onM to 28nM. ZIKV trials include three comparative experiments: (1) a well plate ELISA (Enzyme-Linked Immunosorbent Assay) with horse radish peroxidase and optical readout; (2) a well plate ELISA with urease and pH and nanoribbon readouts; and (3) a microfluidic ELISA with urease and nanoribbon readout. The results from this ongoing experiment are pending. The nanoribbon system, while still early in development, holds promise as a sensitive method for ZK NS1 and other proteins associated with epidemic viruses. Studies to improve the sensitivity by reducing drift and noise will enhance the development of this system.

Genomic Analysis of Osteosarcoma to Identify Novel Key Regulatory Pathways in Tumorigenesis

Samarth Menta

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Mentor: Marc F. 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). In patients who do not respond to chemotherapeutic treatment, it is believed that there are certain genes that are expressed in their tumors. The cancer stem cell hypothesis states that tumors are maintained and evolved by stem cells. There are also bulk cells in OS tumors, which are limited in their replication ability and play a minimal role in proliferation. The aim of this project was to compare gene expression in OS cell lines (which includes stem cells and bulk cells) and non-OS human bone cells. Using a bioinformatics approach, I searched for coordinately regulated genes and hoped to find the master regulatory switch(es). The two gene sets that were analyzed were available from the Gene Omnibus Database on NCBI. After extensive analysis, the only viable gene candidate was CCNB2, also known as Cyclin B2, a cell cycle regulator. It was highly expressed in tumor cells vs. the non-tumor cells and specifically, it was highly expressed in the stem cells compared to the bulk cells. Future studies in the laboratory will test this gene to validate or reject this meta-analysis. If validated, targeting CCNB2 may create new options for complete treatment of OS through the eradication of the stem cells, which perpetuate tumorigenesis.

Growth and Sustainability of Metarhizium on Low-nutrient Substrates

Gabrielle Stonoha

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Mentor: Sara Sullivan

This experiment addressed one aspect of Colony Collapse Disorder(s), the parasitic Varroa mite that preys on Apis mellifera brood and reduces their immunity, causing mass death and colony collapse. Utilizing the fungus Metarhizium, an entomopathogenic fungus that research has shown is effective against Varroa, this experiment studied the growth of the fungus in the field with an aim of improving its cultivation and making it more accessible to beekeepers. The majority of literature on Metarhizium is on its growth in a sterile lab environment. This project, conversely, tested its growth on three different common substrates that A. mellifera may be exposed to readily in the field: wood chips, leaves, and silage. The three substrates were inoculated with Metarhizium spores and left to grow for three weeks in natural conditions. Samples were taken once a week to show growth over time, and weather conditions were monitored. The environmental samples that were taken weekly were suspended in the emulsifier Tween 80 and vortexed. The samples then underwent a serial dilution process, followed by plating on both PDAC/CTAB (cetyl trimethyl ammonium bromide) plates and PDAC only plates. After three weeks of growth on the plate, the number of colonies of Metarhizium and their size was measured. At present, the data collected is tentative, but it appears that the fungus is viable for three weeks after application, with wood chips as perhaps the most effective substrate. Mathematical analysis of the data still needs to be undertaken before any conclusions can be reached.

Detection of Premalignant Pancreatic Cancer via Computational Analysis of Serum Proteomic Profiles

Shobhita Sundaram

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Mentor: Andrew Bramante

Pancreatic cancer (PC) is currently one of the deadliest cancers, with a 5-year survival rate of 7%. Detecting PC while it is localized increases the survival rate to 30%, however to date, such a diagnostic tool is nonexistent. In this project, I proposed the development of a computational classification model that can accurately detect premalignant PC from patient blood mass spectrometry (MS) data. A database of 181 MS samples was used. Preprocessing was performed to eliminate chemical noise and extract true signals. Detected peaks were analyzed to determine the most discriminative biomarkers. Prior research used univariate feature selection methods to measure each variable's importance. In this research, a novel hybrid approach was developed, combining univariate and multivariate methods to analyze interactions between protein markers, and how interdependencies impact predictive value. Using this method, several machine learning algorithms were trained to produce diagnostic models. The highest-performing model achieved an ROC accuracy of 80%, demonstrating significant improvement over past research, which was limited to 69%. Analysis of results suggested that a hybrid approach to feature selection leads to discovery of new biomarkers, and development of superior tools to diagnose premalignant PC, allowing doctors to treat it while curative surgery is still possible.

Portable, Low-Cost Tattoo-Based Biosensor for the Non-Invasive Self-Diagnosis and Quantification of Atherosclerosis

William Yin

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Mentor: Andrew Bramante

Atherosclerosis and subsequent cardiovascular disease causes nearly one-third of all deaths in the world. Unfortunately, atherosclerosis commonly remains asymptomatic for decades, and is properly diagnosed only after a severe, life-threatening cardiac event. A simple, portable, and inexpensive method for early detection of atherosclerosis is highly desirable. This research details the fabrication of a cost-effective and portable tattoo-based system for the detection and quantification of atherosclerosis progression. The system is contained within a screen-printed biosensor which utilizes human immune response in order to quantify macrophage concentration in the bloodstream via the transdermal iontophoretic administration of spermine-silver nanoparticles (spAg-NPs). In clinical usage, the patch is placed on the skin directly above the carotid bifurcation, where plaque quantification/diagnostic accuracy is especially high. The patch utilizes an iontophoretic circuit to introduce spAg-NPs into the interstitial fluid matrix. The patient then waits for macrophages to enter into the matrix and engulf a portion of the spAg-NPs. Remaining spAg-NPs are then extracted via a reversed current, which then react with amine oxidase to produce H₂O₂, which in turn electrochemically reduces Prussian-Blue 'artificial peroxidase'. Current produced is measured to determine concentration of spAg-NPs, and thus the concentration of macrophages in the bloodstream, which correlates directly with progression of the atherosclerotic plaque. The biosensor demonstrated a limit of detection of 3.26×10^{-5} M spAg-NPs, with a sensitivity of $5.07 \mu\text{A}/\mu\text{M}\cdot\text{cm}^2$, allowing for the precise, cost-effective detection of as little as 0.059% arterial cross-sectional plaque buildup within the carotid bifurcation.

Poster Presenters

Crowd-Sourced Detection and Mapping of Nitrate Water Pollutants via a Mobile Web-Based Image Analysis System

Luca Barcelo

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Mentor: Paulina Larrauri

Countless fertilizers and plant-conditioning products utilize nitrates, which when presented into an ecosystem with surrounding bodies of water, catalyze the dangerous process of eutrophication. Eutrophication is both a rapid process and difficult to detect for due to the volatility of nitrate influx into bodies of water. During the day phytoplankton populations grow exponentially where nitrates are present in abundance, while at night most die off, which results in a serious drop in dissolved oxygen levels during the night because of decomposers. To combat this drop in dissolved oxygen levels effectively, a crowd-sourcing detection method is essential in order to accurately, efficiently, and rapidly tag problematic zones. Furthermore, by introducing both a Sulphanilamide coupled with N-(1-naphthyl)-ethylenediamine dihydrochloride compound, and zinc powder into the water sample, and by measuring the color emitted from the solution, through image analysis and supervised machine learning—once both compounds are added to the water sample—the mobile platform will be able to measure the quantity of nitrates that are present in the given water source. The mobile image analysis system uses a picture's RGB values to correlate color intensity to nitrate concentration through an R-based shiny web-based application. Through the implementation of colorimetric analysis of given solutions by the utilization of the user's phone camera, one may attain information on nitrate concentration levels in the tested body of water, which will be uploaded to a database that all contributors may access, thus allowing for the general population to acquire knowledge about their surrounding aqueous environments.

Determining the Optimal Implementation for Secure Multiparty Computation of the Logistic Function

Andrew Benz

Darien High School, Darien, CT

Mentor: Mariana Raykova

Secure multiparty computation is a technique in cryptography that allows for two or more parties to compute an arbitrary function over their inputs without revealing their inputs to the other parties. Yao's garbled circuit protocol provides a method of implementing secure multiparty computation between two parties over any arbitrary function by converting the function into a Boolean circuit and then converting each gate in the circuit into an encrypted form. The objective of this research is to determine the most efficient method of implementing the logistic function in the secure multiparty environment. The logistic function, defined mathematically as the reciprocal of one plus the exponential function reflected about the y-axis, is commonly used in neural networks, where the behavior of each neuron in the network is mathematically modeled using the logistic function. Obliv-C, a wrapper for the GCC compiler that converts numeric operations used in C programs into Yao circuits, will be used for the implementation. Performance will be measured using wall clock time, i.e., the time elapsed between the initialization of the protocol and its execution. The efficient implementation of a logistic function for secure multiparty computation could lead to the development of secure computation for neural networks.

Least Positive Outcome: Health Service Use in a Longitudinal Study of Autism Spectrum Disorders

Claire Borecki

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Mentor: Lauren Pepa

Young adults with autism have higher incidences of psychotropic medications, seizures, hospitalizations, service dissatisfaction, and service limitations. Some people with autism have a "very positive outcome", or lose their diagnosis with age. This group has been estimated at 10% of cases. However, a "least positive outcome" is undefined. This study was conducted at the Center for Autism and the Developing Brain with a 24-year longitudinal study of over 100 probands. Proband parents completed surveys. The data points were counted for frequency within in the longitudinal group. Only 4 probands had a psychologist/psychiatrist/neurologist in primary care despite high medication reporting. Care satisfaction was low, although few reported limits on services, implying that the highest area of need is within services themselves. The most reported limit was behavior. Small percentages had extreme incidences of medication use, seizures, no primary care, hospitalizations and behavioral issues. Almost all probands with no primary care had no autism services, a sign of total disengagement. More analyses are being run to look at the overlaps of these groups in an attempt to determine a "least positive outcome" group based on health.

The Efficacy of Topical Ascorbic Acid as an Inhibitor to Mold and Microbial Growth

Cassidy Fawcett

Bridgeport Regional Aquaculture Science & Technology Education Center, Bridgeport, CT

Mentor: Kirk Shadle

Escherichia Coli and different variants of mold can infest packaged produce and led to roughly 1 in 6 Americans (or 48 million people) becoming ill each year by CDC estimates. Experimentation will determine the efficacy of a topical ascorbic acid application of packaged produce to prevent the spread of mold and microbial growth. Blood agar plates were streaked with E. Coli, inoculated with a 10% ascorbic acid 5mm tab and incubated at 37°C for 24 hours. Controls were established with untreated plates. The zone of inhibition was measured to be ≥ 1 mm. Blood agar plates will be streaked with mold and inoculated with a 10% ascorbic acid 5mm tab and incubated at 37°C for 24 hours. Controls will be established with untreated plates. Based on the preliminary data indicated, a bacterial response to ascorbic acid was observed. Ascorbic acid can be applied in future methods of prohibiting mold growth through a topical application.

The Effect of Collect Nutrient Powder on Mus Musculus Lewis Lung Carcinoma Cell Confluence, Viability and Growth Rate

Marissa Guzzo

Greater Hartford Academy of Mathematics & Science, Hartford, CT

Mentor: Lili Aramli

There is no simple answer to cancer containment, let alone an affordable, accessible, and safe one. Collect, an affordable, sustainable proprietary mineral blend, claims to reduce the proliferation of cancer and even stimulate apoptosis in affected cells, may be the answer to slowing or stopping cancer growth. This investigation observes cancerous mouse lung cells being cultured in different concentrations of Collect made to emulate typical human conditions along with normal lung cells in order to evaluate the effect Collect has on the cell confluence, growthrate, and viability. There has been minimal research on Collect, which is why it was selected as the testing entity. After in-depth research of the powder, it was determined that multiple websites and testimonials from consumers contain positive feedback and excellent reviews, yet the question arose about it functions at the cellular level numerous times. After learning sterile culturing techniques, an experiment was devised in order to research the effects of the powder on both cell types. The findings of the research are still in progress. The current observable trend is as the Collect dose increases, the cancer cell growth increasingly is inhibited. Yet the most important finding is it is current being observed that the normal cell growth is unharmed and proceeds at a healthy rate within each concentration. These preliminary findings are essential in the evolution of cancer treatment as Collect powder is easily accessible to consumers, comes in many varieties, and may have significant effects on cancer growth inhibition.

Predicting the Genomic Pathways of Adaptation in *Spartina alterniflora* Salt Tolerance Protein LSD1 in Response to Sea Level Rises Via Phylogenetic Trees

Amanda Hernandez

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Mentor: Kirk Shadle

Coastal wetland communities are delicate ecosystems, sea level rises can and have easily disturbed the balance in these areas by exposing marsh plants to levels of salt that are higher than can be tolerated. In this research the LSD1 protein gene of 14 different organisms have been mapped with a rooted phylogenetic tree to develop a prediction on how the marsh grass *Spartina alterniflora* will genetically respond to prolonged levels of high salinity using the model organism; *Oryza sativa*. As climate change continues to warm the oceans, plants which reside on lower level altitudes must adapt to the new levels of salt and water elevation. Knowing a way that *S. alterniflora* (key species in salt marshes) may adapt can help coastal management protocols be effectively established. Analysis has shown *S. alterniflora* to have the closest relationship to *Oryza sativa* and *Zea mays* with a divergence of 0.0 nucleotide substitutions per site. Because of this the convergence of *S. alterniflora* is very likely to occur through a silent mutation of the LSD1 protein; changing the rate of its expression similar to *Oryza* or *Zea*. Future research can involve an empirical approach using PCR (polymerase chain reaction) to detect the concentration of this protein in *S. alterniflora* when exposed to different levels of salt.

Whole Exome Sequence Analysis of Sporadic Ossifying Fibroma

Niyati Hora

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Mentor: Jessica Costa

Ossifying Fibroma (OF) is a benign neoplasm that specifically affects the craniofacial bones. The goal of this study is to determine the correlation of the CTNNB1 gene and OF. OF samples were sent to Genewiz company for whole exome Next Generation Sequencing. The resulting data were analyzed and candidate genes selected for further analysis. Primers were designed and Polymerase Chain Reaction (PCR) was carried out to amplify DNA segments in which mutations were observed. Successful PCR amplification was confirmed by gel electrophoresis. PCR products were then prepared and sent for Sanger Sequencing. Resulting sequence data was compared to a reference sequence through chromatograms. Thus far, we have failed to confirm that CTNNB1 mutations are present in OF, and further testing is being conducted to arrive at a more concrete conclusion. This study is relevant as it could lead to the discovery of the cause OF, early diagnosis of the tumor, and development of a cure.

Anticorrosive Barrier Microwave-Assisted Coatings on AZ31 Magnesium Alloy to Reduce Degradation Rate for Metallic Medical Implants

Anish Kosanam

Greens Farms Academy, Westport, CT

Mentor: Mathieu Freeman

Coronary stents are used to treat heart disease by keeping arteries open and prevent their closure due to plaque. These stents are created on a stainless steel or cobalt alloy platform, which are not fully biocompatible and can result in restenosis and thrombosis. They also do not dissolve into the human body after healing and regeneration time has passed, which does not allow for the organ to return to normal function. AZ31 magnesium alloys are promising materials for these issues, but barrier coatings are necessary since magnesium dissolves rapidly in the body. This study decreases the degradation rate of AZ31 magnesium alloy by altering hydroxyapatite-coating compositions. Flat magnesium substrates were coated with prepared solutions, ranging from 0.75 to 3.5 Ca/P ratios and irradiated by microwave. The degradation rate of the coated substrates was tested in simulated body fluid where it was determined that a 1:1 calcium to phosphorus ratio had the slowest degradation rate of 0.0026 (mg/cm²)/hr for a seven day period. The effect of polishing the substrate prior to the deposition produced a higher degradation rate of 0.0416(mg/cm²)/hr. Coatings on rod-shaped substrates were also successful with this technique. The chemical compositions, morphology, and porosity of the deposited substrates prior to and following their immersion in SBF were examined using high resolution scanning electron microscopy accompanied by energy-dispersive x-ray spectroscopy. It was elucidated that annealing would further decrease the degradation rate of AZ31 by increasing crystal size and decreasing porosity in the barrier coating protecting the magnesium alloy.

Flu Induced Alterations in Muscle Cytokine Expression Due To Aging

Ronak Mahatme

Glastonbury High School

Mentor: Jenna Bartley

Despite influenza (flu) being a respiratory infection, it is one of the leading causes of catastrophic disability in the elderly. However, the muscular component of flu infection is under researched as the majority of research focuses on immune responses. Utilizing a well-established murine model of flu infection, I sought to determine the influence of age on muscle-localized, flu-induced inflammation by examining cytokine expression within the gastrocnemius muscle. Cytokines are small proteins that can be largely classified as pro-inflammatory or anti-inflammatory. Young and aged C57BL/6 male mice were intranasally infected with a sublethal dose of influenza. The gastrocnemius muscle was harvested on days 0, 1, 7, 10, and 12 post infection. Muscle was homogenized and protein was extracted and analyzed via BCA Assay for total protein concentration and multiplex for cytokine/chemokine concentration. Cytokine/chemokine concentration was normalized to total protein content. I hypothesized that flu induces prolonged inflammation within the muscle of aged mice. Surprisingly, there was no difference in IL-6 levels throughout

infection between young and aged; however, previous findings have shown that IL6-receptor increases in infected aged mice. Aged mice had dramatically increased CXCL-10 on day 12 post infection compared to young mice. Contrarily, young mice had increased anti-inflammatory signals, both IL-10 and IL-4, during flu recovery. Taken together, young mice had a stronger anti-inflammatory response later in infection, while aged mice had prolonged pro-inflammatory signals. It is possible that these specific cytokines can be targeted for therapeutic use to develop medication that prevents inflammation and resultant muscle degradation.

Synthesis and in vivo Evaluation of an Aromatase Inhibitor as a PET Radiotracer

Jasmine Moon

Amity Regional High School, Woodbridge, CT

Mentor: Songye Li

Recently, the connection between brain aromatase, an enzyme that catalyzes the synthesis of estrogens from androgens, and non-reproductive conditions has been revealed (Roselli, et al. 2009; Simpson, et al. 2001; Fink, et al. 1999). Studies on aromatase can potentially explain gender differences in central nervous system diseases like depression and cocaine addiction. To better understand the distribution and functions of brain aromatase, a functional imaging technique, positron emission tomography (PET), was used in vivo. In PET, radiotracers bind with enzymes and emit γ -rays, which are translated into images (Laruelle, et al. 2003). The first aromatase inhibitor PET radiotracer 11C-Vorozole presented difficulties in synthesis and radiometabolites entering brains, so 11C-Cetrozole was then developed (Takahashi, et al. 2015). This study aimed to 1) test new 11C labeling method: cyanation using H11CN; 2) develop PET radiotracers with improved binding characteristics; 3) develop 18F labeled radiotracer with extended half-life (120 min for 18F vs. 20 min for 11C). These compounds will be assayed for binding affinity, and potential candidates will be evaluated in vivo using PET.

IgM Expands Regulatory T Cells and Demonstrates Therapeutic Potential for Type 1 Diabetes

Caleigh Morr

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Mentor: Daniel Moore

Autoimmunity is the process in which autoreactive cells in the immune system recognize the body's own tissues as foreign and attack them. Several regulatory mechanisms exist to protect the individual from this danger, such as regulatory T cells (Tregs), a type of cell essential for maintaining immune self-tolerance by identifying and eliminating autoreactive cells. However, this regulatory mechanism sometimes fails, and harmful cells remain active in the body. Type 1 diabetes (T1D) is an autoimmune disease which occurs when autoreactive lymphocytes attack and destroy the insulin-producing beta cells of the pancreas. IgM, an antibody produced naturally by B cells, has been shown to prevent T1D in non-obese diabetic mice, though the mechanisms by which this result was achieved are unknown. This research studied the effects of IgM on Tregs in samples of human PBMCs and mouse splenocytes in an attempt to better understand how the antibody works. It was found that incubating the cell samples with IgM significantly increased both Treg numbers and percentages, indicating that IgM likely reestablishes self-tolerance through the correction of defects in regulatory mechanisms and the elimination of autoreactive lymphocytes. By restoring immune homeostasis, IgM has substantial therapeutic potential for autoimmune diseases including T1D.

Investigating the Cooperation in the Sharing Economy using the Wifi Sharing Game

Julia Nadelmann

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Mentor: George Iosifidis

The purpose of this study is to investigate what factors impact how individuals cooperate in a sharing economy. For this study, individual participants will engage in an online WiFi sharing game with other participants, in which each participant is a resident of different nearby house, each with a Wi-Fi connection of a certain bandwidth. When a participant is not home, they have the ability to share their Wi-Fi with their neighbors, and in return one's neighbors can share their internet with other participants when they are not home, corresponding to an economic reward. The independent variable in the experiment was the different information that is shown to the players prior to deciding, to investigate how awareness of other players wealth, node degree, and previous sharing behavior impact cooperation and sharing decisions. It was hypothesized that (1) players are not playing simply a strategy that maximizes their but they are also interested in satisfying some fairness objectives; (2) the information about the degree of each player makes the strategy of the players less altruistic/fair; and (3) the information related to the score changes the strategy in some way, and reduces the satisfaction of the players from the sharing process. Players aware of neighbor's wealth (n=14) were significantly ($p < .05$) less satisfied with the sharing process after the experiment. While 71% of participants in the control group (n=17) played to satisfy an objective of fairness, only 41% in the group with degree visibility (n=18) played to satisfy the fairness objective, supporting the hypothesis.

How Does the Type of Attention During the Imprinting Period Affect Memory Development?

Taryn Rahman

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Mentor: Golam Chowdhury

Imprinting is the early critical learning phase when the brain establishes implicit memories such as behavior. The imprinting process has a direct relationship with memory development; Distinct factors, such as attention, allow a greater exponential growth in memory development overtime. During the imprinting stage, the type of attention a child receives will affect memory

development. I decided to investigate beneficial methods of attention while considering neuron mass within the hippocampus and basal ganglia as my data collection method. I raised ducks for about five months. Five ducks were placed in the village group where they interacted with students, while the other five ducks were placed into the individual group where they were exposed to only one individual, with the intention of having them imprint on this person. Within each group, three of the ducks completed an interactive task for a total of three trials. Throughout the five month period, the behavior of the ducks were tracked overall and under specific conditions. The stained slices of the extracted and sliced brains will reveal differences in the neuron mass within the basal ganglia and hippocampus amongst each duck. For this, the ducks had to be euthanized, which was done at a halal butcher shop, found by my research coach. Overall, the behavior for the village group ducks was much more flexible than the individual group ducks. Regarding the slices, the greater the neuron mass comparatively amongst the ducks, the greater the memory development.

Designing a Canine (Canis familiaris) Facial Recognition System of Emotions

Hannah Rappaport

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Mentor: Tracy Johnson

As pets or service animals, dogs are in close contact with humans. This closeness makes human-dog communication a topic of high importance. Using the engineering design process, a facial recognition system was developed for canines. Communication between humans and dogs can certainly improve and many emotions of dogs can be misinterpreted. This system may improve the accuracy of canine emotion recognition. Videos were taken of eight volunteered dogs after behavioral situations were used to induce emotional expressions of happy, sad, and surprise. The AUs (Action Units) for each emotion were identified from the videos using DogFACS protocol. New AUs were encountered that are not defined in DogFACS. C++ was used to program a facial recognition system to track the faces of dogs and to recognize the AUs that combine to determine the emotions of the dogs. The system was first programmed with manual outlining of the dogs' facial features. Computer Vision was then used to recognize the facial features without manual intervention. The system notifies the owner of the expressed emotion. Owners and dogs have a mutualistic relationship, therefore humans should better understand the quality of life of their dogs, just as dogs work to understand their owners. Ultimately, facial emotion recognition systems could be expanded for many species of domestic or zoo animals so that animals in human contact could be better understood.

Characterization of Pluronic F127 Degradation Patterns and Drug Release Under Laminar Flow for a Preventative Measure Against Failed Back Surgery Syndrome

Neal Soni

Staples High School, Westport, CT

Mentor: Miriam Rafailovich

Pluronic-F127, known for its supramolecular micelle structure and thermoreversible gelation, is a viable FDA approved candidate for the prevention of post-surgery epidural fibrosis from Failed Back Surgery Syndrome. F127 is proposed to function as a membrane to obstruct lumbar epidural fibrosis and conduct sustained drug delivery before eventual degradation. F127 degradation and drug release under flow was characterized to comprehend F127's behavior under in vivo conditions. Baseline rheology established a G'-concentration curve and verified gel viscoelasticity. A novel experimental system was constructed, applying deionized water across F127 samples at 0.1-1.0mL/min flow rates to simulate spinal flow. Post-flow rheology determined G' of gel samples to characterize degradation patterns. UV-Vis spectroscopy on outflow established a peak area-concentration curve, used to verify degradation patterns from rheology. Repeated experiments incorporated vancomycin to analyze drug release; results from both experiments show higher flow rates yielding lower degradation rates and slower drug release. X-ray imaging depicted an interfacial region between flow and gel; lower flow rates exhibited larger interfacial regions, resulting in higher osmotic pressure and prolonged F127 liquefaction and subsequent degradation. Results highlight F127's potential biomedical application as a gel membrane optimal for high flow rate environments such as the lumbar region.

Rapid Colorimetric Field Monitoring System for Zika Virus in Mosquito Populations via DNAzyme-Functionalized Gold Nanoparticles

Rahul Subramaniam

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Mentor: Prem Subramaniam

The ongoing Zika virus (ZIKV) epidemic has emerged as one of the most urgent global health crises of the decade, with over 200,000 people being affected worldwide. However, current methods (RT-PCR, ELISA, etc.) for detecting Zika virus in mosquito populations are either too costly, too time-consuming or require highly specialized training. The goal of this research was to design and test a rapid detection kit for ZIKV in mosquito saliva that is inexpensive and requires little special training to analyze. Synthetic viral RNA was detected using gold nanoparticles functionalized with deoxyribozymes; detection was observed visually through a red-to-clear color change in the solution. A mosquito trap that effectively attracts mosquitoes was also constructed, and mosquito saliva was detected using previously established methods. Finally, the long-term stability and detection limit of the assay was established to confirm its validity as a field test. The research will be considered successful when all of the above requirements are met. Upon completion, this will fill a vital gap in current ZIKV detection methods by creating a kit that can detect virus in mosquito saliva and provide colorimetric results in a very short period of time.

The Role of Acidity in Phosphorus Fixation of Brassica rapa through Induced Systemic Resistance by Inoculation of Azospirillum brasilense

Melani Zuckerman

Joel Barlow High School, Redding, CT

Mentor: Katherine Nuzzo

The use of fertilizer as a means to mediate abiotic stress and increase nutrient uptake has been used widely in the past 100 years. Phosphorus fixation is key components in plant development, playing an essential role in photosynthesis, respiration, energy storage and transfer, cell division and cell enlargement. Plant Growth Promoting Rhizobacteria (PGPR) solubilize phosphorus into compounds that the plant can use, which increases its uptake and increases the plant's biomass. In this experiment, we hope to investigate the effect that low pH has on the phosphorus fixation of a rhizobacteria inoculated plant. Two of the plants will have a soil pH of 7.0, and the other two 5. One of each soils will be inoculated with rhizobacteria, and the other two will not. This experiment includes a control for each of these factors. After 14 days of growth, we expect to see a higher level of phosphorus fixation in the plants with the inoculated PGPR, and a higher level of phosphorus fixation in the neutral pH soil compares to the acidic one. If our hypothesis is correct, PGPR may serve as an effective biofertilizer to help plants combat acidic stressors as opposed to harmful artificial fertilizer.



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