

**19th
Annual**

Connecticut STEM Fair

Saturday, February 9, 2019

Sponsored by:



Inspiring and Educating Students

CTSTEMfoundation.org

Fair Schedule 2019

7:30 am – 9:15 am:

Security Check and Registration (Entrance Lobby)
Judges' Orientation (Cafeteria) followed by
Judges' Training (Auditorium)

8:30 am – 9:15 am:

Exhibitor Check-In (Athletic Entrance)
Exhibitor Breakfast (Cafeteria) and
Exhibit Set-Up (Main Gymnasium)

9:30 am – 12:30 pm:

Judging of Exhibits (Main Gymnasium)
12 pm – 1:30 pm:
Fair Exhibits Open to Public (Main Gymnasium)
Lunch for Exhibitors & Judges (Cafeteria)

1:00-1:30 pm:

Sponsors/Advisors roundtable talk on
the research process

1:30 pm – 3:30 pm:

Keynote Presentation by
Dr. Stormy Chamerlain, Ph.D. (Auditorium)
Followed by the Awards Ceremony

Keynote Speaker

19th Annual Connecticut STEM Fair

We are honored to welcome
Dr. Stormy Chamberlain, Ph.D.



Dr. Stormy Chamberlain is a widely published, 10-year researcher in the field of Angelman syndrome and UBE3A, who has given more than 30 talks and lectures about a variety of related topics. She is the Raymond and Beverly Sackler Endowed Associate Professor of Genetics and Genome Sciences at in the University of Connecticut's Genetics and Developmental Biology department and is assistant director for UConn's Graduate Program in Genetics and Developmental Biology.

Dr. Chamberlain established her own lab at UConn in 2009, using induced pluripotent stem cells (iPSC) to model and study human imprinting disorders, focusing on Angelman syndrome, Prader-Willi syndrome, and Duplication 15q syndrome. Her lab works closely with Dr. Marc Lalande's lab and currently has two major on-going projects. She is also a frequent collaborator with other high-profile Angelman syndrome researchers. In addition to the ASF Scientific Advisory Committee, Dr. Chamberlain serves on the Dup15q Alliance Scientific Advisory Board and on the International Journal of Medical Genetics Editorial Board. Dr. Chamberlain earned her B.A. in Molecular Biology from Princeton University and her Ph.D. in Molecular Genetics from the University of Florida and conducted post-doctoral work at the University of North Carolina and UConn Health Center.

Angelman syndrome is a complex genetic disorder that primarily affects the nervous system. Characteristic features of this condition include delayed development, intellectual disability, severe speech impairment, and problems with movement and balance. Dr. Chamberlain is the chair of the scientific advisory committee at the Angelman Syndrome Foundation and serves on the professional advisory board for the Dup15q Alliance, which provides family support and promotes awareness, research and targeted treatments for a chromosome duplication syndrome.

She is enthusiastic about the opportunity to speak at the Connecticut STEM Fair. She was a science fair participant for five years—including ISEF for four years!

Special Thanks

We Gratefully Acknowledge the Generous Support of

The Sexauer Foundation

The continued support from the Sexauer Foundation is crucial in allowing us to grow and deliver valuable STEM programs to the students and teachers of Connecticut.

Each year Sexauer's donations have underwritten major expenses associated with producing our fair and have allowed us to expand our mission to engage universities, businesses, and students of all ages.

Acknowledgements

The Connecticut STEM Foundation, Inc., gratefully acknowledges these generous contributors:

**Major Sponsor of the Fair,
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The Connecticut STEM Fair could not exist were it not for the contributions of dozens of volunteers who devote their considerable talents and thousands of hours to fair activities. We acknowledge in a special way the Faculty and Staff of Amity Regional High School, which hosted the Fair.

Our volunteers include approximately 200 judges, 40 individuals who prepare materials for the fair; 25 who assist with fair day activities, and the members of the Connecticut STEM Foundation Board of Directors who manage the fair.

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Our volunteers include approximately 200 judges, 40 individuals who prepare materials for the fair; 25 who assist with fair day activities, and the members of the Connecticut STEM Foundation Board of Directors who manage the fair.

For Their Dedicated Service:

Our Talented and Hard-Working

Judges (as of 1.19.2019)

Dorothy Adams
Chirag Adhia
Aakriti Aggarwal
Benjamin (Ben) Alper
Luis Antunez
Sundararajan Balaraman
Megan Behan
Shumin Bian
Candace Bichsel
David Boudreau
Ryan Bower
Larry Bowman
Randall P. Bright
John Callaghan
Joseph Carraway
Prakash Chakravarti
Rex Chen
Jose Colon-Rivas
Lisa H. Conti
Jessica Crowson
Cheryl Damiani
Greg D'Andrea
Barak Davidi
Paul Delano
Frank DiCristina
Michelle Dilworth
Michael Doery
Arthur Doweiko

Donna Duesse
Sophie Dutheil
Robert Epstein
John Everett
Jesus Fabian
Philip Faraci
Linda Farber
John Feder
Karin Finberg
John Fleming
Apoorv Garg
Michael Giordano
Thomas A. Giordano
Emily Goldberg
Ken Goldman
Maria Grishanina
Scott Haeffner
Allen Hall
Amy Handmaker
Alison Herold
Patty Heyl
Andrew Jackson
Judit Jimenez Sainz
Tommy John
Kelley Johnson
Evan Jones
Adel Joobeur
Eduardo Kamenetzky
Andrew Keane
Sarah Keeney
Sarah Kieck
Betty Klein
Craig Knebel
Rajeswari Kompalli
Jasper Lam
Jean Larson
Tom Larson
Judith Leahy
Wilson Lin
Bob Logano
Carolyn Macica
Isaac Macwan
Harvey Mamrus
Daniel Martens
Ray Martinelli
Robert McDougal
Timothy McGinnis
Matt Miller
Ruth Montgomery

Bruce Morris
F. Carl Mueller
Bikshandarkoil (BA) Narayanan
Guinevere Ngau
Kyle O'Connor
Jo Ann Olsen
Chaitanya (CK) Pai
John Pelegano
Francis Pfeiffer
Bernd Pfrommer
Luu Pham
Jeff Pierce
Karen Pierce
Christopher Pittenger
Doug Polnar
Francis J. (Frank) Robinson
Harry Rosvally
Karin Russo
Marie Sabo
Teresa Sauer
James Saulnier
Joshua Schwartz
Michelle Schwenger
Bernard Sekula
Veronika Shabanova
Beth Siegelbaum
Deirdre Silberstein
Ray Skorupa
Chris Smith
Tom Spak
John Sterpka
Brendan Stewart
Natasya Sulisty
Shane Sullivan
Ambady Suresh
Benedict Tan
Paul Testa
Sorin Toba
Kenan Tokmic
Carol A. Tomczyk
Jeremy Toyn
Alla Tsipenyuk
Karen Varco
Corbinian Wanner
Aubrey Winarski
Nancy Wyshinski
Philip Zuckerman



The **Connecticut STEM Foundation, Inc.** is a non-profit organization. Your contribution, financial or otherwise, is greatly appreciated. Our goal is to expand our Fair to include students from other areas of Connecticut, create educational programs, and lecture series, and increase our annual awards and scholarships.

We also welcome volunteers to assist with fundraising, web development and development.

If you'd like to make a tax-deductible donation, or volunteer to help us reach our future goals, please contact us at CTSTEMfoundation.org, or send us an email to connecticut.stem@gmail.com, or donate directly via PayPal at <https://www.paypal.me/CTSTEM>.

Thank you for your support!

How to Contact Us:

The Connecticut STEM Foundation, Inc.

PO Box 1048, Redding, CT 06875

203-978-3689

www.CTSTEMfoundation.org

connecticut.stem@gmail.com

You can find us on Facebook and LinkedIn



The Connecticut STEM Foundation, Inc. (CTSTEM), an IRS Sec. 501(c)(3) non-profit organization, seeks to inspire and educate students by encouraging inquiry and exploration in science and engineering, and by exposing them to exciting and practical advances in science. In addition to sponsoring the Connecticut STEM Fair (CTSTEM Fair, www.ctstemfair.org) each year, CTSTEM has held some extraordinary events for students to see the practical application of science, including a visit to Pratt & Whitney's aircraft engine facilities, a physics lesson using an actual LeMans race car and a seminar by "citizen astronaut" Greg Olsen.

For more information, sponsorship opportunities, or how to make a donation, please visit us at our web site at CTSTEMfoundation.org.

Yale New Haven Hospital congratulates the participants in this year's CT STEM Fair

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Health

Yale New Haven
Hospital



Yale New Haven Hospital has been honored to care for this community for more than 185 years. We're proud to be part of a rich tapestry in which so many organizations work together for the entire community. Best wishes to the students in this year's health, science and technology fair.

Does your company match your donations to a non-profit?

Please consider a donation to **Connecticut STEM Foundation, Inc.** and ask your employer to match your donation.

For further information, please send an email to: connecticut.stem@gmail.com.



The winners in life think constantly in terms of "I can, I will, I am."

-Denis Waitley



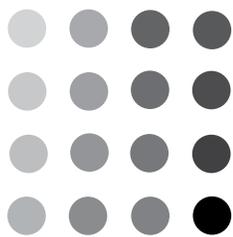
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The Board of Directors of
Connecticut STEM Foundation, Inc.
would like to congratulate

AJ Scheetz

recipient of this year's

Paul Heilman Award

There is no truer representation of the Heilman award than AJ Scheetz. Inrecognition for the tireless commitment and dedication to the CT-STEMFoundation. AJ has brought a high level of professionalismand energy in his role as Registration Chair. He has worked endless hours meeting the needs of the students and board members with criticaldocumentation. His ability to communicate effectively and efficiently have beeninfluential in the success of the program.

Congratulations on a very well deserved Award, and much appreciation for the tremendous support.





The Connecticut STEM Foundation, Inc.
would like to thank the

Office of Naval Research

for their generous support of our
Connecticut STEM Fair by providing
five Awards to deserving students.



The Board of Directors, and the Advisory Board would like to extend our
deepest heart-felt appreciation to

The Sexauer Foundation, Inc.

for their continuous support of our Foundation. This year, the Sexauer
Foundation are proud sponsors of the Health and Behavioral Science
Awards. Plus the two college scholarship awards to graduating seniors
are given on behalf of the Sexauer Foundation.





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A black and white photograph of a cleanroom environment. Several workers in white protective suits and masks are working with large, complex machinery. The scene is brightly lit, and the workers are focused on their tasks. The image is framed by a large, curved, semi-transparent white shape that contains the text.

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The logo for allnex, featuring the word "allnex" in a bold, lowercase, sans-serif font. The letters "a", "l", "l", and "n" are connected. There are horizontal lines above the "l"s and "x".

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About the Connecticut STEM Fair

The Connecticut STEM Fair was started in 2001 and has grown rapidly over the last 16 years. The 2017 fair was held at Darien High School in Darien, CT and showcased the original research of 250 students and the participation of a similar number of judges, science and technology professionals drawn from our communities. A key element of the Fair is comprehensive interactive judging of all entrants. In 2017, for the first time, we were able to send three of our top students to participate in the International Science and Engineering Fair (ISEF), the Olympics of science fairs. We will continue our affiliation with ISEF in the coming years.

The Fair promotes critical thinking skills and motivates students to pursue science and engineering after high school. Students receive awards in four scientific categories: health, physical, environmental, and behavioral. Within each category, awards are given for both completed projects and research proposals. The 2019 Fair will be

held at Amity Regional High School in Woodbridge, CT on Saturday February 9, 2019.

Our mission is to foster interest among all Connecticut high school students in science, technology, engineering, and math (STEM) by providing experiences for them to present their original research and interact with like-minded students and professionals.

We advocate for STEM and we seek to inspire and educate students, academics, parents and other members of our communities. In addition to sponsoring the Connecticut STEM Fair each year, the Connecticut STEM Foundation has supported advanced teacher training, and held some extraordinary events for students to see the practical application of science via field trips and lectures.

Please visit us at our website: CTSTEMfoundation.org for more information.

About The Connecticut STEM Foundation, Inc.

The Connecticut STEM Foundation, Inc. is an all-volunteer non-profit organization. Our mission is to foster interest among pre-college Connecticut students in science, technology, engineering, and math (STEM). Our objective is to instill in them understanding and appreciation of the way science is studied and conducted and the scientific way of thinking to help them become scientists, citizen scientists, and enlightened citizens prepared to navigate through a world in which STEM is ever more important to our civilization.

We advocate for STEM and we seek to inspire and educate students, academics, parents and other members

of our communities. The Connecticut STEM Fair is our flagship event. In addition to sponsoring the Connecticut STEM Fair each year, the CT STEM Foundation has supported advanced teacher training, has held some extraordinary events for students to see the practical application of science via field trips and lectures and has a scholarship program for high school seniors participating in the annual Fair. This year we are initiating both a state-wide essay competition and a state-wide laboratory equipment donation program. We are also initiating scholarship programs for summer study both for high school students and for middle school students.

Connecticut STEM Foundation, Inc. 2019 Scholarship Program

The Connecticut STEM Foundation is offering three scholarship programs in 2019: A College Scholarship for graduating seniors, a Summer Scholarship for undergraduate aspiring STEM high school students and a Middle School Scholarship for aspiring STEM middle school students.

For the College Scholarship Program, two scholarships of \$1,000 each will be offered to two graduating seniors to help defray first year college expenses. Recipients must have participated in the 2019 CT STEM Science Fair and must be planning to major in one of the following four categories at college: Behavioral Science, Environmental Science, Health Field/Medicine or Physical Science/Engineering.

The deadline for submission of completed College Scholarship application is Friday, May 10, 2019.

For the Summer Scholarship Program, one scholarship will be offered to a Connecticut undergraduate high school student to help defray the cost of attending a

STEM summer program offered by any college or university, a summer STEM internship program, a science education center program or a tuition high school summer STEM program. Up to \$500 will be awarded, depending on tuition and related costs.

The deadline for submission of completed Summer Scholarship application is Friday, June 7, 2019.

For the Middle School Scholarship Program, one scholarship will be offered to a Connecticut Middle School student to help defray the cost of attending a STEM summer program offered by any college or university, a summer STEM internship, an informal science education center program or a tuition middle school summer STEM education program. Up to \$500 will be awarded, depending on tuition and related costs.

The deadline for submission of completed Middle School Scholarship application is Friday, June 7, 2019.

Welcome & Thanks to the Science Teachers

Amity Regional High School

Deborah Day
Catherine Piscitelli
Scott DeMeo

Convent of the Sacred Heart

Mary Musolino

Darien High School

William Heher
Christine Leventhal
David Lewis

Greens Farms Academy

Mathieu Freeman

Greenwich High School

Andy Bramante

Joel Barlow High School

Katherine Nuzzo

Newtown High School

Tim DeJulio

Ridgefield High School

Ryan Gleason
Patrick Hughes
Michael Yagid

Sacred Heart Academy

Elizabeth Christophy

Staples High School

Karen Thompson

The Connecticut STEM Foundation, Inc.

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Dr. Harry Rosvally

Directory of Student Participants

Student	School	Category	Project #
Acharya, Eesha	ARHS	Completed Project Health and Medical	1
Adams, Alice	SHG	Completed Project Environmental	2
Agrawal, Anika	ARHS	Completed Project Health and Medical	3
Akula, Monisha	DHS	Research Proposal Behavioral	4
Amoruso, Malika	SHG	Research Proposal Environmental	5
Armster, August	JBHS	Research Proposal Behavioral	6
Attisani, Deanna	DHS	Research Proposal Health and Medical	7
Bachman, Jeremy	ARHS	Research Proposal Physical Science	8
Badagliacca, Caroline	SHG	Research Proposal Behavioral	9
Barnett, Abby	SHG	Research Proposal Environmental	10
Barretta, Katie	ARHS	Completed Project Health and Medical	11
Batal, Olivia	SHG	Completed Project Environmental	116
Beaudette, Mason	ARHS	Completed Project Health and Medical	12
Bell, Savannah	RHS	Research Proposal Behavioral	13
Belmont, Emma	SHG	Environmental Completed Project	92
Bennett, Grayson	SHG	Research Proposal Environmental	36
Berkery, Isabelle	SHG	Research Proposal Environmental	14
Bonner, Avery	DHS	Research Proposal Behavioral	15
Brady, Ainsley	RHS	Research Proposal Health and Medical	16
Burbank, James	NHS	Research Proposal Physical Science	17
Butler, Emma	SHG	Completed Project Health and Medical	165
Calcano, Cameron	SHG	Research Proposal Environmental	18
Calvert, Justin	JBHS	Research Proposal Environmental	19
Carnes, Ashley	NHS	Research Proposal Environmental	20
Catalano, Lucy	SHG	Research Proposal Environmental	21
Chalasani, Aditi	ARHS	Completed Project Behavioral	22
Chang, Eugene	ARHS	Research Proposal Behavioral	23
Chaudhry, Ariba	ARHS	Completed Project Physical Science	24
Chen, Cindy	ARHS	Completed Project Behavioral	25
Chen, Caroline	ARHS	Completed Project Environmental	26
Chen, Christian	ARHS	Completed Project Physical Science	27
Choy, Alexa	SHG	Completed Project Health and Medical	28
Clifford, Caroline	ARHS	Research Proposal Health and Medical	29
Coale, Grace	SHG	Research Proposal Health and Medical	30
Coelho, Victor	DHS	Research Proposal Health and Medical	31
Connolly, Emma Rose	SHG	Research Proposal Environmental	115

ARHS: Amity Regional High School, Woodbridge
CSH: Convent of the Sacred Heart
DHS: Darien High School, Darien
GFA: Greens Farms Academy, Greens Farms

GHS: Greenwich High School, Greenwich
JBHS: Joel Barlow High School, Redding/Easton
NHS: Newtown High School, Newtown

RHS: Ridgefield High School, Ridgefield
SHG: Sacred Heart Academy, Greenwich
SHS: Staples High School, Westport

Directory of Student Participation (continued)

Student	School	Category	Project #
Conrod, Caroline	SHG	Environmental, Completed Project	92
Correya, Sandra	ARHS	Completed Project Environmental	32
Cortellesi, Sophia	DHS	Research Proposal Health and Medical	33
Crooks, Kol	JBHS	Research Proposal Behavioral	34
Cunningham, Megan	DHS	Completed Project Physical Science	35
Curto, Sophia	SHG	Research Proposal Environmental	36
Daugherty, Emma	RHS	Research Proposal Health and Medical	37
Davis, Gillian	RHS	Research Proposal Physical Science	38
DeAlessandrini, Elle	SHG	Research Proposal Environmental	36
Desai, Shriya	DHS	Research Proposal Health and Medical	39
DiBiase, Gaby	SHG	Completed Project Health and Medical	117
Dillon, Taylor	ARHS	Completed Project Environmental	40
Dorais, Ashley	ARHS	Research Proposal Behavioral	41
Dortenzio Jr., Louis	JBHS	Research Proposal Environmental	42
Drake, Ethan	DHS	Research Proposal Health and Medical	43
Dunphy, Megan	RHS	Research Proposal Environmental	44
Edelstein, Sophie	WCHS	Completed Project Health and Medical	45
Estra, Dana	ARHS	Completed Project Physical Science	46
Fassman, Olivia	JBHS	Research Proposal Environmental	47
Feuerstein, Joshua	ARHS	Completed Project Environmental	48
Finn, Regina	SHG	Research Proposal Health and Medical	85
Fiordelisi, Claire	NHS	Research Proposal Health and Medical	49
Ford, Skylar	DHS	Research Proposal Health and Medical	50
Gardone, Luke	JBHS	Research Proposal Physical Science	51
Gilbert, Piper	SHG	Research Proposal Environmental	52
Goldenberg, Hannah	GHS	Completed Project Health and Medical	53
Goldstein, Hana	RHS	Research Proposal Behavioral	54
Greco, Gianna	RHS	Research Proposal Health and Medical	55
Grey, Julia	RHS	Research Proposal Health and Medical	56
Griffin, Claire	RHS	Research Proposal Health and Medical	57
Gross, Ava	ARHS	Research Proposal Environmental	58
Grosso, Nicole	ARHS	Completed Project Behavioral	59
Gunawardana, Dilan	JBHS	Research Proposal Physical Science	60
Hannett, Alexandra	SHG	Research Proposal Environmental	10
Hyland, Chelsea	SHG	Research Proposal Environmental	14
Hirsch, Cameron	JBHS	Research Proposal Environmental	61
Hisiger, Luke	RHS	Research Proposal Health and Medical	62
Hisler, Caroline	SHG	Research Proposal Environmental	63
Holm-Hansen, Colin	JBHS	Research Proposal Physical Science	64
Howell, Brooke	SHG	Research Proposal Environmental	63
Ingwersen, Bryan	NHS	Research Proposal Physical Science	65
Jafri, Danya	DHS	Completed Project Health and Medical	66
Jeniski, Laura	RHS	Research Proposal Behavioral	13
Jarad, Khaled	ARHS	Completed Project Behavioral	67

Directory of Student Participation (continued)

Student	School	Category	Project #
Jog, Niharika	ARHS	Completed Project Physical Science	68
Juan, Charlotte	DHS	Completed Project Environmental	69
Jureller, Isabella	RHS	Research Proposal Health and Medical	70
Kadimi, Srilekha	ARHS	Completed Project Health and Medical	71
Kanlian, Henry	DHS	Research Proposal Environmental	72
Karl, Lila	DHS	Research Proposal Environmental	73
Khwaja, Kabir	ARHS	Completed Project Health and Medical	74
Kim, Andrew	ARHS	Completed Project Behavioral	75
Kim, Mina	ARHS	Research Proposal Health and Medical	76
Kins, Grant	WHS	Research Proposal Environmental	77
Kongani, Keerthi	ARHS	Completed Project Health and Medical	78
Kongani, Adarsh	ARHS	Completed Project Environmental	79
Kosnik, Lily	DHS	Completed Project Environmental	80
Kosyakov, Alexander	GHS	Completed Project Physical Science	81
Krepplein, Hallie	DHS	Research Proposal Environmental	82
Kunichetty, Sachchit	FLHS	Completed Project Physical Science	83
Kupcho, Lindsey	ARHS	Completed Project Health and Medical	84
Lauria, Gabby	SHG	Research Proposal Health and Medical	85
Lavi, Ethan	ARHS	Completed Project Health and Medical	86
Lebreck, Michael	ARHS	Completed Project Environmental	87
Lee, Danielle	ARHS	Completed Project Environmental	88
Lee, Sean	ARHS	Completed Project Health and Medical	184
Lehman, Makenzie	WHS	Research Proposal Physical Science	89
Levinson, Nick	DHS	Research Proposal Behavioral	90
Li, Daniel	ARHS	Research Proposal Health and Medical	91
Liddy, Claire	SHG	Completed Project Environmental	92
Lindell, Samantha	DHS	Research Proposal Environmental	93
Liu, Nicholas, A	DHS	Research Proposal Environmental	94
Liu, Nicholas, S	GHS	Completed Project Environmental	95
Liu, Kathryn	JBHS	Research Proposal Environmental	96
Livesay, Thomas	ARHS	Completed Project Behavioral	97
Lodewick, Grace	ARHS	Completed Project Behavioral	98
Lomax, Jessica	ARHS	Research Proposal Health and Medical	99
London, Philip	ARHS	Completed Project Environmental	100
Lord, George	WPS	Completed Project Physical Science	101
Lowder, Scott	ARHS	Research Proposal Physical Science	102
Lowe, Daniel	DHS	Research Proposal Health and Medical	103
Lu, Brodey	ARHS	Completed Project Environmental	104
Lu, Kevin	ARHS	Research Proposal Behavioral	105
Lu, Raymond	ARHS	Completed Project Health and Medical	106
Luo, Jessica	ARHS	Completed Project Health and Medical	107
Luo, Ningxin	ARHS	Completed Project Health and Medical	108
Luo, Margaret	ARHS	Completed Project Health and Medical	109
MacKenzie, Ethan	RHS	Research Proposal Environmental	110

Directory of Student Participation (continued)

Student	School	Category	Project #
Maher, Amy	SHG	Research Proposal Environmental	21
Malik, Aamnah	ARHS	Completed Project Health and Medical	111
Mansourian, Emma	DHS	Research Proposal Health and Medical	112
Marin, Audrey	ARHS	Completed Project Health and Medical	113
Marino, Collin	GHS	Completed Project Health and Medical	114
Marshall, Mary	SHG	Research Proposal Environmental	115
Massello, Bianca	SHG	Completed Project Environmental	116
McCloskey, Avery	SHG	Completed Project Health and Medical	117
McHale, Sean	JBHS	Research Proposal Behavioral	34
McNeill, William	RHS	Research Proposal Environmental	118
McTigue, Katherine	DHS	Research Proposal Health and Medical	119
Mills, Ethan	RHS	Research Proposal Environmental	120
Mohanraj, Prastik	ESUMS	Completed Project Physical Science	121
Mu, Aurora	RHS	Research Proposal Physical Science	122
Muchhal, Aria	DHS	Research Proposal Health and Medical	123
Murali, Aniruddha	SHS	Completed Project Health and Medical	124
Nemec, Grace	SHG	Research Proposal Environmental	125
Ng, Marcus	GFA	Research Proposal Environmental	126
Novak, Sam	SHG	Research Proposal Environmental	115
O'Connor, Annie	SHG	Research Proposal Environmental	10
O'Connor, Erin	SHG	Research Proposal Environmental	127
O'Connor, Catherine	DHS	Research Proposal Health and Medical	128
O'Connor, Colby	ARHS	Research Proposal Physical Science	129
Ota, Hannah	JBHS	Research Proposal Behavioral	130
Paragas, Parker	ARHS	Completed Project Health and Medical	131
Pardo, Taryn	DHS	Research Proposal Health and Medical	112
Park, Hoon	CRH	Completed Project Physical Science	132
Pashankar, Sana	ARHS	Completed Project Health and Medical	133
Patel, Armaan	ARHS	Completed Project Health and Medical	134
Patel, Ashwini	DHS	Research Proposal Health and Medical	135
Paul, Akanksha	ARHS	Completed Project Environmental	136
Pereyra, Jonah	RHS	Research Proposal Environmental	137
Pittaro, Claire	SHG	Research Proposal Health and Medical	138
Prabhu, Varun	ARHS	Completed Project Behavioral	139
Qin, Andrew	DHS	Research Proposal Health and Medical	140
Rai, Aditya	DHS	Research Proposal Health and Medical	141
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Acharya, Eesha

Project #1

Completed Project, Science, Health and Medical

The Study of Peri-implantation cytokine to Identify Molecules Signatures Prognostic of Pregnancy Loss

Some women experience multiple miscarriages prior to having a healthy baby. About 50% of miscarriages are unexplained. One possible cause is immunological problems. Cytokines, inflammatory markers in the bloodstream, modulate immune responses. It is hypothesized that a signature cytokine assay, collected at 5-6 weeks gestation with the first positive serum beta-hcg in infertility patients undergoing in vitro fertilization (IVF), will be predictive of pregnancy loss. Levels of PDL-1, TNF-a, IL-10, and CXCL-10 cytokines will be checked. It is thought that PDL-1 is higher in healthy pregnancies, TNF-a attacks the embryo, and CXCL-10 and IL-10 help the embryo invade the maternal uterus. Women undergoing IVF will be enrolled at the first beta-hcg serum check after embryo transfer and will be followed for pregnancy outcome: biochemical, clinical, or a healthy pregnancy. Demographic information will be collected. T-tests will be used to determine if cytokine values are significantly different between the healthy and pregnancy loss group. 26 patients so far were eligible for the study because they were healthy singleton pregnancies, clinical losses with normal genetics, or biochemical pregnancies. In ongoing pregnancies vs. pregnancy loss groups, IL-10 first and last draw levels were both statistically significant. TNF-a was significantly higher in biochemical pregnancies compared to the control and clinical losses. Other cytokine levels are still inconclusive. More data is being collected. Pregnancy loss has a big emotional cost to couples. If miscarriages can be identified during the first beta-hcg serum check it would help women prepare and cope with a miscarriage better.

Amity Regional High School
Teacher: Deborah Day

Adams, Alice Stanley, Eliza

Project #2

Completed Project, Science, Environmental

Testing the Optimum Delivery Method of Plant Probiotics

It has been demonstrated that probiotics, known for maintaining a healthy balance of bacteria in the human digestive system, are also good at promoting plant growth. One area of research that is lacking, however, is the best system for plant probiotic delivery. Most plant probiotic products are mixed with soil, but in this study it is hypothesized that other delivery methods may also be suitable or even superior. Several methods of probiotic application were tested, including a dry coating of the seeds, a probiotic solution sprayed directly onto the seeds, and mixing the probiotics directly into the soil. Two control groups were also tested: seeds sprayed with water and seeds grown with no coating or soil enhancement. Three seed types tested were tested and grown under the same conditions. Growing the seeds in nutrient poor soil and under drought conditions was also explored. It was expected that the seeds sprayed with the probiotic solution would be able to grow faster and more abundantly than the other variables and controls. They were also expected to withstand being given less water, and experience superior growth in nutrient poor and salty soil. Results thus far point to the probiotic spray and direct seed contact being the superior delivery methods, depending on the seed type. This study will provide additional information on the best methods to deliver plants probiotics so that the plants experience optimum benefits. This research explores possible solutions and replacements for traditional fertilizers, which can be harmful to the surrounding environment, and can be used at both a household and mass production level to minimize environmental impact without sacrificing the benefits of using a fertilizer.

Sacred Heart Greenwich
Teacher: Mary Musolino

Agrawal, Anika

Project #3

Completed Project, Engineering, Health and Medical

The Effect of Implicating Different Materials into the Current Mechanical Replacement of the Mitral Valve on its Performance

Mitral valve prolapse is a condition in which this valve is not closing properly, resulting in mitral regurgitation. Open-heart surgery and mechanical valve replacements are very common to correct it. This experiment aims to determine whether changing the materials and structure of the current mechanical valve can aid its success over time to combat stenosis and maintain its performance. Simple overlapping leaflets will be designed, mimicking the original design, but instead, it will also have artificial tendons. Different elastic materials will be tried under water pressure. Along the way there will be periodical tests. The nozzle pressure will be adjusted to match what it would be in a real, healthy heart. The mechanical valve will be placed on its site, and the nozzle will be placed alongside it, facing directly at the valve. Data will be recorded in several tables, line graphs, and bar graphs. If the prototype is successful, there should be minimal leaking from the other side of the model valve, opposite to the nozzle, measured in mL over a bucket. It is predicted that this research project will be able to provide a somewhat more accurate representation of the mitral valve through a mechanical valve. This research should help contribute to a better understanding of using different materials in a mechanical valve. If successful, the project can help improve the quality of life for one who needs a valve replacement. Either way, it will further the research regarding the engineering behind the most efficient and long-lasting transplant.

Amity Regional High School

Teacher: Deborah Day

Akula, Monisha

Project #4

Research Proposal, Science, Behavioral

Active Dispersal of Kemp's Ridley Sea Turtles in 'Lost Years'

Sea turtles are an endangered migratory marine species which will travel long distances to reach their breeding grounds or warmer climate. There are gaps of information on oceanic dispersal in these species. Few studies have been conducted to determine how sea turtles navigate their environment by using satellite technology and simulation models. Scientists require more information on whether sea turtles participate in active or passive dispersal to devise conservation strategies. In this proposed research, Kemp's ridley sea turtles (*Lepidochelys kempii*) will be tracked for multiple years during their 'lost years' at sea. An oceanic circulation model will be used to simulate trajectories of passive dispersal of Kemp's ridley sea turtles released from the Gulf of Mexico. The simulated particles and the observed sea turtles will be compared to determine if sea turtles participate in passive or active dispersal. It is hypothesized that the at-sea distribution of simulated ocean current-driven particles will have different trajectories from that of the tracked sea turtles. The Kemp's ridley sea turtles will participate in active dispersal during their 'lost years'. These results can provide information for spatially explicit conservation advances which can be applied to the endangered population.

Darien High School

Teacher: Guy Pratt

Amoruso, Malika

Project #5

Research Proposal, Engineering, Environmental

Using Graphene Oxide to Purify Drinking Water

Polluted water sources is a global problem, from developing nations to established ones. Graphene oxide has been tested to desalinate sea water. It is hypothesized that when water contaminated with lead, chromium-6, or arsenic is filtered through an enhanced membrane of graphene oxide, with holes small enough to be impermeable to the dangerous pollutant ions, then the pollutants would be filtered out and safe drinking water would be left behind. To test this hypothesis, graphene membranes would be nano-structured with pores of different sizes using plasma etching technology. Then, solutions of different concentrations of polluted water would be created. Baseline concentration data would be collected using a spectrophotometer. The solutions would be filtered through the enhanced graphene oxide membranes and the resulting concentration of the solutions would be measured, again using a spectrophotometer. Results should demonstrate a significant reduction in concentration of pollutants found in the water. As graphene oxide is capable of adsorption instead of absorption, it is expected that once the correct size of pores is achieved, a large amount of carcinogenic ions will be trapped in the membrane. This work could lead to additional measures being taken at wastewater treatment plants to incorporate the graphene oxide filter, as well as implementing the technique in wells and water treatment products in developing countries. It could also be important in places that suffer from a specific type of water pollution, such as lead pollution in Flint, Michigan.

Sacred Heart Greenwich
Teacher: Mary Musolino

Armster, August

Project #6

Research Proposal, Science, Behavioral

Effect of Water Temperature and Increased Presence of Carbon Dioxide on the Ability of *Procambarus clarkii* to Respond to Stimuli

Carbon dioxide is flooding our atmosphere. Preliminary studies suggest certain krill have the ability to sink massive amounts of carbon dioxide. However, the earth's climate is changing. This experiment stands to determine, through carefully controlled trials and variables, whether the temperature of water has an effect on the ability of krill to absorb carbon dioxide. Using three separately controlled aquarium tanks, each containing a set amount of adult specimens, this experiment will determine the viability of krill to sink carbon dioxide under different conditions of water temperature. Acidity will be measured over time in three main trials based on varying temperatures, and a control tank without krill. Carbon dioxide will be bubbled in at set amounts in various sub-trials. Project is in progress. Krill are an extremely important keystone species upon which many ecosystems rest. Additional studies suggest krill, being easy to raise and healthy to consume, could solve global hunger crises. This experiment would determine whether krill could work to partially solve another problem, carbon dioxide, in a warming climate. Success of this project could imply krill will be one of the most important animal species in the future, economically and environmentally.

Joel Barlow High School
Teacher: Paul Testa

Attisani, Deanna

Project #7

Research Proposal, Science, Health and Medical

The Effectiveness of CCRM and TATP Auditory Training to Improve Auditory Processing in Patients with APD

Sound processing occurs in the brain and is controlled by auditory nerves. These nerves take sound waves from the outer ear and transmit their energy to receptors in the inner ear, where electrical signals are created and then dispersed throughout the brain. Auditory Processing Disorder (APD) is a learning disability where the transfer of sound is interrupted or blocked. APD affects about 7% of children; while this is a frequent problem, systematic approaches to diagnosis and treatments have only been forming over the past 30 years. This study will look further into the current, most effective auditory training programs used for treatment of APD; The Children's Coordinate Response Measure (CCRM) and the Temasek Auditory Training Program (TATP). The study will be divided into three groups. There will be two groups of 15 children that have been diagnosed with APD, one group receiving the CCRM training, the other receiving TATP. The third group is a control with 15 children without APD that will receive no training. Training sessions will be given for 5 days a week for 4 weeks. It is expected that children who receive the CCRM training will show greater improvement in Auditory processing than the TATP because there is a higher requirement for percent of answers correct in order for the training session to be completed. This type of auditory training could help lead to more comprehensive treatments for APD and therefore help those with APD process information more effectively.

Darien High School

Teacher: David Lewis

Bachman, Jeremy

Project #8

Research Proposal, Science, Physical Science

Engineering Phenylalanine and Aspartic Acid Structures from Beta-Lactamase Inhibitory Protein

Beta-lactam antibiotics are a family of antibiotics that are highly useful in a medical setting, however, they are deactivated by a group of protein in bacteria called beta-lactamase, providing antibacterial resistance for the bacteria. Therefore, the goal of this experiment was to utilize a natural inhibitor of beta-lactamase, which is produced by bacteria, in order to modify it to create a compound that is feasible as a method of inhibition of beta-lactamase. Computer simulations were run in order to create the optimal compound for inhibiting beta-lactamase. These compounds will then be tested and modified in order to optimize the compound being tested. Once the optimal compounds have been determined, the compounds will be produced, and will then be tested in vitro. The compounds will be exposed to beta-lactamase, and a beta-lactam in an aqueous solution (an enzymatic assay). Then spectrographic tests will be run to see if the compound has successfully inhibited beta-lactamase. The computer simulations have indicated that by extracting phenylalanine, and aspartic acid peptide strings that are near to the inhibition site of BLIP and the beta-lactam, multiple compounds can be created that have potential to be effective inhibitors. In vitro tests have not yet been conducted. Due to the fact that bacterial resistance to antibiotics are an enormous problem in the medical field, determining a way to prevent resistance allows for many of the clinically useful antibacterial compounds that were previously rendered irrelevant due to antibacterial resistance will be able to be utilized in a clinical setting.

Amity Regional High School

Teacher: Deborah Day

Badagliacca, Caroline**Project #9**

Research Proposal, Science, Behavioral

Determining the Effect of Musical Enrichment on Cognition in Patients with Alzheimer's Disease and Dementia

Alzheimer's disease and dementia are neurological disorders that attack brain cells causing loss of memory and language, and behavioral changes. Musical enrichment, including the use of personalized music-listening, can spark memories and engage those with Alzheimer's. It is hypothesized that musical enrichment will increase the cognitive function and quality of life for seniors with Alzheimer's disease or dementia due to key brain areas linked to musical memory remaining undamaged. This study will be conducted through Brown University in partnership with the National Institute on Aging. In the first year, instructions for implementing the Music and Memory individualized music program will be tested using four nursing home corporations to solve any unforeseen issues. In the following three years, the guide will be tested in sixty homes that are randomized to execute musical intervention immediately or in phases over three years. Previous smaller-scale studies have shown that those receiving musical intervention benefitted and experienced a better quality of life compared to residents of the same nursing home not receiving intervention. In this study, it is expected that these results will be further demonstrated. Quality of life, shown through decreased use of antianxiety drugs, antipsychotic drugs and behavioral problems, is expected to increase along with the cognitive ability of the residents. This study brings a unique perspective on musical enrichment research as it covers a large number of individuals over a large area. Additionally, there will be specific data demonstrating that it is possible to track an individual's progress over the course of the study while monitoring the exact activities they partake in. This will show researchers exactly which activities are most effective for reducing the effects of Alzheimer's.

Sacred Heart Greenwich
Teacher: Mary Musolino

Barnett, Abby**Hannett, Alexandra****O'Connor, Annie****Project #10**

Research Proposal, Science, Environmental

Determining the Prevalence of Microplastics in Sand Adjacent to Sea Turtle Nests and Testing a Remediation Plan

Microplastics are plastic fragments smaller than 5 millimeters in size that can currently be found in many marine environments such as in sand and on the sea surface. The presence of microplastics in sand in which sea turtle nests are created can increase the temperature of the sand, thereby altering the gender of the sea turtles. This project proposes the use of an activated charcoal and magnetic synthetic iron oxide suspension to reduce the prevalence of microplastics in sand. It is hypothesized that the amount of microplastics affecting the nests can be effectively reduced. The first phase of experimentation will be to determine the type and abundance of microplastic pollution on several sandy beaches. Five replicate samples of sand will be collected from each of two transects on a chosen beach using quadrats that are positioned randomly along the transect. To make the remediation suspension, activated charcoal will be combined with black magnetic synthetic iron oxide and water. The suspension will be applied and then removed from sand containing microplastics and compared to the control of untreated contaminated sand. Results will be determined by using a sieve and microscope to collect and observe particles in the sand between 1 and 5 millimeters, recording temperature measurements, and using a specific dye that detects microplastics. It is expected that multiple microplastic types such as fragments, filaments, and pellets will be found in each sand quadrat. Furthermore, the remediation suspension will work to decrease the prevalence of these microplastics in the contaminated sand. If the suspension is applied over time, it is predicted that there will be a significant regulation in the genders of the sea turtles, which can be affected by microplastics.

Sacred Heart Greenwich
Teacher: Mary Musolino

Barretta, Katie

Project #11

Completed Project, Science, Health and Medical

Recent Advances in Diabetes Technology: How does knowledge about automated insulin delivery systems influence who chooses them?

Type one diabetes is an autoimmune disease where the immune system attacks beta cells, which produce insulin. Insulin regulates blood glucose levels to avoid hyperglycemia or hypoglycemia. Luckily, a recent breakthrough in technology, automated insulin delivery (AID) is aiding in the care for T1D, helping them minimize unwanted hyperglycemia and hypoglycemia. The research question is, are people who have more knowledge about insulin delivery systems more likely to use them? In a recent study by Pediatric Endocrinology at Yale, *Recent advances in diabetes technology: what do our patients know and where are they learning it?*, it was determined that Non-Hispanic whites had more knowledge about AID through their clinic or endocrine specialists. This study will follow the patients from the previous study, to see who switched to an AID. Additionally, we will determine what features patients look for in an AID, and see how those preferences related to whether people decided to use an AID. It is hypothesized that T1D who have more knowledge will be more likely to have switched to an AID in the year following the previous study. Data was collected via questionnaires and interviews. The independent variable of the study is utilizing the AID. The dependent variable is the patients' or parents' knowledge. The projected outcome of this study is that we will have a greater understanding of how people decide to choose whether or not to use AID. This study will be used for determining what features to include in future AID.

Amity Regional High School
Teacher: Deborah Day

Beaudette, Mason

Project #12

Completed Project, Engineering, Health and Medical

Designing an Affordable Fall Detection Bracelet

During 2016, 737,352 people older than 65 reported cases of falling. Most of the falls occurred inside the home. The main goal of the project was to devise a low cost bracelet that detected falls and alerted necessary help in a timely manner. The bracelet was 3D printed on the school's printer. The fall detection software was coded in robotC that I taught to myself, and was flashed onto a Arduino Uno for prototyping. The final product included a Arduino Micro with components soldered to it. To detect falls, an accelerometer and gyroscope were used. Before prototyping started, g-force data was recorded. The constant of the data was $\geq 1g$. Once a fall occurred the code detected $\geq .8g$. Once the code detected a drop of g's it looked for a return to $1g$. If the accelerometer didn't detect movement within 1 minute an alarm sounded. The code waited 30 seconds for the alarm to be turned off, if the alarm wasn't turned off, the bracelet contacted necessary help through a Wi-Fi chip that contacted a central server, which contacted the proper authorities. Results thus far show that the bracelet is able to detect falls. The code could alert the necessary help. The projected outcome is an affordable bracelet that can provide the necessary help to fall victims in the timeliest manner. This bracelet can be further developed into a hospital monitoring system. Also, if the bracelet is produced, it could be sold as a kit to reduce costs.

Amity Regional High School
Teacher: Catherine Piscitelli

Bell, Savannah
Jeniski, Laura

Project #13

Research Proposal, Science, Behavioral

Studying the Effects of Discrimination Learning in Canis rufus and Canis lupus baileyi in Comparison to the Canis lupus familiaris

Although there has been much research into wolves and dogs separately, there is limited knowledge on the comparison of the two, especially in the area of memory. Learning more about how wolves and dogs compare in experiments could provide insight into how domestication has changed them. The experiment would consist of having two kong-like toys, each having either a positive connotation or a negative connotation. If the wolf chooses the toy with the positive connotation, they will receive a reward. If the wolf chooses the toy with a negative connotation, they will not receive anything. A wolf chooses a toy by touching the toy with their nose. A separate trial will be conducted with the dogs using the same method to compare their memory. These trials will be repeated and data will be collected based off how well each species remembers which toy has a positive connotation. The results are expected to show that Canis rufus and Canis lupus baileyi will have a better short term and long term memory than the Canis lupus familiaris because Canis lupus familiaris have been bred to rely on humans more than the Canis rufus and Canis lupus baileyi. Our research will provide insight into how domestication and evolution has changed from wolves to dogs. If we can understand more about the domestication process, that research could apply to understanding the process by which humans domesticate animals.

Ridgefield High School
Teacher: Ryan Gleason

Berkery, Isabelle
Hyland, Chelsea

Project #14

Research Proposal, Science, Environmental

Increasing The Drought Resistance of Crops Using the Microbes Bacillus subtilis and Paenibacillus illinoisensis

Droughts are a big problem in many different places around the world, making it exceedingly difficult to grow plants. This study plans on testing specific types of microbes that can be added to soil so that crops can grow better in drought conditions. It is hypothesized that if specific microbes are added to soil to grow tomato and radish plants, then they will increase the drought resistance of the plants and promote healthy growth by activating a proton pump in root cells that helps roots take up more water from the soil. In this experiment we are going to mimic drought conditions while growing radish and tomato plants. The microbes will be added at the onset of planting, both separately and in combination, and these plants will be compared to the plants grown in drought conditions without the added microbes. The drought groups with and without the microbes will be compared to plants grown under normal conditions. Numerous replicates and trials will be completed. It is expected that when the microbes are added to the soil of tomato and radish plants, they will successfully colonize and enhance the roots, and plant growth and crop production will prosper even in drought conditions. These plants will grow better than the plants in drought conditions without the added microbes, although likely not as well as the normally watered tomato and radish plants. If this study demonstrates that microbes can assist in the plant growth process in drought conditions, it will help people who live in dry regions grow a wider variety of crops. Another implication of this research is that it could help conserve the water needed for irrigation in dry regions. Future work will include testing different crops as well as different microbes.

Sacred Heart Greenwich
Teacher: Mary Musolino

Bonner, Avery**Project #15**

Research Proposal, Science, Behavioral

Long-Term Effects of Reading Intervention on Reading Ability and Gray Matter Volume in Dyslexic Children

Reading intervention is formal education aimed to improve reading ability. Previous research suggests that, in dyslexics, reading intervention increases reading ability and gray matter volume (GMV). Gray matter is a type of brain tissue less prevalent in dyslexics and critical in memory and sensory perception. However, these studies only account for short term effects. This proposal investigates the behavioral and neurological long-term effects of reading intervention in dyslexic children. It is expected that dyslexic children who undergo reading intervention in second grade will demonstrate stronger reading skills and show to have greater GMV in fifth grade. To test this, 20 dyslexic second-graders will undergo a six-month intervention, another 20 dyslexic second-graders continuing with normal education. MRI Scans administered on the experimental group will record GMV before, immediately after, and three years after intervention. MRI Scans will be administered on the dyslexic control group in second and fifth grade for comparison. Behavioral tests will also be conducted, measuring reading ability at these times. 20 non-dyslexic children will take behavioral tests, their results accounting for average grade-level reading ability. Behavioral tests are expected to show dyslexic children who received intervention demonstrating greater reading abilities in fifth grade than dyslexic controls. MRI scans are predicted to show children having received intervention to have increased GMV than dyslexic controls. The non-dyslexic group is expected to show the strongest reading abilities. If intervention is proven effective in the long run, more dyslexic children will be directed to receive proper help to cope with their disabilities.

Darien High School

Teacher: David Lewis

Brady, Ainsley**Project #16**

Research Proposal, Science, Health and Medical

The effect of genetics and lifestyle on the development of Alzheimer's Disease

As global longevity, sedentary life, and access to fatty food all increase, the rate of Alzheimer's Disease (AD) has skyrocketed globally. Many factors may result in the development of biomarkers and potential diagnosis of AD. The project will focus on four potential influences: presence of ApoE4, BMI, VO2 max, and MeDi score. The analysis will compare data regarding each influence and compare their effects on the development of AD. Data will be found regarding the four potential influences listed above. Data will be screened to identify subjects with early onset AD. Groups will then be formed by taking into account BMI range, VO2 max, diet, and ApoE4 allele presence. This will allow an analysis of subjects in each group who develop AD. The results from this meta analysis would provide a wealth of knowledge on how different factors impact the development of AD. It will become clear, through the use of graphs and charts, which factors have the most severe impact on the development of Alzheimer's. The information that is gathered from this study will help inform others as to what factors are most detrimental to brain health, and which factors are most beneficial in prevention of AD. For example, the data may reveal that a high BMI is more likely to lead to AD than low adherence to MeDi. Information will then be passed on to inform others on the best prevention against Alzheimer's Disease.

Ridgefield High School

Teacher: Patrick Hughes

Burbank, James**Project #17**

Research Proposal, Science, Health and Medical

The effect of genetics and lifestyle on the development of Alzheimer's Disease

My project is replacing the pistons of an alpha type sterling engine with low friction liquid seal ferrofluid piston in hopes to improve overall efficiency. The experiment will include building a working sterling engine and having multiple pistons as well as a control. The experiment will include using a hot plate to get the engine to produce electricity and recording the results for each piston. No significant results yet, only a proof of concept with a working ferrofluid piston. Hopefully the experiment will increase the overall efficiency of the engine. Sterling engines can operate on almost any heat source especially renewable ones like solar and geothermal heat and have great promise to be used in the future heavily in such energy production applications. a higher efficiency engine made with ferrofluid seals would greatly improve energy produced.

Newtown High School

Teacher: Tim DeJulio

Calcano, Cameron**Rogers, Bella****Project #18**

Research Proposal, Science, Environmental

The Effect of Construction on the Water Quality of the Mianus River

The Mianus River has over seven rowing teams who practice daily on the river 3 seasons every year. In the near future, a large construction project will start on the river with the RowAmerica Greenwich Boathouse being built. It is hypothesized that the construction and debris will affect the quality of the water and have detrimental effects to the marine life in the area and people who use the river. This study will involve testing samples of the water in the Mianus River adjacent to the construction site obtained before, during, and after the project, in the hopes of discovering the effects of the materials used for the construction project on the water. We will determine the levels of dissolved oxygen, bacteria, nitrates, phosphates, total dissolved solids, as well as other factors. We expect to learn which are the most detrimental pollutants in the water likely due to the construction. It is expected that the water quality will have debris and pollutants from the construction site. Once we learn this information, we can find a way to limit the pollution to the water and help save the marine life and protect people. There are many pathways to take after learning the results, such as improvement to boats in the Mianus River to help return the water to a healthy state, regulating construction rules when they are in the vicinity of a body of water, and general improvements to the well-being of the Mianus River and its ecosystem.

Sacred Heart Greenwich

Teacher: Mary Musolino

Calvert, Justin

Project #19

Research Proposal, Science, Environmental

Oil Absorbing Properties of Asclepias amplexicaulis

The accidental release of oils into a land environment can cause lasting effects to the surrounding ecosystem. Removal of these oils can be costly and extensive, often involving complicated procedures in order to absorb the oil contaminant. In this study, *Asclepias amplexicaulis* will be introduced to an oil-enriched soil and provided a grow light, as well as access to regular watering and fertilization. Olive oil will be administered to the soil as a fine spray, rooting itself in the soil. In this study, the oil content of the soil will be analyzed in order to assess the oil sorption ability of *Asclepias amplexicaulis* in a natural germinated state. Results gathered from this experiment will shed light on possible methods for oil sorption in contaminated environments.

Joel Barlow High School
Teacher: Paul Testa

Carnes, Ashley

Project #20

Research Proposal, Science, Environmental

Newtown Water Quality Comparison

How has the watershed of Deep Brook changed in the past 12 years? I will be using the past data on the Deep Brook watershed collected over the past 12 years by the Pootatuck Water Association (WPA) at their sampling points DB 1,2 and 4. Three points on the past data of Deep Brook were chosen, DB1, DB2, and DB4. Points DB1 and DB2 are upstream. DB1 is runoff from more urban areas and DB2 is runoff from more rural areas. DB4s runoff is a mixture of both suburban and urban areas. The first test is conductivity. To test conductivity you place the meter in the water, wait for the numbers to stabilize and record the answer. From each of the points 70mL of water will be collected to take to the school and be tested for phosphorus and nitrogen levels. Each of these plastic bottles will be labeled DB1, DB2, and DB4. Before chemical testing the water will be warmed to about 23 for the best results for the chemical testing. The temperature will also be taken onsite as the conductivity is being measured. The process will be done over one day for each point and then repeated again at the same time on the same day a week after. Once a week there will be testing for four weeks. Once the samples are collected they will be brought to the school the next day and be tested on either during the school day or after school. The first test will be the nitrogen test, this will begin by filling a test tube to the 5mL mark with the DB1 water. Then a nitrate tablet that's labeled Nitrate #1 Tablet will be added to the water in the tube.

Newtown High School
Teacher: Timothy DeJulio

**Catalano, Lucy
Maher, Amy**

Project #21

Research Proposal, Science, Environmental

The Effect of Climate Change on the Hibernation of Northeastern Groundhogs

Climate change has been previously found to affect hibernation in various species of animals. For example, Columbian ground squirrels have been found to emerge ten days later from hibernation over the past two decades due to late spring snow falls. This is a problem because they have less time to eat enough food to survive through the following hibernation period. This may also be a problem for groundhogs since they also hibernate and may be negatively affected. It is hypothesized that climate change will cause groundhogs to emerge from hibernation later than normal. The data from past years regarding the number of groundhogs that emerged from hibernation on time and later than normal will be analyzed. We will also observe, using motion sensing cameras, groundhogs from our region currently to assess when they go into hibernation and when they emerge. It is expected that the number of groundhogs that emerge late from hibernation will have increased over the years in the same manner as climate change has increased. We expect that the data obtained from the motion sensing cameras will continue this trend of late hibernation. It is important to study this field of research so that we can better determine how to prevent the effect that climate change has on hibernation. With more time and climate change, late hibernation emergence may cause groundhogs to decrease in population because it will affect their ability to gather enough food prior to the next hibernation. This study will likely point to new research including the study of additional animal species and their hibernation habits.

**Sacred Heart Greenwich
Teacher: Mary Musolino**

Chalasan, Aditi

Project #22

Completed Project, Science, Behavioral

The Effect of Visualization on a Student's Performance in a Game of Darts

The question this experiment was aimed to answer is, "What effect, if any, does visualization have on a student's performance in a game of darts?" This study examined the effect mental imagery has on students' performance in a game of darts using a magnetic dart board. The motivation for this study came from having background knowledge and a curiosity towards the topic of mental imagery. Two groups met on separate days, after school in Amity High School, with the control group throwing ten magnetic darts each, sitting down (the students were allowed to relax and talk) for the same amount of time as the visualization inducing recording, and lastly, throwing ten darts again. The experimental group started off throwing ten magnetic darts, then sat down to listen to the computer-generated, visualization inducing recording, and after, threw ten darts each. The students stood five feet from the dart board when throwing darts. Results thus far show that the majority of students apart of the experimental group received higher scores than those in the control group. The main comparison was between the difference of the students' scores from their first to their second time throwing darts. It was found that visualization can improve students' performance. This study can result in higher athletic/academic achievement for students, as it teaches them to implement visualization prior any test/competition. Other studies have only tested the effect of different types of visualization or its affect over time, and haven't focused of affecting the youth.

**Amity Regional High School
Teacher: Catherine Piscitelli**

Chang, Eugene

Project #23

Research Proposal, Science, Behavioral

Effect of Cell Phone Usage Times on Nomophobia among High School Students

As smartphone technology advances, more people, especially high school students, gain access to these technologies. Along with this advancement, the average smartphone owner seems to be spending significant time using their devices to the point of feeling addicted to them. This study will research the effect of cell phone usage times on feelings of nomophobia, a fear of being separated from one's mobile device. To accomplish this, a total of 20-30 high school students who own iPhones, strictly, will partake in this experiment. The students will be asked to go into "Screen Time" in the Settings app and report their statistics under the "Last 7 Days" tab. Then, the participants will be given the NMP-Q questionnaire and answer a series of questions to rate their nomophobia from a scale to 20-140. It is anticipated that people who spend greater amounts of time on their iPhones will report having higher levels of nomophobia. Therefore, there will be a positive correlation between cell phone usage times and feelings of nomophobia among high school students. The majority of high school students own smartphones, so this data can be used to develop ways to reduce or prevent cell phone. Also, the results may raise awareness of the growing issue with cell phone addiction and may pose people to reconsider their own cell phone usage. One may take conscience actions to restrict their usage and prevent developing nomophobia.

Amity Regional High School
Teacher: Deborah Day

Chaudhry, Ariba

Project #24

Completed Project, Science, Physical Science

Characterizing Shift Reagents for Use in Separating Extracellular and Intracellular Sodium NMR Signals

All healthy cells are characterized by a small concentration of sodium intracellularly and a higher concentration extracellularly. This is called the sodium gradient of a cell. A weakening of this gradient is indicative of disease, so a method to recognize the weakening of the gradient may be a helpful diagnostic tool. Nuclear magnetic resonance (NMR) is a non-invasive method of detecting this gradient, but current limitations make it difficult to distinguish between the intracellular and the extracellular sodium, which consequently limits the potential usage as a diagnostic method. The purpose of this experiment is to use NMR probes and the biosensor imaging of redundant deviation in shifts (BIRDS) method to distinguish between the sodium levels. It is hypothesized that if the correct NMR probe at the correct frequency is used, the two different sodium levels will be distinguishable. In this study, the independent variable is the chemical that is used, and its corresponding chemical shift. The dependent variable is the spectroscopic peak, which relates to the strength of the signal. The stronger the signal is, the more likely it is that the solution being tested, when used as an IV Contrast agent in an MRI, will demonstrate a difference in the sodium gradient. An NMR machine will be used in order to process and interpret NMR data. All of the information gathered from these areas of research will contribute to a larger research project regarding novel NMR probes and their effect on the physiology and chemistry of biological tissue.

Amity Regional High School
Teacher: Catherine Piscitelli

Chen, Cindy

Project #25

Completed Project, Science, Behavioral

Relationship Between Academic Affinities and Time Management Abilities

Practicing the habits that improve time management skills allow people to use less energy to complete a task, organize their work better, gain more satisfaction from work, feel less stressed, make fewer mistakes, and achieve goals quicker. This study, investigating the functional localization of the human brain, will see if there is a correlation between a student's academic affinities and time management abilities. Participants will answer a modified version of the TMBS (Macan et al.) and fill out a Google Form indicating their best subject. "Best subject" refers to the subject that one has achieved the highest grades in the most often in the past five marking periods (quarters). The TMBS score of participants associated with each subject will be averaged, and the means will be displayed on a bar graph for comparison to determine whether or not there is a correlation or trend. It is hypothesized that if there is a correlation, then students who generally get the highest grades in subjects based on communication (writing, reading, etc.) will tend to have better time management skills because the areas of the brain that control time management are related to communication as well; however, brain anatomy varies dramatically. If there is a correlation between one's best academic subject and time management abilities, then further research can be conducted to find if it is possible to improve certain academic skills by improving time management skills or vice versa. This may aid people in developing either skill and help them succeed.

Amity Regional High School
Teacher: Deborah Day

Chen, Caroline

Project #26

Completed Project, Science, Environmental

Comparing the Rate of Classical Conditioning in Platy Fish with Varying Stimuli

Ivan Pavlov discovered the phenomenon of classical conditioning in which an individual would associate one stimulus to another. In his experiment, he rang a bell before feeding dogs and observed that the dogs associated the ringing bell to food. It is understood that Pavlov's theory applies to fish. This study will compare the ability of different sensory systems of platy fish to associate a visual or auditory stimulus to food. Three 10 gallon tanks with five platy fish in each will be set up. Tank A will have an LED light cast above the tank and Tank B will have a Bluetooth speaker near the tank. Tank C will be fed without the light or sound stimulus. Before being fed, the LED light will be turned on for Tank A when the tone for Tank B is triggered. This process will continue each day until the fish begin to swim to the water's surface when the stimulus is triggered and before food is given. This will suggest that the platy fish have associated the stimulus to food. It is hypothesized that the rate of classical conditioning will be faster with the sound stimulus than with the light stimulus. It has been suggested that the fish auditory sense is stronger than the visual sense. Results of this study may be applicable in fisheries to increase the efficiency and productivity of fish feeding.

Amity Regional High School
Teacher: Deborah Day

Chen, Christian

Project #23

Completed Project, Engineering, Physical Science

Identifying the Most Efficient Bell-Shaped Lift Distribution for a Flying Wing

A flying wing is a novel type of plane without a conventional fuselage and tail. This design promotes greater lift and less drag, but the plane is highly unstable. What is the optimal bell-shaped lift distribution in order to achieve adequate stability while maintaining conventional drag? It is hypothesized that a model with 20 grams of central lift will prove most viable. The amount of central lift acted as the manipulated variable. The amount of central lift affected the bell shape since it was inputted into the bell curve equation. Central lift was measured by attaching the airfoil to an apparatus. The apparatus stood on a scale in front of a fan. It produced lift as the wind from the fan flowed around the attached airfoil. The difference between the initial mass and the mass with lift created by the fan determined the lift value. The dependent variables were stability and drag. Stability was measured by observing dynamic stability, the altitude differential. The models were equipped with propellers, and flight was recorded. Drag was measured in a wind tunnel. The distance that the plane moved backwards was noted. Anticipated results predict that the 20 gram model will be most successful. Six prototypes were produced out of balsa wood and aluminum foil, with the control having a conventional spanload. Data was analyzed in a pugh matrix, and further tests determined if the results were significant. Graphical representations were included. These results could potentially aid a greater integration of flying wings.

Amity Regional High School
Teacher: Deborah Day

Choy, Alexa

Project #28

Completed Project, Science, Health and Medical

The Effect of Insurance Company Policies on Patient Access to Preferred Biologics in Treating Psoriasis

Psoriasis is a painful and chronic inflammatory skin condition that affects the physical and psychological health of patients. Aside from impacting quality of life, there is also a socioeconomic burden regarding the cost of treatment. This is significant as psoriasis has no cure and requires extensive and long-term treatment. The purpose of this study is to examine the effect of insurance company policy on access to preferred biologic treatments. This study reviewed randomized, de-identified charts of psoriasis patients from the medical electronic database, Epic, at Mount Sinai Dermatology Department. The charts had the following insurers: Aetna, Blue Cross Blue Shield (BCBS), Empire BCBS, Medicare A&B and United Healthcare, treated with the following biologics: Cosentyx, Enbrel, Humira, Remicade, Siliq, Stelara, Taltz and Tremfya. Stata Version 15.1 was used to generate baseline statistics for prescribed biologics for patients with each insurance company. Finalized results are still underway. However, initial results indicate that over 50% of psoriasis patients at Mount Sinai are prescribed Stelara. Though Stelara is less effective than other biologics, patients receive a medical benefit because Stelara is administered during the office visit. It was also discovered that certain insurers favor certain drugs: Empire BCBS has a disproportionate amount of Humira prescriptions, and United has a disproportionate amount of Cosentyx prescriptions. The results of this study show that ultimately, the determining factor for a patient's treatment is not necessarily what is ideal for the patient but what the insurance company allows. Although more research is needed, this study is important as it highlights the limitations in patients' access to the most effective medication due to the policies of insurance companies.

Sacred Heart Greenwich
Teacher: Mary Musolino

Clifford, Caroline Project #29

Research Proposal, Science, Health and Medical

The Effects of Infrapatellar Straps and Kinesiology Tape on Patellar Tendinopathy in High School Athletes

Patellar tendinopathy is a common volleyball injury in high school athletes. It is a knee overuse injury that results in the degeneration and fibrotic scarring of the patellar tendon. It's essential for athletes to avoid returning to play until they're properly rehabilitated to prevent the issue from becoming chronic. However, there are a variety of prevention strategies for this injury and it is unclear about which one is most effective. This controlled laboratory study would be performed by testing the effectiveness of kinesiology tape versus the infrapatellar strap. Human subjects would be used to test kinesiology tape, the infrapatellar strap and the control of no strap or tape. The subjects would be instructed to perform numerous jumping exercises to test this. The knee flexion angle and patellar tendon length would be measured to illustrate the effectiveness of each method. The results are expected to show that the infrapatellar strap is the most effective method of preventing and alleviating pain associated with patellar tendinopathy. These findings would show the proposed benefits of an athlete wearing an infrapatellar strap to prevent patellar tendinopathy. The findings of this study could greatly benefit high school volleyball athletes. This is because there would be a known, effective prevention and treatment strategy for patellar tendinopathy. This would prevent volleyball athletes from experiencing unnecessary, chronic knee pain associated with patellar tendinopathy. These results could also benefit athletes of other sports and of all ages. This is because patellar tendinopathy is common across multiple age groups and sports.

Amity Regional High School

Teacher: Caroline Clifford

Coale, Grace Project #30

Research Proposal, Science, Health and Medical

The Presence of Antibiotics in Beef and Poultry

Many poultry and beef products are labeled antibiotic free. The purpose of this study is to determine if these products are indeed free of antibiotics. This is significant because antibiotics found in these products can cause antibiotic-resistant infections. It is hypothesized that if beef and poultry products that are labeled antibiotic free, or not labeled, are tested, approximately 30% will contain antibiotics due to contamination or to extend the life of the animal. To test the presence of antibiotics in the beef or poultry, I will use PremiTest25 and conduct three trials for each beef and poultry product tested. I will have a positive control, which will be beef or poultry that is known to contain antibiotics, and a negative control, which will be distilled water. The independent variable is the type of beef and poultry product tested, and the dependent variable is the presence of antibiotics. It is expected that there will be some mislabeling, and that antibiotics will be found in products that are labeled antibiotic free. It is also expected to find antibiotics in products that do not indicate whether the product contains antibiotics. Overall, it is expected that 30% of the samples that should be antibiotic free will contain antibiotics. This study will ensure the safety of consumers when buying different beef and poultry products. The results will likely convey that there are in fact antibiotics present in beef and poultry products that are not labeled or are labeled antibiotic free. An avenue of research that would be explored next is how the products are contaminated if labelled antibiotic free.

Sacred Heart Greenwich

Teacher: Mary Musolino

Coelho, Victor

Project #31

Research Proposal, Engineering, Health and Medical

Restoring tactile sense while improving control of hand prosthesis

People who have prosthetic hands have limited control of their prosthetics and they lack tactile sensations. With the AMI procedure, restoration of tactile sensation and prosthetic control is tested. It is expected that tactile sensations will be restored and a greater control of the prosthetic will be present, which will increase amputee quality of life. With the AMI procedure the subject will use both a prosthetic hand and an unaffected hand to differentiate between five objects' texture. Pressure will be applied to the hand prosthetic and an unaffected hand, which will be rated by the subject. With these results tactile sensation can be measured. In addition, the subject will grasp object and manipulate them as directed, with accuracy of movements recorded. These results measure the amount of control. In other studies, tactile sense has been restored, but the AMI system has been shown to have a greater range of control. It is expected the prosthetic hand will differentiate between the textures and rate the pressures correct. The subject will also be able to manipulate the objects in the directed manner. The use of the AMI system will provide tactile sensations and a greater control of the prosthesis. With tactile sensation and greater control a hand amputee will be able to live an unaided and comfortable life, returning to a state similar to what was experienced pre-amputation. This result can generate the ability for this technique to be used all over the body.

Darien High School
Teacher: Guy Pratt

Correya, Sandra

Project #32

Completed Project, Science, Environmental

The Effect of the Amount of Copper Nanoparticles on the Growth of *Elodea canadensis*

A lot of cleaning agents and household items contain nanometals that contaminate the water when they're discharged from drains. This is a problem because nanometals destroy many organisms in ecosystems through their antibacterial properties. The objective of this experiment is to determine if *Elodea canadensis*, a plant that can thrive near seepage areas, is able to thrive in water contaminated with copper nanoparticles. The independent variable is the amount of copper colloid poured into the water and the dependent variable is the height of the plant. It is hypothesized that the plant will thrive and grow in both the controlled and contaminated water because it can thrive in bodies of water that are polluted. The materials in this experiment are elodea, soil, distilled water, copper colloid, seven 500mL beakers, 100mL graduated cylinder, and a ruler. In each beaker, 400mL of water will be poured using the graduated cylinder. The height of the elodea will be measured and it, along with the soil, will be placed in each beaker. Three beakers will have 25mL and three other beakers will have 50mL of colloid poured in it. One beaker will be left as control with no colloid in it. The elodea's height will be measured each day for 2 weeks and all data will be noted and analyzed using graphs. If the elodea can grow despite being in contaminated in water, it could help other scientists research how elodea and similar plants can be used in phytoremediation.

Amity Regional High School
Teacher: Deborah Day

Cortellesi, Sophia

Project #33

Research Proposal, Science, Health and Medical

The Genetics of Aging in Yeast

Although aging is common amongst all species, the mechanisms behind aging are not well understood. Past studies have demonstrated that both environment and lifestyle impact aging. This study will specifically investigate the role of genetics in aging, aiming to find genes that significantly impact the lifespan of yeast, an emerging model organism in the field. A gene is a unit of hereditary information that is transferred from parents to offspring and determines a characteristic in the offspring. Yeast is used to study aging because scientists are able to monitor the effects of gene changes in both dividing and non-dividing cells. In order to characterize the function of each individual yeast gene, DNA with single gene deletions will be purchased from an outside company for use in the experiment. This DNA will then be sequenced to validate the deletion of the genes. The yeast will then be grown with the DNA that has the gene deletions. Every two days, an Epoch Plate reader will be used to determine the yeast's lifespan curve. The results are expected to show that deleting genes connected to critical life functions will decrease the lifespan of yeast. The results will help determine the importance of genetics in aging, leading to a more focused understanding of genetics as a whole.

Darien High School

Teacher: Guy Pratt

Crooks, Kol

McHale, Sean

Project #34

Research Proposal, Engineering, Behavioral

The Real Time Classification of American Sign Language with a system of 2D and 3D Convolutional Neural Networks

There are roughly 250,000-500,000 Americans that use ASL. Communication for the deaf is difficult and presents numerous challenges. Our project will use a system of 2D and 3D convolutional neural networks to analyze video in real time, detect and recognize dynamic American signs, and generate a probable output sign based on a pre-learned data set. This automated sign language recognition will ease the lives of many Americans. The entire application is composed of a three-layer system: a graphics user interface (GUI) layer, a 2D convolutional neural network layer (CNN), and a 3D CNN. Video will be streamed into a computer for a video-processor to alter so OpenCV can isolate hand and arm movements. The CNN will then analyze the result from OpenCV and compare it to a previous pre-learned dataset to predict a probable output sign. Our final results and products will show how accurate a system of 2D and 3D CNNs are capable at video recognition in real time. Based on the percent accuracy for types of signs, the strengths and weaknesses for this type of system will be apparent. Communication for the deaf is difficult and presents numerous challenges. With the ability to detect signs, communication will be eased between the society of signers and people with no hearing impairments. This application will also aid in advancements of machine learning algorithms involving video. Currently, there have been not that many advancements in machine learning regarding video due to the arduous nature of utilizing real-time detection.

Joel Barlow High School

Teacher: Katherine Nuzzo

Cunningham, Megan Project #35

Completed Project, Science, Physical Science

Environmental Enrichment to Increase Explorative Behaviours in Captive Wolves

With deteriorating ecosystems and the extinction of keystone populations across the world, it is critical that zoos work to promote the most natural behaviours in their endangered animals so as to better prepare the creatures for reintroduction into the wild. This study aims to test which combinations of environmental enrichment are most effective to increase explorative behaviours in captive gray wolves. The experiment observed 3 different subjects of the *Canis lupus* species over the span of 4 weeks which were divided into 4 enrichment periods - control, scent enrichment, cognitive (physical) enrichment, and scent and cognitive enrichment. Scent enrichment was administered to the bars of the enclosure every 5 minutes, and cognitive enrichment was administered once at the beginning of each day - 3 days a week, for one hour each day. The observer used instantaneous group scan sampling to record each subject's behaviour at 30-second intervals into one of three behavioural categories: Explorative, Stereotypic, and Resting. Upon use of a standard chi-square test to assess the female and male data separately, the results displayed a significant negative trend in stereotypic behaviour during combination enrichment. The males, additionally, demonstrated a significant increase in explorative behaviour during this time period while females showed no significant change. In light of the results, better methods of environmental enrichment can be suggested for other captive mammals whose natural behaviours are very important to preserve. To look even further, such an experiment could be modified to search for similar results in a non-mammalian species.

Darien High School
Teacher: Guy Pratt

Curto, Sophia DeAlessandrini, Elle Bennett, Grayson

Project #36

Research Proposal, Science, Environmental

Testing a Novel Air Filter for the Remediation of Indoor Air Pollution in Developing Countries

Two and half billion people in developing nations rely on biomass for cooking. Biomass consists of organic matter used as a fuel that unfortunately emits indoor air pollution (IAP). Homes in these countries often lack proper ventilation, forcing an accumulation of smoke from the biomass and posing an extreme health risk. It is hypothesized that a multi-component air filter can be developed that will help reduce IAP from these homes. The air filter that is being designed and tested will contain three main parts, each designed to remove a major component of IAP. These indoor air pollutants are carbon dioxide, carbon monoxide, and soot. The pollutants will be tested individually for filter effectiveness using monitors that will record the potential reduction of each substance. It is expected that the levels of each pollutant will be significantly reduced due to the special properties of the filter. It is hoped that the filter will ultimately prevent excess accumulation of biomass pollution in homes in countries such as India and Uganda, to ensure a much safer indoor environment. The air filter will also be more affordable than current alternatives and will help individuals in these locations maintain their current cooking practices and therefore their cultural identity.

Sacred Heart Greenwich
Teacher: Mary Musolino

Daugherty, Emma

Project #37

Research Proposal, Science, Health and Medical

The Effect of Exercise on the Development and Progression of Alzheimer's disease

An increasing amount of people are developing Alzheimer's Disease (AD). Alzheimer's affects the brain, specifically the hippocampus. The hippocampus is responsible for learning and retaining information. Many people develop AD due to the presence of a gene, APOE-e4. One factor that has been shown to help slow down the progression of the disease is exercise. Exercise, specifically aerobic exercise, has the potential to decrease the amount of people with AD. In order to perform this meta-analysis, data will be collected from multiple studies that measure exercise and its effect on Alzheimer's Disease. The data would be analyzed for trends and differences between the variables of the amount of time spent exercising and the specific type of activity. The results will provide information on whether or not daily aerobic exercise for a specific amount of time decreases the risk of developing AD. It is expected that the results will support other studies by showing that longer amounts of exercise will be more beneficial. These findings would demonstrate that in order to decrease the risk of AD, longer amounts of time should be spent doing an aerobic activity. This is significant to many people suffering from AD. People carrying APOE-e4 will be able to decrease their already elevated risk of developing AD. Additionally, people who have developed AD will be able to decrease the rate of cognitive decline by following an exercise routine. Although AD is only one type of dementia, it is important to find a solution to this rapidly growing problem.

Ridgefield High School
Teacher: Patrick Hughes

Davis, Gillian

Project #38

Research Proposal, Science, Physical Science

Manufacturing a Polariton Laser through the Generation of Entangled Photons in Enhanced Cyan Fluorescent Proteins

I was interested in quantum biology and quantum entanglement, and I had found a novel type of laser called a polariton laser, and thus I set out to create a more cost effective and easily created polariton laser using ECFP (Enhanced Cyan Fluorescent Protein), and a TA laser which could create entangled particles. First, I will build the TA laser to create the entangled photons. Then, I will grow the CFP on a bed of E.Coli to create the ECFP. Next I will evenly distribute the ECFP over two mirrors, so that it is encased. Then I will use the TA laser to pulse light onto the ECFP, and take down the data to conclude if I have created quasiparticles. I believe that I will be able to create a polariton laser using the manufactured ECFP I will grow on a bed of E.coli bacteria, and pulsing entangled light (Using a TA laser I will build) on the final set up of the ECFP in a mirrored casing. Polariton lasers are usually hard and costly to manufacture. My experiment will test if variants of EGFP can be used to create a polariton laser and eliminate the issues with the manufacturing of such a machine. An easy cost efficient polariton laser created from not just EGFP, but its variants, that operates at room temperature that is easy to make could be used to revolutionize quantum technology and super computers.

Ridgefield High School
Teacher: Ryan Gleason

Desai, Shriya

Project #39

Research Proposal, Science, Health and Medical

Inhibition of MASTL Kinase to Increase Mitotic Death of Triple Negative Breast Cancer Cells through the Activation of PP2A

Out of the 1 million diagnosed cases per year, 170,000 cases are defined as Triple Negative Breast Cancer (TNBC). TNBC occurs when a tumor is progesterone-receptor negative, estrogen-receptor negative, and HER2 negative. Since the tumor is not supported by hormones and lacks a large amount receptors, TNBC does not respond to hormone therapy. In addition to a poor prognosis for advanced stages, this type of cancer is more aggressive and has a higher chance to metastasize. The MASTL kinase is overexpressed in cancer patients because it regulates the mitotic entry of cells, and since cancer cells want to replicate as quickly as possible, the kinase is found in larger concentrations. PP2A is a protein which regulates mitotic initiation and controls the cell cycle. By inhibiting the MASTL kinase in cancerous cells, the goal is to activate the PP2A in order to stop tumor growth and allow for a more successful treatment. Previous research indicates that the inhibition would allow for an increase in tumor cell death due to the failure of proper mitosis, which would cause the PP2A to prevent the cell from duplicating and end in cell apoptosis. Current treatment for TNDC is difficult since the tumor does not respond to hormone therapy, which allows for it to grow at a higher rate and have an increased chance of metastasis. If the inhibition of the MASTL kinase proves to be successful, it would allow for a more effective method of treating the stagnating tumor.

Darien High School
Teacher: Christine Leventhal

Dillon, Taylor

Project #40

Completed Project, Engineering, Environmental

Analysis of Quality of Various Types of Paper Straws to Best Replace Plastic Straws

Many plastic straws are polluting the environment because they are too light to be sorted with the other plastic when being recycled. Some companies have started using paper straws which are better for the environment. These straws don't hold up well over the course of two hours. The purpose of this experiment was to analyse the quality of various types of paper straws to best replace plastic straws in Connecticut. The independent variable is the type of paper straw. The dependent variable is the quality of the straw. The quality of the straw was determined by weight gain, change in thickness in straw, and the change in how much pressure the straw and withstand. Different types of beverages were tested over the course of two hours. I would be testing different types of straws in a man made environment over the course of six weeks mimicking rainfall rates and soil types of Connecticut. These will be measured by weight and the pressure a straw can withstand. When creating the environment, used a large plastic container filled with soil on each type of straws. If the physical integrity of a straw is tested in an environment for six weeks and in a beverage for two hours, than a straw made of tree pulp held up best. To determine the amount of pressure a straw can withstand, I used hardness picks however a backup plan was to use a mineral hardness test, however this was not necessary.

Amity Regional High School
Teacher: Catherine Piscitelli

Dorais, Ashley

Project #41

Research Proposal, Science, Behavioral

The Effects of Viewing Nature and Urban Settings on Mood and Well-Being

Scientists have long pondered the possibility that our environment has a significant effect on our population's well-being. This study will investigate the potential link between the environment and health. It is hypothesized that if people are exposed to natural settings, they will feel more relaxed, calm, and physically well, impacting their overall health. The study will include two groups of fifteen participants, who will each view a natural settings video and an urban settings video on a computer (in a location of each participant's choice). One group will view the nature video first and the other group will view the urban setting video first, thereby removing any sequencing factor. The independent variable will be the two types of scenery in the videos. The dependent variable will be the reported effects of the videos on the participants, who will each fill out questionnaires before and after viewing each video to share their mental impressions and physical feelings. The questionnaires will include questions with scales describing the participants' level of calm/anxiety and ask them to list any physical problems before and after each video. The data compiled from the questionnaires will be analyzed to determine whether nature or urban settings measurably affect one's sense of well-being. The results may suggest alterations to current city planning or park designing to incorporate the most impactful elements of well-being.

Amity Regional High School
Teacher: Deborah Day

Dortenzio Jr., Louis

Project #42

Research Proposal, Science, Environmental

The Effects of Increasing Carbon Dioxide Levels on the Germination of Fresh Water Based Algae

In today's environment it is no secret that greenhouse gases such as Carbon Dioxide (CO₂) are part of the cause of the increase in global temperatures recently. The excess amounts of CO₂ are leading to higher global temperatures, but that is not the only effect that this gas seems to be having on the environment. In this experiment, we will take three samples of algae of the same size and mass and expose each to different levels of CO₂ in containers of freshwater. By using three separate samples, one control, one in excess CO₂ and the other with very little, we can very accurately see the effects of CO₂ on the growth of freshwater algae very clearly in production of oxygen over the course of 2-3 weeks. Algae is so important because it is one of the biggest oxygen producers on our planet and without it, many fish would die due to low oxygen levels and this experiment will show whether or not this increase in environmental CO₂ levels will help save marine life in the future by helping algae grow or hinder it by stunting algae growth. Gather materials and place tanks by window and other locations with more or less access to CO₂ depending on which sample. Mass each piece of algae and trim some if necessary to make sure each piece of algae starts at equal masses to each other. Add about 0.5 gallons of freshwater to each tank and label each tank, tank 1= most CO₂ exposure, tank 2= control group with normal exposure and tank 3= least amount of CO₂. Place each piece of algae in a separate tank and measure temperature with a thermometer to make sure sunlight is reaching the water.

Joel Barlow High School
Teacher: Katherine Nuzzo

Drake, Ethan

Project #43

Research Proposal, Science, Health and Medical

Exogenous HMGB1 and other alarmins accelerate scarless puncture wound healing by transitioning stem cells in the dermis to GAlert.

HMGB1 has been shown to activate stem cells for bone repair and provides a potential model for reducing healing time and scarring in serious epidermal wounds. Will HMGB1 decrease the wound healing time and scarring, and if so, by how much? HMGB1 will decrease the time that it take for a puncture wound to heal fully and result in less scarring when administered two weeks or less prior to injury. One week prior to creating 6mm puncture wounds, researchers will inject 50 μ L of HMGB1 a day into 6, 6-week-old mice and 50 μ L a day of saline into 6 control mice. This will cause HMGB1 to transition stem cells into GAlert phase, resulting in faster healing time and smaller scars compared to controls. Puncture wounds of this size typically take 2 or more days to heal and result in large scar formation. Researchers can conclude that HMGB1 does accelerate wound healing and reduce scarring in puncture wounds by transitioning existing stem cells into the GAlert phase. We will see this in the data, as the wounds will heal in less time and with less scarring, due to the preactivation of cells in the dermal layer of the skin. By using HMGB1 to treat wounds, it may be possible to help still-healing people with puncture wounds, or even those with first or second degree burns.

Darien High School

Teacher: Christine Leventhal

Dunphy, Megan

Project #44

Research Proposal, Science, Environmental

The Impact of Population Size on Water Quality

Water quality is continuing to decline in bodies of both freshwater and saltwater. A major impact on water contamination is runoff of groundwater that contains harmful chemicals and pollutants. Human activities such as urbanization increase the amount of these pollutants and ultimately lead to water degradation. The purpose of this experiment is to investigate the effect of population size on water quality. The population of four different coastal towns will be determined. Two samples will then be taken from the largest freshwater body and the largest saltwater body in these towns. The samples will be analyzed to determine the water quality. Factors that will be examined are fertilizers, metals, oils, pesticides, and pollutants. It is hypothesized that areas with larger population size will have worse water quality. The water quality will be evaluated by the amount of pollutants present. There are many stressors that influence water quality yet little is known about the direct relationship between population size and aquatic contamination. Once this correlation is explored, the impact of humans on marine ecosystems will be established. Testing the role of population on water quality will show humans the detrimental effects they may have on aquatic life.

Ridgefield High School

Teacher: Ryan Gleason

Edelstein, Sophie

Project #45

Completed Project, Engineering, Health and Medical

Developing a Functional Tracheal Replacement Graft: Studying the Effects of Graft Stiffness on Host Response

The field of tracheal engineering has been struggling due to the need for a graft that integrates with the host without causing a strong immune response. A previous study (Zhao 2016) developed a tracheal graft that is biocompatible and that has mechanical characteristics that prevent collapse. However, such grafts showed stenotic narrowing of the graft when implanted in rats and monkeys likely due to the stiffness of the nitinol stent. This new study works to develop injection molded (3D printed), rubber tracheal stents of varying stiffnesses that will elicit less of a stiffness-mediated response, since it has been found that stiffness-mediated pathways (Hippo and TGF- β) contribute to this stenotic response. 2D studies on the effects of stiffness-mediated pathway inhibitors, Verteporfin and SB-431542, were performed to study the stiffness-mediated response. The mechanical properties of our new graft stents were evaluated using an Instron apparatus for both the tensile and compressive mechanics. These results were compared to those of native trachea mechanics. 2D studies on the effects of stiffness-mediated pathway inhibitors, Verteporfin and SB-431542, on pulmonary fibroblasts revealed a downregulation of myofibroblastic pathways, specifically the Acta2 gene, when cells were given increasing doses of Verteporfin and SB-431542. By evaluating the mechanical properties of our new graft stents, a range of tensile and mechanical properties within the range of native tissue were achieved. This will enable us further study into the fibrotic response in vitro using grafts of different stiffness, as well as candidate inhibitors to knock-down stiffness-mediated pathways of interest to evaluate their effect on overall graft failure. With this data, a tracheal replacement graft that will lessen the chance of an acute host response and provide an improved tracheal replacement for the field in order to treat infection, cancer, prolonged intubation, or trauma injuries will be created.

Wilbur Cross High School
Teacher: Nick Farrell

Estra, Dana

Project #46

Completed Project, Science, Physical Science

Analyzing the Efficiency of an Approximate Nearest Neighbor Search Algorithm

Dimensionality reduction is the process of reducing the number of random variables under consideration by obtaining a set of principal variables to make high dimensional data easier to understand and process. One of the most common types of algorithms used for dimensionality reduction is a nearest neighbor search algorithm (NNSA). t-distributed Stochastic Neighbourhood Embedding (t-SNE) is an NNSA that has become widely popular in recent years. t-SNE can be very efficient, but it does not scale well to datasets with hundreds of thousands to millions of high dimensional data-points. Recently, a version of t-SNE, Fast Fourier Transform-accelerated Interpolation-based t-SNE (Fit-SNE), has been developed, which dramatically accelerates the computation of t-SNE. However, it had not yet been studied how accurate Fit-SNE is compared to t-SNE. The purpose of this project was to determine the efficiency of Fit-SNE in comparison to t-SNE. The study was conducted by running both algorithms on a number of different data sets. The differences between the principle values computed by each algorithm for each data set were then compared. The differences between computed principle values were then statistically analyzed to determine the accuracy of Fit-SNE and its efficiency in relation to its run time. It is projected that there will not be a significant difference between the principle values computed by the two algorithms. This study has the potential to strongly support the efficiency of Fit-SNE, which may encourage its usage in data analyzation by researchers, drastically decreasing the time it takes to process high-dimensional data.

Amity Regional High School
Teacher: Catherine Piscitelli

Fassman, Olivia**Project #47**

Research Proposal, Science, Environmental

**Detrimental Ecological Impacts
on *Eruca vesicaria sativa***

With the acidification of rainwater, *Eruca vesicaria sativa*, or arugula, which thrives in only slightly acidic conditions, is left vulnerable. Arugula is an extremely nutrient dense cruciferous green that ranked in the top 30th percentile by the Centers for Disease Control and Prevention (CDC) in Nutrient Density Scores of powerhouse fruits and vegetables. It also falls among the top 20 foods on the Aggregate Nutrient Density Index scale (ANDI score). Growing in thoroughly moist soil, leafy greens like arugula require frequent watering and have exposed leaves, vulnerable to precipitation. Both of these factors making leafy greens extremely susceptible to the acidification of rain. Nitrogen oxides and sulfur dioxide are released primarily by the burning of fossil fuels. In the atmosphere they react with oxygen and water, where they form acidic pollutants. In this experiment, samples of water with pH values of 6.5 (control), 6, 5, 4, and 3 will be tested on arugula microgreens to see how the varying acidities affect the growth and development of the plant. Arugula and other nutrient dense crops are endangered by the acidifying of rainwater and may not be able to grow naturally if the upward trend of acidification prevails. In the near future, the population could be deprived of a whole collection of organic vitamins and nutrients and be forced to artificially recreate these through supplements and genetically modified food.

Joel Barlow High School
Teacher: Paul Testa

Feuerstein, Joshua**Project #48**

Completed Project, Engineering, Environmental

**Creating an Algorithm to Determine the
Best Driving Route with Lowest Carbon Emissions**

Mapping algorithms, such as the one used in the Google Maps software, are complex systems that have existed for years. Using distance and traffic conditions, among other factors, these mapping services are currently more efficient than they have ever been. However, in creating the algorithm to transport between two points identified by GPS location in as little time as possible, an element largely overlooked is carbon emissions. No single routing algorithm has been created that accounts for and attempts to limit carbon emissions. To create this, an extremely basic routing algorithm was created in Java, utilizing local streets and a select few known GPS locations. Many factors were taken into account, including speed limits, traffic predictions, miles per gallon and carbon emissions by speed, and, to an extent, time constraints. Data was largely collected from online sources. This data was analyzed and processed into a regression and used in the algorithm as a function to predict unknown values for the aforementioned factors. The proposed result is an algorithm capable of creating the route between two points that produces the least carbon emissions for a specific car model. However, if time allows it, the Google Maps API and directories of fuel economy and carbon emissions information may be utilized to allow the algorithm to function with many vehicles and locations. This could then evolve into a much larger project, including a graphics interface for Android for ease of use.

Amity Regional High School
Teacher: Catherine Piscitelli

Fiordelisi, Claire

Project #49

Health and Medical, Research Proposal

Social anxiety in adolescence

My project focuses on the affects of anxiety in regards to social interaction. Overall, I am primarily centralizing my observations and data on the teenage age group. My motivations stems from my personal experiences and interest in the topic. Along with this, I am interested in how people adjust and change in varied social situations when in distress or when anxious. This includes the tendencies shown by those who deal with anxiety along with their reaction when something is said or happens. In regards to my methods and procedure, I plan to work with someone certified in the field to collect data and insight on the topic. Within Newtown Highschool there are many resources such as the school psychologists which I can work with, along with outside psychology offices I can reach out too. I want to continue my research focusing upon psychological aspects regarding how the brain changes when a person becomes anxious, either diagnosed or not. In order to do this, I would need to work with patients and ask questions that will help to show how they act socially and if anxious habits become apparent. This would include irrational fears, nervous habits, trouble concentrating, etc. Throughout this process though it would be important to know their previous medical history and their degree of anxiety. Between myself and my mentor also, we would need to work out the confidentiality aspects, along with approval from patients and people involved.

Newtown High School
Teacher: Timothy DeJulio

Ford, Skylar

Project #50

Health and Medical, Research Proposal

Determination of Metastasis-Driving Genes

Metastasis is the process in which cancer cells break away from the original tumor and travel to a separate location in the body, forming a secondary malignant tumor. Metastasis is estimated to be responsible for approximately 90% of cancer deaths. Although mutations associated with metastasis have been determined through deep sequencing of tumor samples, no study has investigated the driving forces of metastasis. CRISPR is a genetic engineering technique that creates double strand breaks at specified locations on a genome with the help of guide RNAs (gRNAs). The cell responds to a double strand break with a mutation, which silences the gene. An AAV-mediated CRISPR screen that targets metastasis-associated genes in a melanoma mouse model will induce metastasis. To create the melanoma model, an AAV-library of gRNAs that targets melanoma-associated genes will be injected into immunocompetent mice. Different combinations of gRNAs that target specific metastasis-associated genes will be tested. Rate in which metastasis occurs and the frequency of metastasized tumor occurrence will be recorded and used to determine metastasis-driving genes. The determination of metastasis-driving genes will allow doctors to accurately predict a patient's likelihood of metastasis and respond accordingly. Future research may be done with the findings to develop targeted immunotherapies as well as personalized treatments to metastasis-vulnerable tumors.

Darien High School
Research Proposal, Science
Teacher: Guy Pratt

Gardone, Luke

Project #51

Physical Science, Research Proposal

Determining Optimal Moon to Mars Trajectory In Terms of TOF Using the BFR Rocket

An important part of establishing a base on Mars is creating a lunar base. Refueling on the Moon would allow for larger payloads to be carried on each mission and allowing for less time to be necessary to meet a particular goal amongst many other benefits. The meaning of this project is to determine the optimal path for mission time. First I will make educated guesses as to the probable landing and launch sites. Next I will use the BFR rocket specs to place the craft on a trajectory towards Mars. Depending on the difficulty I will also describe the landing of the rocket. I hope to find the fastest possible route from the Moon to Mars. An important factor for doing so is determining the best landing and launch dates. This is important due to the position of planets and moons being described by the dates. My project will prove to be relevant to space exploration because it will provide a template for which others can create similar paths. When the creation of a lunar base begins to become a reality Moon to Mars trajectories will become necessary. As of right now there are no publicly available Moon to Mars trajectories therefore they need to start being made to prepare for the future of space travel.

Joel Barlow High School
Research Proposal, Science
Teacher: Katherine Nuzzo

Gilbert, Piper

Project #52

Environmental, Research Proposal

The Effect of Simulated Martian Soil on the Growth Rates of Plants

Space exploration allows the human race to determine its place in the universe and move forward to an advanced civilization. This project seeks to aid Martian colonization by determining the growth rates of plants in simulated Martian soil. It is hypothesized that, while the overall plant growth time will need to increase, a simulated Martian soil will allow for the growth of fruits and vegetables like tomatoes, potatoes, and mizuna lettuce. A Martian simulant soil was selected, the Planetary Simulant Database's MGS-1 Mars Global Simulant, for the growth of tomatoes, potatoes, and mizuna lettuce. A control group will be included by growing the same crops in Earth soil and comparing against the crops in Martian simulant soil. The plants' levels of germination, the length of time required to grow the plants, and the plant height will be measured over 45 days. It is expected that the experimental variable of Martian soil will limit the growth of the plants. The plant height and percent germination will be lower at any given point in time, and the length of time needed to grow the plants will be greater. Nevertheless, the plants will grow over the 45 allotted days and the experiment will reveal the possibility of growing consumable plants on Mars. The implications of these results are immense; it allows for further research in refining survival techniques in space, what types of plants work best with Martian soil, and other avenues as technology continues to advance. Mars' surface conditions make life incredibly difficult and as such, NASA has not yet sponsored a human mission. This experiment can support the possibility of Martian colonization and furthers the possibilities of future space exploration.

Sacred Heart Greenwich
Research Proposal, Science
Teacher: Mary Musolino

Goldenberg, Hannah

Project #53

Health and Medical, Completed Project

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

E-cigarette use, especially among teenagers and young adults, is becoming a global epidemic. With research about e-cigarette's content only just beginning, the correlation between frequent e-cigarette use, subsequent exposure to unidentified vapor components, and ensuing respiratory disease, remains unexplored. In phase one of this research, a hollow 3D-model of an adult lung was used to trace compounds of e-cigarette vapor that enter the lungs, both as a gas, and as a re-condensate, within the propylene glycol (PG) solvent. Absent of water, more than 50 compounds were detected, including nicotine, PG, ethanol, and significant concentrations of diacetyl, a flavorant that has been linked to bronchiolitis obliterans. In this current research, a correlation between exposure to e-cigarette compounds and Chronic Obstructive Pulmonary Disease (COPD) is sought. Human bronchial epithelial cells (HBEs) were exposed to practical concentrations of (unaltered) e-cigarette liquid, nicotine, diacetyl, ethanol, and phosphate-buffered saline (PBS and ethanol were controls); an LDH cytotoxicity assay was used to measure toxicity of e-cigarette liquid and diacetyl. Increase in LDH is an indicator for tissue damage. For those cells treated with e-cigarette liquid, a 32% increase in LDH was seen, while diacetyl caused a 26% increase. In concurrent experiments, the mRNA produced by cells was used as a template by reverse transcriptase, which then produces complementary DNA (cDNA). The cDNA is then copied by RT-PCR, and the strands analyzed for increase in genes MUC5AC and MUC5B. Increase in these genes is indicative of increased mucin production, which is directly linked to COPD. Increase in MUC5AC gene expression was found for diacetyl (1.3x), e-cigarette liquid (2.2x) and nicotine (2.3x). For MUC5B, diacetyl caused a 1.2x increase in relative gene expression. Collectively, these increases in MUC5AC/MUC5B highlight increased risk for COPD for e-cigarette users.

Greenwich High School
Completed Project, Science
Teacher: Andrew Bramante

Goldstein, Hana

Project #54

Behavioral, Research Proposal

Testing the Effect of Re-introduction of the MAOA gene on Mouse Behavior

A gene on the X-chromosome instructs the production of monoamine oxidase A (MAOA), an enzyme that metabolizes dopamine and serotonin. Presence of a mutation in the MAOA gene genetically increases one's risk for exhibiting aggressive and criminal behavior as an adult. This mutation leads to MAOA deficiency and an excess amount of neurotransmitters which is directly connected to abnormal behavior. The experiment will be performed in a lab setting by creating a model of MAOA deficiency using a transgene integration into mice. The mice will be observed for behavior, levels of neurotransmitters, and levels of the MAOA enzyme. Then re-introduction of the MAOA gene will occur and behavior, level of neurotransmitters, and the levels of MAOA enzyme will be recorded again and compared to the earlier observations. The results will show that the reintroduction of the MAOA gene will increase production of MAOA enzyme and fix the deficiency. Results will also show regular degradation of neurotransmitters and a decrease in aggressive behavior in mice. The results will help develop new treatments for those who test positive for the MAOA mutation and exhibit aggressive behavior. Although there is a small amount of these cases, the results will be important in helping prevent or stop criminal behavior of those who are affected by the MAOA mutation.

Ridgefield High School
Research Proposal, Science
Teacher: Patrick Hughes

Greco, Gianna

Project #55

Health and Medical, Research Proposal

Targeting donor specific antibodies: The liver's helping affect on the kidney

Acute rejection is a risk in kidney transplants, especially when there is a positive cross match between donor and patient. When the patient has already been exposed to certain foreign proteins, they will most likely have developed donor specific antibodies. When the patient receives the kidney, these antibodies cause inflammation in the kidney tissues, which can lead to rejection. Transplanting a liver simultaneously may impact these antibodies, which is what the experiment will determine. Blood samples will be collected with and without donor specific antibodies. 6 different types of blood will be used: blood containing no antibodies, immunoglobulin A, D, E, G, and M. Two trials will be conducted: first, podocytes will be injected into each sample of blood, and then both hepatocytes and podocytes will be injected into each sample. Each trial will determine how the cells and different types of antibodies interact with each other. The results will show antibodies in the blood containing podocytes will survive, and antibodies in blood containing both podocytes and hepatocytes will deactivate. It is believed that when a simultaneous liver-kidney transplant is performed, inflammation of kidney tissues is decreased, so a similar effect will occur in cells and it will be possible to see why the liver has this effect. Results of this experiment can be used to discover why the liver has this effect on the kidney. A protein or substance with similar traits to the liver could be developed that would reduce the effects of the antibodies on the kidney.

Ridgefield High School
Research Proposal, Science
Teacher: Patrick Hughes

Grey, Julia

Project #56

Health and Medical, Research Proposal

Proposed Research on Fabrication Techniques of Human Tissue Scaffolds

Thousands of people die every year waiting for organ transplants. These deaths are either due to an insufficient amount of donor organs, or the failure of temporary fixes such as dialysis, bypass machines, or joint replacements. In order to combat this issue, researchers are looking into a permanent fix which will allow tissues to regenerate by themselves with the aid of tissue scaffolds, comprising synthetic polymers or other materials. Experimentation will determine which of two methods is most sufficient for developing a tissue scaffold. In the first method, a polymer (PLGA or PLLA) is dissolved in chloroform then cast into a petri dish filled with NaCl. In the second, pieces of the polymer-porogen composite are molded into cylindrical form and cut into discs. Tissue cells will be planted onto these scaffolds and their growth will be examined in vitro. The results I obtain from my experiment will tell me what solvent casting approach is most suitable for forming effective scaffolds which facilitate new tissue growth. Based on my prior knowledge, the second approach to solvent casting will likely be more successful due to the uniformity of scaffolds it promotes. This research is important as it will help to advance tissue regeneration technology for the future. The widespread need for organ transplants will hopefully decrease as scaffold fabrication techniques are tested for reliability and efficiency and begin to be used in medicine.

Ridgefield High School
Research Proposal, Science
Teacher: Ryan Gleason

Griffin, Claire

Project #57

Health and Medical, Research Proposal

Utilizing CRISPR-Cas9: the Gene Editing Technology and Homology Directed Repair in the Termination of Antibiotic Resistance in Bacterial Cells

There is an increased prevalence of antibiotic resistance due to genes that allow for bacteria cells to break down antibiotics. Using CRISPR-Cas9, it is possible to mutate the enzymes that cause antibiotic resistance and create bacteria cells without resistance to specific antibiotics. The purpose of this research is to successfully edit the genomes of bacterial cells, thus providing a solution to the antibiotic resistance issue. Bacterial plasmids will encode for the CRISPR-Cas9 complex, and will be expressed in the cell. Then, adeno-associated viruses (AAV) would be used to insert the plasmids into bacterial cells. Afterwards, Homology Directed Repair (HDR) will be used to insert the specific codon into the resistance gene. This stop codon will cause the resistance enzymes to be nonfunctional. Finally, the altered bacteria cells will be treated with a certain antibiotic to determine if the antibiotic resistance was terminated. The results of this experiment will be a bacterial cell treated with the CRISPR technology which will eliminate the enzyme responsible for breaking down a certain antibiotic. Therefore, these bacteria cells will die in the presence of the certain antibiotic. Ultimately, the research will confirm the potential of CRISPR-Cas9 to remove antibiotic resistance from bacteria cells, and that the CRISPR-Cas9 system along with the process of HDR has the ability to edit the genomes of bacterial cells. Without antibiotic resistance, it is possible to make the treatment of various infections and illnesses much easier.

Ridgefield High School
Research Proposal, Science
Teacher: Patrick Hughes

Gross, Ava

Project #58

Environmental, Research Proposal

The Effect of 5 3D TED Designs on the Percentage of Turtle Bycatch

Every year, turtles are being caught and die in shrimp trawls. A device called a TED, turtle excluder device, has been put into trawls to keep out the turtles. 4 new prototypes, the independent variable, will be tested for percentage of turtle bycatch or unwanted catch, the dependent variable, and compared against the results of a certified TED in use today, the control. Design A will have vertical bars and diagonal bars cutting across. Design B will also have horizontal bars across the width and vertical bars perpendicular to the horizontal bars with the same dimensions as the previous. Design C will be a hexagonal honeycomb shape with 0.5" long sides. Design D will be a spherical pattern with no crossbars. The control model is a certified TED with 4" bars. All of the TEDs are the same size with different patterns. The tests will take place at home in a kiddie pool. First, the TED will be sewn onto the net and dragged through the water picking up 3D printed shrimp and plastic turtles along the way. The amount caught will be counted, recorded, and calculated into percentages. The shrimp and turtles will be randomly thrown back and the process will be repeated for every other TED. The expected results will be that the TED with the smallest opening will exclude the most turtles. The most efficient TED will be the one that excludes the most turtles while also maintaining a sufficient amount of shrimp.

Amity Regional High School
Research Proposal, Engineering
Teacher: Deborah Day

Grosso, Nicole

Project #59

Behavioral, Completed Project

The Effect of Time Perception on Time Management

Time perception refers to a person's experience of the passage of time. One's time perception is rarely accurate, and studies have shown that the average US citizen overestimates their time spent working by up to 10%. The purpose of this experiment was to test whether time perception affected time management in adolescents. The independent variable was time perception, and the dependent variable was the time management skills in adolescents. The hypothesis was that if one has weak time perception, it would negatively affect their time management. In order to test this, a form was sent to high school students who had completed consent forms. They watched a series of videos and answered questions concerning what they watched. The last question in the poll asked how much time the participant thought they spent watching the video. Subsequently, they took a time management survey containing statements about how they managed their time (ex: I do things in order of priority), and the participant was asked to check one box- always, sometimes, rarely, or never. To keep results impartial, clocks were covered. The results of the survey and perception test were compared to each other to determine the connection between the two, if one existed. If results support that there is a connection between the two, further research will be conducted to figure out how best to improve time perception skills, resulting in better management of time. Results thus far show that there may be a connection, though few experiments have been performed.

Amity Regional High School
Completed Project, Science
Teacher: Catherine Piscitelli

Gunawardana, Dilan

Project #60

Physical Science, Research Proposal

Using Catalysts to Increase the Efficiency of Hydrogen Production in Water Electrolysis

Currently, the methods of energy production are causing pollutants to enter the environment when burning fossil fuels by contributing to Global Warming. Unlike other methods of energy production, using Hydrogen fuel cells only yields water - a molecule that harmless to humans and the environment. Unfortunately, Hydrogen has to be produced, as it isn't readily available on Earth, and current methods are inefficient. I will use metal catalysts to increase the efficiency of hydrogen production during water electrolysis. This will be done by placing two electrodes in a basic KOH solution and passing a current between them which will yield oxygen and hydrogen. There will be a copper wire connecting each of the electrodes to a multi meter and 9 volt battery. I will do the experiment above with a control run without the metal catalysts for a set amount of time and an experimental run with the metal catalysts for the same amount of time. I expect that the experimental run will produce a greater volume of hydrogen gas than the control run and there will be a higher current going through the electrodes. If there is a higher current going through the wires and more volume of hydrogen gas produced, then water electrolysis is being carried out at a more efficient rate. With a better efficiency, this means that less energy input will be required to produce the necessary amount of hydrogen for use in fuel cells, making the hydrogen fuel energy source less demanding of energy.

Joel Barlow High School
Research Proposal, Science
Teacher: Katherine Nuzzo

Hirsch, Cameron

Project #61

Environmental, Research Proposal

Investigating the Effects of Different Sound and Water Levels on the Growth of the Common Bean Plant (*Phaseolus vulgaris*)

The earth is currently undergoing global warming, a phenomenon that has many negative effects on our environment, one of which is water shortages. This, along with the growing human population, will present us with the challenge of making sure we can still produce enough food. In order to address this problem, I wanted to address how we might be able to decrease our water usage in agriculture. To conduct my experiment, I will be exposing Common Bean plants to varying water levels and sounds. Each specimen will receive a set amount of water and will be exposed to a 1kHz or 10kHz tone for one hour each day. The project will last 30 days. I believe that by exposing the bean plants to “dio tones, they will be able to grow as well as specimen grown normally while also using less water. The results of this experiment may give us a better method of producing crops while also conserving our water supplies.

Joel Barlow High School
Research Proposal, Science
Teacher: P”l Testa

Hisiger, Luke

Project #62

Health and Medical, Research Proposal

Induced Pluripotent Stem Cell Applications

People who have lost limbs or have physical disabilities are seeking solutions such as robotic prosthetics. But the best solution to limb loss may lie within the body. The salamander’s ability to regenerate perfect limbs is still a mystery to humans. The medical world would be revolutionized if the regenerative abilities of the salamander could allow humans to regenerate healthy limbs and organs. Through the use of induced pluripotent stem cells, or iPSCs, humans could unlock their full regenerative potential. iPSCs are pluripotent stem cells, meaning that they are capable of becoming any type of somatic cell in the body. By researching iPSCs and their connection to regenerative abilities, the properties and uses of stem cells could be applied to regenerative medicine. Looking at how iPSCs are made and how salamanders can regenerate limbs, the knowledge of how iPSCs work may be achieved. This knowledge can be applied to somatic cells in a specific condition such as limb loss to make them pluripotent. This would create somewhat of a human blastema (which is a pocket of cells that become a limb) so that people will be able to create working limbs. If this research is successful, the knowledge of what makes a cell pluripotent, especially in salamanders will be gained. This knowledge would be extremely important to the medical community because it can be applied to most physical conditions in the body. Successful iPSCs could be the first step to a whole new field of regenerative medicine.

Ridgefield High School
Research Proposal, Science
Teacher: Patrick Hughes

Hisler, Caroline
Howell, Brooke

Project #63

Environmental, Research Proposal

**Testing the Root Extract Fallopi multiflora
to Determine the Effect on Life Span
in Armadillidium vulgare**

It has recently been found that the root extract Fallopi multiflora, or Chinese knotweed, enables the nematode *C. elegans* to live longer. This is a very recent finding, however, and more research is needed. This study will test the extract to determine if similar results will be found in *Armadillidium vulgare*, the common pill bug. It is hypothesized that lifespan in this species will increase by twenty percent after administration of the highest concentration of the extract used. Three concentrations of extract will be made and administered to thirty pill bugs each in separate containers. One additional container will contain the same number of pill bugs but will not be administered the extract. Life span and overall health will be noted over the course of six months. Once the optimum concentration is determined, another trial will occur under stressed conditions to determine if the extract shows the same level of effectiveness in extending life in pill bugs that are stressed. It is expected that the extract at the highest concentration will extend the lifespan of the pill bugs by twenty percent. The lower concentrations will also extend life but by not as significant a margin. In addition, the lifespan and health of the pill bugs will be significantly improved when under stressful conditions, such as higher temperatures, when given the extract. This research will evaluate the extract on improving health and extending life expectancy in organisms other than *C. elegans*. This study adds to the limited research conducted in order to determine the importance of this extract. In addition to lifespan, future studies will include a determination of the effectiveness of the extract in improving memory and in preventing the development of plaques found in Alzheimer's disease.

Sacred Heart Greenwich
Research Proposal, Science
Teacher: Mary Musolino

Holm-Hansen, Colin

Project #64

Physical Science, Research Proposal

**Analysis of water production on lunar regolith as
a result of solar wind implantation**

Until recently, the lunar surface was perceived as quite uneventful in its opportunity for discovery. However, it is now known that a diverse presence of molecules are strewn all across the lunar regolith, and learning how they interact with the moon can help to understand how to harness and account for materials on any celestial body with a very thin atmosphere, or lack thereof, like the planet Mercury, for example. To perform a statistical analysis of the distribution of water on the moon's surface versus areas of the lunar surface most affected by solar wind, to determine the efficacy of solar wind implantation being the cause of water on the lunar surface. I hope to find an association between the density of water molecules in a specific region of the lunar surface and the amount of solar wind that hits that region of the moon.

Understanding this reaction is a vital first step in potentially harnessing a natural reaction on the moon for resources, in this case water.

Joel Barlow High School
Research Proposal, Science
Teacher: Katherine Nuzzo

Ingwersen, Bryan**Project #65**

Physical Science, Research Proposal

**Computational Fluid Dynamics
Study of Turbulence**

Fluid turbulence is an area of classical mechanics that is still not well understood, but new techniques have the potential to better identify the critical point of its formation. Current investigation into this has been carried out through physical experiments which face challenges of maintaining extreme precision. This project is exploring the use of computer simulations to more effectively approach the problem. A computer simulation of a fluid-filled duct will be created for conducting trials. Disturbances will be semi-randomly introduced into a laminar flow, and the simulation frame will pan in order to examine the disturbances over a long time span. Trials will be conducted while altering the Reynold's Number of the flow in order to establish its relationship with the probability of disturbances to decay or propagate. After data are collected, the results of many trials will be used to determine the average decay and replication rates of the disturbances. From these data points, a growth curve and a decay curve can be extrapolated relative to Reynold's Number, and their intersection will provide an estimate of the critical point for turbulence formation. Engineering often seeks to limit turbulence in order to improve systems' efficiencies. A particular area that this research relates to is pipeline design where much of a system's energy can be lost to turbulence. At the same time, carefully controlled turbulence is desired in certain circumstances such as for better circulation in cooling systems and for generating vortices to increase the lift of airfoils.

Newtown High School

Research Proposal, Science

Teacher: Timothy DeJulio

Jafri, Danya**Project #66**

Health and Medical, Completed Project

**The Determination of LVEF and PA Pressure as
Valuable Indicators of Long Term Left Ventricular
Damage and Deterioration in Patients with
Hypertrophic Cardiomyopathy**

Hypertrophic cardiomyopathy (HCM) causes the heart muscle to become abnormally thick, resulting in ineffective hemodynamics and a weakened, enlarged left ventricle (LV). Previous echocardiography studies on HCM have recognized left ventricular ejection fraction (LVEF) as a short term indicator of damage, but LVEF and pulmonary artery (PA) pressure as long term indicators of LV deterioration have not been well characterized. The performed research tested LVEF and PA pressure changes as possible markers for the long term effects of left ventricular damage in HCM patients. It was hypothesized that these markers will demonstrate a pattern of change that will distinguish the severity of left ventricular damage over a prolonged period of time. Thirty patients were assessed using a medical survey and echocardiography results of the past five years to determine their clinical history and symptoms associated with their cardiac health management. Statistical analysis was used to identify numerically significant changes in LV function in accordance with HCM. Current data analysis indicates that the aforementioned hypothesis holds true; PA pressure and LVEF became increasingly exacerbated upon each patient's follow-up echocardiogram during the five year interval. The resulting conclusions will aid in preemptive care of HCM and associated pulmonary hypertension and adequately addressing long term LV deterioration in the grand scheme of cardiac diagnostic testing and treatment.

Darien High School

Completed Project, Science

Teacher: Christine Leventhal

Jarad, Khaled

Project #67

Behavioral, Completed Project

Effect of an Educational Model on the Likelihood of Adolescent Participation in Addiction Research Studies

Research has shown that people are less likely to participate in studies if they are not well informed about: the study's goals, measures taken to keep information private, and the implications of the study or what will be the outcome of the research. This research projects aim to develop, test, and refine an informative model in the form of a video presentation to help improve the likelihood of parental consent for adolescents' participation in addiction research studies. As a member of the research team, my role will be in developing and programming the video and analyzing the satisfaction and usability data. For this study, the participants will be the parents of children from the Adolescent Clinic at Yale-New Haven Hospital, Primary Care Center, Yale-New Haven Hospital. After viewing the video, participants will also be asked if they would allow their children to participate in the study described by the video. Participants will also be asked if they would allow their children to participate in the study described by the video. A survey will be administered to analyze the effect on the parents' decision. This data will be compared to the proportion parents who have consented to research in our clinic before the creation of the video (39%). This project is significant and beneficial since it addresses the important issue of recruiting participants for sensitive studies. This project is novel since there is limited work that has been done surrounding parental consent in research involving adolescents.

Amity Regional High School
Completed Project, Science
Teacher: Deborah Day

Jog, Niharika

Project #68

Physical Science, Completed Project

Using Oxygen Based Cleaning Solutions to Erase Trace Evidence of Blood on Cotton Fabric

Blood patterns can reveal many truths of a crime scene. However, a Spanish study conducted in 2009 at the University of Valencia concluded that detergents containing active oxygen can eliminate all trace evidence of blood. This experiment is designed to determine which oxygen-based cleaner can eliminate all trace evidence of synthetic blood on cotton fabric. This experiment involves washing synthetic blood on cotton fabric in three different oxygen-based cleaners in three trials. The fabric will be hand-washed. Luminol will be used to reveal any trace amounts of synthetic blood, the remaining stains will be compared, and pictures of the fabric will be taken as well. After the experiment is conducted, the stains left behind by the cleaners will be compared, along with the amount of blood visible with luminol after washing. Pictures that are taken of the cloth held up against a source of light will also be compared. These will be used to come to a conclusion of which cleaner is able to erase evidence best. At a crime scene, police may fail to detect a bloodstain due to thorough cleaning done by a culprit. However, police may use methods to detect trace evidence of a certain type of cleaner that could have been used to erase blood. This is especially useful if police find a container of the same cleaner in another area of the scene.

Amity Regional High School
Completed Project, Science
Teacher: Deborah Day

Juan, Charlotte

Project #69

Environmental, Completed Project

Using LCA to Determine the Nutrient/Impact Ratio of Foods Available to Connecticut Consumers

Two percent of the total amount of energy used in the United States each year is wasted during the production of food. It is important to make sure the nutrient output of the foods we eat is maximized in comparison to the energy needed to produce the food. Energy used is always counted as a negative impact on the environment due to the life cycle carbon footprint associated with food production and consumption. When the life cycles of 5 of the most consumed food products in the United States are analyzed by the amount of energy needed to produce 100 grams of each food product, it is predicted that vegetables will have a higher nutrient output to energy waste ratio (N/I) than the meat products, indicating that vegetables have a high nutrient value in relation to the energy waste associated with their production. Nutrient output was based on daily recommended values of micro and macronutrients. Energy waste was determined by the overall consumption of raw materials, production, and transportation of the product to market. There was a significant difference between the N/I ratio of meats and vegetables, with the vegetables having a higher ratio. To feed an ever growing human population without further environmental degradation, it is necessary to utilize food sources with higher N/I ratios. In order to continue to consume meat, there must be a way found to reduce the amount of wasted energy in the production of meat.

Darien High School
Completed Project, Science
Teacher: Guy Pratt

Jureller, Isabella

Project #70

Health and Medical, Research Proposal

Mitochondrial Transplant to Restore Heart Function

When the heart suffers from ischemic and reperfusion injuries, mitochondria viability deteriorates. Ischemia increases the volume of the mitochondria, and it decreases mitochondria's protein and enzyme efficiency, as well as the amount of oxygen and ATP. Thus, cellular respiration stops and the energy supply decreases. This experiment will restore heart function by harvesting viable mitochondria and injecting them into failing heart tissue to increase the production of cellular energy. The procedure will replace nonviable mitochondria with viable mitochondria from nonischemic "tologous tissue to overcome the nonviable mitochondria. Muscle tissue, from the rectus abdominis or the pectoralis major, is harvested and homogenized in a buffer and treated by subtilisin A enzymes. The isolated mitochondria are injected directly into the ischemic myocardium. After transplantation, the heart will be analyzed for function and ATP generation. Mitochondria transplantation will ultimately, restore proper heart function, and rebuild the heart's energy supply. The ischemic injury will decrease. Ten minutes after the transplant, heart function will enhance, and the ATP levels will increase. The conclusions of this research will help ischemic patients worldwide regain normal heart functions. This research could be used to develop treatments for other heart problems that millions of Americans suffer from every day. Mitochondrial transplantation will lead to new methods of regenerating failing heart tissue and could make a difference in the lives of people all over the world.

Ridgefield High School
Research Proposal, Science
Teacher: Patrick Hughes

Kadimi, Srilekha**Project #71**

Health and Medical, Completed Project

**Effect of Histone Modification
In Species Development**

Poised chromatin is the simultaneous presence of histone modifications associated with gene activation and repression. The activation histone modification is H3K4me3 and the repression histone modification is H3K27me3. Developmentally important genes maintain chromatin states associated with gene activation. Some genes are poised in humans and mice, while some are poised in one organism. The question asked was where different genes are expressed in mice versus humans and how that affects species development. The independent variable was histone modification. The dependent variable was the presence of the gene. It was hypothesized that if a change is induced in histone modification, then that will result a difference in gene expression, causing a difference in organ development. To test this question, ChIP-sequencing was used to look at differences in mouse and human genes. This method determines protein-binding sites on DNA. The student used an online genome tracker to identify genes poised on either humans, mice, both, or none. Research was conducted at the student's house. The results were analyzed to look for similarities in organ development in order to determine why similarities occur. Data thus far has shown that some genes are expressed in mice and humans but not in the same amounts. Also, some genes are expressed in one organism. A major question in biology is how a single genome can generate different cell types and tissues. The function of a particular type of genome regulation, epigenetic poising, was addressed in specifying how the genome is used differently in different cell types.

Amity Regional High School
Completed Project, Science
Teacher: Catherine Piscitelli

Kanlian, Henry**Project #72**

Environmental Research Proposal, proposal

Microplastics in Long island Sound

This experiment will aim to measure the amount of mesoplastic, macroplastics, and microplastics in the viscera and gills of 4 dried fish species. The species that will be used in this experiment are Bluefish, Winter Flounder, Atlantic Herring, and Striped Bass, and this will help to judge the dangers of microplastics in Long Island Sound. The dried fish species' edible flesh will undergo simulated digestion. Organic matter and inorganic matter will be separated through this process. Data will be recorded as number of independent pieces of microplastics or macroplastics in the viscera, gills, and edible flesh of the four types of experimental fish. Expected: After analysing the specified fish species edible flesh I expect to find multiple independent pieces of microplastics. If the hypothesis of this experiment is supported, then it could mean that CT, NY, and surrounding states with rivers flowing in the sound would have to lower their amount of plastic waste. It could also result in the a reduction of fish c"ght in the sound, due to their toxicity.

Darien High School
Research Proposal, Science
Teacher: Christine Levanthal

Karl, Lila**Project #73**

Environmental, Research Proposal

Concentration of Heavy Metals in Tissues of Green Turtles (*Chelonia Mydas*) Sampled off Nansei Island

Pollution of heavy metals in oceans is a major problem all over the world from human urbanization and industrialization hurting marine populations such as sea turtles. There has not been enough research in waters off the coast of China, where pollution is the worst. There will be a collection of 15 juvenile and 15 adult green sea turtle's or *Chelonia Mydas*, an endangered green sea turtle species, off of the coast of Nansei Island in the Sea of Japan. A Flame Atomic Absorption Spectroscopy will be used so element concentrations can be expressed on a dry weight basis. ANOVA will be used for a statistical analysis of the concentrations of the metals. It will be tested how the age of the green sea turtle will correlate with the concentration of various heavy metals (cadmium, copper, nickel, manganese, and lead) found in the liver and kidney tissue of the sea turtles. It is predicted that the adult green sea turtles will have higher concentrations of heavy metals in their liver and kidney tissue because the metals will accumulate with age. With the results from Nansei Island, concentrations of heavy metals found in green sea turtles can be compared to areas all over the world. The sea turtles found in Japan will have overall higher concentrations compared to the sea turtles in Brazil because there is more pollution in Japan. These results will help gain more knowledge on how to conserve sea turtles.

Darien High School
Research Proposal, Science
Teacher: David Lewis

Khwaja, Kabir**Project #74**

Health and Medical, Completed Project

Analyzing Shod vs. Barefoot Running in relation to Angular Knee Motion

Running is an increasingly common yet unexplored physical activity with large potential for biomechanical research. This project aims to establish a quantifiable understanding of the relation between changing between shod or barefoot running style and how this can impact the positioning of the angles at the knee. The hypothesis is that if one runs shod, then the angles formed at the knee would be larger than while barefoot. Recreational runners will be recruited for the project. The participants will be between the ages of 18 to 50 and have no significant injuries. The runners will have infrared markers and EMG pads placed on specified areas of the legs and will wear Teva sandals to mimic running shoes. The runners will run six trials at three different speeds, each lasting 4 minutes on a treadmill and alternating between running shod and barefoot. During each 4 minute trial, high speed cameras will be used in three 15 second sections (start, middle, end) of the run to record 3D data for modelling of each subject. Muscle activity will also be recorded, and the data will be collected in MATLAB. This data will display the various angles formed between various parts of the leg, with the angles at time of landing phase recorded for analysis. After statistical and graphical analysis is used to examine any changes in knee flexion and produce conclusions, the project will offer an expansion of our knowledge of the human body. The results of this project would strengthen biomechanical knowledge and increase understanding of different training styles. This information could lead to improvements in the approach taken by runners toward preventing injury and enhance training programs to better suit individuals.

Amity Regional High School
Completed Project, Science
Teacher: Catherine Piscitelli

Kim, Andrew**Project #75**

Behavioral, Completed Project

Comparing the Extent of the Effect of Peer Pressure and “tonomy Support in High School Students and Teachers

Psychology and interpersonal interactions have always been a passion and interest of mine. The primary research question was if adolescent perceptions of peer pressure and “tonomy support are stronger compared to those of adults. The secondary question was whether there is a relationship between age and peer pressure and “tonomy support. It was hypothesized that the relationship between peer pressure and “tonomy support is that the students will have a stronger perception of peer pressure (PP) but a weaker perception of “tonomy support (AS), while teachers will have a stronger perception of AS and a weaker perception of PP. The independent variable was teachers and students surveyed, both male and female, and the dependent variable was the amount of perceived PP and AS. Consent forms were given to the participants, and after the forms were returned, they were allowed to complete the survey, which will be sent out via email. These surveys collected basic demographic information and investigate two constructs: PP and AS. They were created using the Likert scale, and there were twenty questions to answer. After receiving every survey back, the data was analyzed using means, standard deviation, correlations, and t-tests. If the hypothesis is supported by the data and results, that would mean that AS and its importance in development would need to be t”ght and encouraged to adolescents. In addition, knowing how AS and PP affect adults would be essential in educational strategies and intervention for health-care providers and developmental psychologists.

Amity Regional High School
Completed Project, Science
Teacher: Deborah Day

Kim, Mina**Project #76**

Health and Medical, Research Proposal

Degradation study of polymeric scaffolds with different composition for bone healing and regeneration

Bone grafts used currently have several disadvantages including disease transmission, limited availability, and complicated surgical operations. To address these problems, we attempt to create novel mechanically competent, porous, and degradable polyester scaffolds by using the dynamic pore formation concept (blending low and high degrading polymers). The challenge in creating these scaffolds is optimizing their porous structure without sacrificing their mechanical properties. The purpose of this study is to design and optimize a various composition of polymeric scaffolds for bone tissue engineering. Independent variable is varying ratios of differing compositions polymers of scaffolds. Dependent variable is degradation character including weight and molecular loss, pore size, pH, and mechanical strength. Using two different polymers with varied degradation rates and strength will create sufficient mechanical properties, appropriate for load bearing areas in the body. We will measure initial weight for all samples. Cylindrical polymeric composites are subjected to degradation in 37 C and 65 C in phosphate buffer saline with 1% sodium azide. Dry and wet weight will be measured through mass over time. Sample size is n=3. Mechanical properties will be measured by comparing properties of human bone and polyether ether ketone. pH will be measured and scaffold will be air dried for weight loss measurement. Results reported are an average of three measurements. Scanning electron microscopy will be used to measure porosity, pore size distribution, total surface area, and total pore volume. Results will address challenges with current clinical practices in reconstruction of bone defects by utilizing different combined polymers.

Amity Regional High School
Research Proposal, Science
Teacher: Catherine Piscitelli

Kins, Grant**Project #77**

Environmental, Research Proposal

Observing the differences in growth, development, and reproduction rate between two fairy shrimp genera (Thamnocephalus and Sterptocephalus)

Fairy shrimp is a species of shrimp located in the West Coast that live in vernal pools formed by rainwater. Recently their population has been declining and they are now endangered. I am going to study redbelt and beavertail fairy shrimp which have very different sized populations to see what contributes to the variation in population. I plan to identify the differences between the species with the hopes of finding the factors that result in the variations of populations. By raising the shrimp in similar environments this will clearly show how their characteristics impact traits such as survivability, growth rate, and reproduction. I will record the data from multiple tanks and compare my results. I am hoping to use the data I collect to compare the growth, reproduction, and survival rate of the two species to find what causes such a large disparity between the population. The information I collect will portray the differences between the two species of fairy shrimp which is important to know because of the current endangered state of their population. It will let me know what factors contribute to a sustainable fairy shrimp population

Research Proposal, Science

Teacher: Stacey Greenberg

Kongani, Keerthi**Project #78**

Health and Medical, Completed Project

Does Bitter Melon Have Antibacterial Properties

Bitter Melon is a type of vegetable that is used in South Asian Cuisine. It is said to have antidiabetic properties as well as anti-virulent and antibacterial properties. There have been studies on the antibacterial properties of bitter melon, however, many of them are either flawed or small scaled. My project aims to test if bitter melon, in various proportions of rind, inside, and seeds, can kill bacteria. The proportions were 1 gram rind, 1 gram inside and 3 grams seeds. The second set of proportions were 1 gram rind 3 gram inside and 1 gram seeds. The third proportion was 3 grams rind, 1 gram inside and 1 gram seeds. I will be conducting 5 trials. For proof of principle studies, E. coli bacteria was used as a surrogate for MRSA (safety precaution), which was grown in vitro in petri dishes. Disks were then be soaked with the predetermined amount of bitter melon puree, and were placed on the bacterial culture after plating the culture. An incubator was used to speed up bacterial growth. I put my results in a line graph. In the future this research can be used as an alternative way to treat e. coli or even try to treat antibiotic resistant bacteria like MRSA. In the future I plan on testing if bitter melon could help diabetic patients with their insulin levels as well.

Amity Regional High School

Completed Project, Science

Teacher: Catherine Piscitelli

Kongani, Adarsh

Project #79

Environmental, Completed Project

Optimizing Flow Field Design in a PEM Fuel Cell Using Biomimicry

In this project, 3D printing will be used to design and test flow fields influenced by nature. A flow field has 4 main roles: uniformly distribute reactant gasses to reaction sites, transport products away from reaction sites, facilitate transportation of electrons, and minimize pressure drop from the inlet to the outlet. The main problem with the flow field is the water produced condenses, producing liquid water in the channels. These droplets can clog the channels. Having an ineffective flow field decreases the fuel cell performance and life. I hypothesize that the leaf flow field, that is influenced by nature will be more effective than than the current industry standard. My independent variable is the type of design while the dependent variable is the flow rate. The control is the serpentine design, the current industry standard. The designs being tested are parallel, lung, leaf, and serpentine. The pressure, material, and cross-sectional area all have been kept constant. First, I will have to model these designs, print them using a 3D printer, and finally test them. To test I will calculate flow rate of water and gas of flow field. Also the formation of water droplets will be imaged as well with direct optical imaging. The outcome is that the leaf pattern will do the best. These designs can help make fuel cells more efficient, and open up the areas of different applications of the PEM fuel cell and use it for clean energy alternatives.

Amity Regional High School
Completed Project, Science
Teacher: Catherine Piscitelli

Kosnik, Lily

Project #80

Environmental, Completed Project

Effect of Site History and Organic Matter Content on Methylmercury Contamination in River Sediments

The pollution of water systems by methylmercury, a toxic form of mercury, has harmful effects on ecosystems and humans. Methylmercury enters ecosystems through precipitation, deposition, and runoff from industrial sources. This study aimed to determine the effect of site history and organic matter content on methylmercury contamination in river sediments. Samples were collected from the Still River, the Hackensack River, and as a control three western Connecticut streams with no history of pollution. Methylmercury contamination in the Still River came from hat-making factories in Danbury and in the Hackensack River pollution came from a chemical processing plant. Samples collected from each site were combusted to determine percent organic matter and run through a mercury analyzer to find mercury concentration. The Hackensack River had significantly higher concentrations of mercury, followed by the Still River. The Western Connecticut rivers with no history of pollution had lower concentrations of methylmercury. The percent organic matter had the highest values in the Hackensack River and lowest in the unpolluted Connecticut streams as well, indicating a correlation between higher mercury concentration and higher percent organic matter. Outliers in the data for the Still River were all from the same sample site suggesting that there are other possible sources of contamination. The concerning levels of methylmercury pollution in the Hackensack River and Still River are indicative of a need for toxic waste cleanups and measures taken to decrease mercury pollution.

Darien High School
Completed Project, Science
Teacher: Christine Leventhal

Kosyakov, Alexander

Project # 81

Physical Science, Completed Project

Rechargeable Magnesium-Air Batteries Using C12A7 Superoxide Clathrate Cathode for More Efficient and Sustainable Electric Vehicles

Automobiles propelled by internal-combustion engines are responsible for 28% of the greenhouse gas emissions that contribute to climate change. Electric vehicles (EVs) can potentially diminish this figure; their market viability, however, is severely limited by current lithium-ion batteries, which are too expensive, unsafe, and inefficient to make EVs a feasible option for consumers. Magnesium-air batteries, with their immense energy density of 14 kWh/L, can enable better performing and cheaper EVs. However, creating rechargeable Mg-air batteries has been hindered the formation of irreversible cathode products like MgO. In this research, a C12A7-based superoxide ion clathrate cathode was developed. In a simple two-step procedure, gamma-alumina and calcium-carbonate were heated together in a furnace under dry oxygen flow to form C12A7 with encaged superoxide ions. Mg-air cells were produced using the C12A7-based cathodes and standard control anodes and electrolytes. The cells were found to be function with complete reversibility as a result of the stored superoxide ions reacting with Mg ions to produce MgO₂ rather than the electrochemically inactive MgO. The method of essentially storing the oxygen in the battery in a clathrate was also found to be a safer than current open-air methods. Mg-air batteries implementing a C12A7-derived cathode exhibited fully rechargeable properties that allow their energy density to be used in EV applications. These Mg-air batteries were also more cost-effective and safe than current alternatives. This technology can contribute to the advent of market-viable EVs in the effort to combat global warming.

Greenwich High School
Completed Project, Engineering
Teacher: Andrew Bramante

Krepplein, Hallie

Project #82

Environmental, Research Proposal

The Significance Of Mercury In Shortfin Mako Sharks (*Isurus oxyrinchus*) From The Northwest Atlantic Ocean

Shortfin Mako sharks (*Isurus oxyrinchus*) are common targets in the seafood industry and trophy hunting; Nearly 28% of the yearly Mako Shark population is harvested every year. Fisheries across Long Island constantly receive Mako Sharks from accidental catchings. At this rate, there will soon be an extreme decrease in all shark populations. In this study, Mercury (Hg) contents will be measured in the stomachs of Shortfin Mako shark caught off of Long Island. Mercury in the stomachs of sharks is a clear indicator of possible dangerous concentrations of mercury in other marine organisms lower in the food chain and if the meat is safe for human ingestion; the safe amount of Mercury intake for humans and animals is about one microgram per kilogram of body weight. The problem investigated in this study is: what is the influence of weight, sex, and age on levels of Mercury in Shortfin Mako Sharks? It is predicted that older and bigger sharks will contain the most amount of Mercury and concentrations will not differ from male or female. 20 Shortfin Mako sharks will have stomach tissues extracted to find the concentrations of Mercury. A semi-automated atomic absorption spectrometer will be used to calculate the concentrations of Mercury in the samples. The results will reveal that the larger and older the shark is, the more Hg will be present in the stomachs. The findings will help to determine how we can minimize the amount of Hg in the ocean which harms organisms and ourselves.

Darien High School
Research Proposal, Science
Teacher: David Lewis

Kunichetty, Sachchit

Project #83

Physical Science, Completed Project

Reduction of Cost and Maximization of Coverage for School Bus Routes

This project analyzes the various methods to create an optimized bus route based on geographic knowledge of students' addresses. In some current school bus systems, children must walk far distances to reach their bus stop, or do not have enough space on the bus to sit comfortably. For these reasons, this project aims to investigate what factors lead to a better bus route. This program uses K-Means Clustering to identify bus stops for a group of students by geographic location. Stops are connected using the Depth-First Search algorithm, which will output all possible paths to connect the stops. The best path is found using a genetic algorithm, which simulates biological evolution to reach an optimal path, based off the Travelling Salesman Problem guidelines. The program will output the location of possible bus stops, along with the shortest, most efficient routes between those bus stops to reach the school, given a set of student addresses. These routes will be optimized for maximum coverage and cost reduction for operation. By using this program, a better school bus service system can be created to help students have a better experience riding the bus, along with providing budgeting options for operating schools buses in any district.

Fairfield Ludlowe High School
Completed Project, Engineering
Teacher: Robert Benjamin

Kupcho, Lindsey

Project #84

Health and Medical, Completed Project

Gender Differences in the Acute Physiological Response to Delta-9-Tetrahydrocannabinol (THC)

Cannabis has an array of psychological (intoxication), cognitive (difficulty in verbal learning), endocrine (increase in cortisol levels) and physiological (increased heart rate) effects. Public Health data indicates an increase in rates of cannabis use for women, and newer data suggests women may be more sensitive to its primary psychotropic component, delta-9-tetrahydrocannabinol (THC). This study seeks to determine whether men and women have differences in acute physiological responses to THC, measured in heart rate and blood pressure. It's hypothesized women, compared to men, will experience a greater increase in heart rate and blood pressure after receiving THC, in line with greater vulnerability to its effects. The independent variable is gender (self-reported) and the dependent variable is change in heart rate (beats per minute) and blood pressure (mmHg), recorded before, during and after the infusion of THC. Data will be analyzed from an ongoing double-blind experiment examining gender related differences in the effects of THC on a wide range of outcomes. Weight, body mass index, serum estradiol and menstrual cycle history (in women) will be collected at baseline every test day. Data will be analyzed, through one-way ANOVA analysis of variance to determine if there's a valid correlation between gender and THC induced change in heart rate and blood pressure. Participants will be recreational, occasional cannabis users. Those who take daily medication will not be included. This study will add literature on gender-specific differences with cannabinoids and inform specific treatments for cannabis use disorders.

Amity Regional High School
Completed Project, Science
Teacher: Deborah Day

Luria, Gabby
Finn, Regina

Project #85

Health and Medical, Research Proposal

**Testing the Ability to Track Hypertrophic
Cardiomyopathy by Measuring the
Pulse Strength Using a Novel Heart Rate Monitor**

Hypertrophic Cardiomyopathy (HCM) is a disease that causes the thickening of the heart muscles. It usually goes undetected and when this happens it becomes fatal. This study will try to accurately measure pulse strength in patients with HCM in order to determine whether or not the patient is in danger. The significance of this project is that it would allow patients to understand their situation and seek help when needed. It is hypothesized that by using a monitoring bracelet that tracks the amplitude of the pulse, patients will be able to determine if they have abnormalities in their heart rate related to HCM, as well as the extent of the problem. To begin we will need to find the differences between amplitudes between a normal patient and a patient with HCM. Using this information we will be able to create a specialized heart rate monitoring bracelet that will be tested to track pulse strength. It is expected that a strong correlation between high amplitude pulse strengths and the severity of the condition in patients with HCM will be found. This project will allow for the understanding of the differences and similarities in pulse strengths in patients with the same disease. Hopefully in the future this monitoring bracelet and technology can help avoid sudden deaths in patients with HCM. As we expand our project, it is hoped that the technology can also be used to help with other cardiology problems.

Sacred Heart Greenwich
Research Proposal, Science
Teacher: Mary Musolino

Lavi, Ethan

Project #86

Health and Medical, Completed Project

**Studying Helicase Targeting Drugs in Synergism
with PARP Inhibitors for Treatment of Epithelial
Ovarian Cancer**

Ovarian cancer kills 14,000 out of 21,000 women, and new ways to treat this cancer need to be found. Recent research shows that a novel treatment using PARP (Poly ADP Ribose Polymerase) inhibitors is being developed. PARP plays a significant role in the DNA damage repair as well as other enzymes. The question posed is if there is synergism with inhibitors of the Helicase enzyme and PARP inhibitors. The cells will be grown in the lab and tested in vitro. Cells will be treated with drugs and the survival of cells will be measured after 3 days using cell proliferation assays. The degree of DNA damage in each drug treatment group will be determined using western blot analysis. Data is collected from three trials. The growth of the cancer will be plotted in the four groups: no drugs (control), helicase inhibitor, PARP inhibitor, helicase and PARP inhibitors. The line graphs between drug groups will be compared, based on the slope of each line. Also, statistical tests for correlation could be compared to determine which drug group is the strongest and if it supports the hypothesis. The implications of this experiment are that it could improve upon the already existing therapy. This will be done by adding a synergism effect to the emerging cancer treatment with PARP inhibitors by incorporating helicase inhibitors. Additionally, more experiments could be created based on this result to further push this approach into clinical trials.

Amity Regional High School
Completed Project, Science
Teacher: Deborah Day

Lebreck, Michael

Project #87

Environmental, Completed Project

The synthesis and characterization of Iron Oxysulfide nano-sheets for optical and catalytic applications

Solar power is a common type of renewable energy typically used for generating electricity but the power can also be stored as a fuel. This is accomplished by utilizing photocatalytic water splitting, using the solar energy and a catalyst to split water into H₂ and O₂. Hematite (Fe₂O₃) can potentially be an effective catalyst. Hematite excels in all categories except conductivity as a catalyst. In an attempt to increase its conductivity sulfur doping will be used on hematite to create iron oxysulfide. The purpose is to improve the performance of water splitting photocatalyst by tuning the properties of hematite, for example, its conductivity. The independent variables will be the pH level, temperature, and concentration at which iron oxysulfide is synthesized. The dependent variables will be the bandgap and conductivity. The experiments will be devised using the Box-Behnken design, therefore, a minimum of 13 experiments will be conducted using the independent variables. The iron oxysulfide will be synthesized by taking previously made iron oxysulfide nanosheets and putting them in a solution with sodium sulfide. Then the pH and temperature will be adjusted to the desired point. The solution will then be filtered and the resulting iron oxysulfide will be dried in an oven. After synthesizing, the band gap and conductivity will be measured. UV-visible spectroscopy will be used to determine the band gap and 4 point probe measurements for resistivity/conductivity. Creating the ideal photocatalytic water splitting catalyst can effectively provide renewable energy in the form of H₂ and O₂ gas.

Amity Regional High School
Completed Project, Science
Teacher: Deborah Day

Lee, Danielle

Project #88

Environmental, Completed Project

Molybdenum Disulfide with Enhanced Interlayer Spacing on Electrospun Fibers for Water Remediation

Much of the earth's freshwater supply is contaminated by chemicals such as mercury. MoS₂ with an expanded interlayer distance on carbon-nanofibers is a novel material that can be used for mercury removal, while minimizing nanomaterial release into the environment and maximizing the surface area to volume ratio of the nanomaterial. The research question is what combination of precursors will synthesize the MoS₂ nanofibers with the most mercury adsorption, sustainability, largest interlayer distance, and low cost. Nanofibers will be electrospun using polyacrylonitrile(PAN), polystyrene(PS), and dimethylformamide(DMF). Then, the fibers will be oxidized and calcinated by heating up to 250C, then to 800C. MoS₂ will be synthesized on these fibers by placing various precursors into an "toclave and heating at 190C for 18 hours. The morphology of the fibers will be analyzed using SEM, TEM, and ImageJ. Then, mercury adsorption tests will be run on the fibers by placing fibers in a solution of mercury and measuring concentration over time. It is hypothesized that using ammonium tetrathiomolybdate (ATTM) and DMF will yield the most expanded interlayer distance, which leads to better mercury adsorption. MoS₂ synthesis using molybdenum and sulfur in one precursor is projected to have better adsorption, sustainability, and cost. This study will contribute to the development of novel nanomaterials for water remediation. MoS₂ with nanofibers has a sulfur-rich unique 2D structure with the potential to be an innovative method for mercury removal. This project is dedicated to finding a sustainable and cost-effective solution to water contamination, alleviating the world's water scarcity problems.

Amity Regional High School
Completed Project, Science
Teacher: Deborah Day

Lehman, Makenzie

Project #88

Physical Science, Research Proposal

How do Monoglyceride, Sodium Stearoyl Lactylate, and Diacetyl Tartaric Acid Ester of Monoglycerides and Diglycerides Affect the Overall Quality of Baked Goods?

Throughout history, chefs have used emulsifiers to provide yeast-based products structure and texture. In this experiment, I will be testing and comparing the effects of monoglyceride, SSL, and DATEM in eggless cakes. I will be testing the effects of these emulsifiers on appealing qualities of cake; symmetry, contour, batter viscosity, shelf life, and moisture loss. My motivation for this project is my passion for baking. To test symmetry, contour, and batter viscosity, I will be using equations and recording the results. For shelf life, I will be using a camera to measure the distance between crumbs. For moisture loss, I will be weighing cakes for two days to see how much weight was lost. All of these tests will be compared between the three cakes. For the symmetry and contour tests, the lower the product, the more desirable the cake is. For my moisture loss test, the cake with the least amount of moisture loss, the more desirable. For the batter viscosity test, the batter with the lowest value has the lowest viscosity. For crumb density, the densest cakes would be staler than the rest. This project means a lot to me because I have an obsession with baking. I even own an LLC, Makenzie's Cupcakery. A little over a year ago, I started having questions about how and why things happen. The main question being, what is behind the chemical reactions in baking? This experiment is a step into more deeply understanding my passion.

Weston High School
Research Proposal, Science
Teacher: Stacey Greenberg

Levinson, Nick

Project #90

Behavioral, Research Proposal

The effect of human disturbance on Kodiak Brown Bear den abandonment

How do human disturbances near Kodiak Brown Bear dens affect the rate of den abandonment? This experiment will be conducted to understand the effects of humans on denning bears. This information can provide insight to the repercussions humans have on the ecosystems they enter. It could also be used to give scientists a greater knowledge of the ecological systems they are researching. Studies by Moen G. K. and Sahl V. have used and tested ideas similar to the ones in this experiment. I propose to place cameras and a human indicator (scent or human used obstructions) at a bear den. This would test whether bears, based on gender, have a higher response to a human indicator. It is predicted males that encounter human obstructions inside the den will have the highest rate of den abandonment and the lowest rate will be found in single females that have encountered a human scent nearby. We propose to use GPS collars to track whether a bear has abandoned its den. The data will be analyzed by abandonment, and then categorized into gender of bear and human indicator at den. The implications for this research could help conservation efforts. If bears are abandoning their dens as a result of human indicators, conservationists would have to completely close off dens for conservation efforts to have the desired effect. The results of this experiment could also lead to a study of bear behavior on other stimuli in the same period like other dens in close proximity.

Darien High School
Research Proposal, Science
Teacher: Guy Pratt

Li, Daniel

Project #91

Health and Medical, Research Proposal

The Effect of the Overexpression of bZIP Protein Family Members on EBV Lytic Viral DNA Replication

EBV (Epstein-Barr Virus) is one of the most common human herpesviruses, with roughly 95% of all adult humans carrying it at some point in their lives. EBV establishes two alternating life cycles in hosts, the latent and the lytic cycle. Two genes, BZLF1 and BRLF1, have been identified to cause lytic applications. BZLF1 bears similarities to several human proteins, namely FOS and JUN. This project aims to study the effects of two proteins (JUN and FOS) on the regulation of the lytic cycle. My role in this project will solely consist of the data analysis. A one-way ANOVA test will be conducted to compare the results of the effects of FOS and JUN on EBV lytic replication rate and concentration. It is predicted that both FOS and JUN will yield a greater lytic DNA replication rate. This is because the two proteins bear many similarities in structure and protein as BZLF1, which is directly responsible for inducing the lytic life cycle in EBV. Results from this project may help identify future therapeutic targets for treatment of EBV, as well as research of the virus mechanics and replication. A better understanding of the life cycle of the virus is needed. Findings may also aid in research of cancer development caused by EBV.

Amity Regional High School
Research Proposal, Science
Teacher: Deborah Day

Liddy, Claire Belmont, Emma Conrod, Caroline

Project #92

Environmental, Completed Project

Testing Alternative Fertilizers to Reduce Hypoxia in the Long Island Sound

While traditional fertilizers benefit and provide essential nutrients to surrounding soil, they are also the main contributor of excess nutrient runoff and eutrophication which negatively affects ecosystems. We wanted to determine if a plant-based fertilizer that promotes plant growth, prevents algae growth, and combats eutrophication could be used as an alternative fertilizer. We hypothesized that specific formulations of food waste could be processed and used as fertilizer, even without composting. We started by collecting different fruit peels and food waste. We then dehydrated and ground the waste into fine particles and mixed each sample separately with soil. Soil alone and traditional fertilizer mixed with soil were used as controls. These soil samples, with either food waste or traditional fertilizer, were used to grow produce, mixed with pond water to determine algae growth, and were tested for nutrient levels. In initial testing, the soil containing banana peels had the highest overall concentration of nutrients and produced the greatest number of plants. The soil with the apple peels produced the second highest number of plants with the second tallest average height and produced the least algae. In addition, in subsequent individual nutrient testing, apple waste demonstrated superior nitrogen and phosphorus levels when compared to all other samples, including traditional fertilizer. This study demonstrated that food waste could be used to successfully enrich soil when compared to traditional fertilizers. Several of the types of waste tested were promising, but apple waste was deemed the most effective due to the combination of excellent plant growth and low algae production. Therefore, soil enriched with apple is the best alternative, and will be further pursued in order to combat hypoxia produced by traditional fertilizers.

Sacred Heart Greenwich
Completed Project, Science
Teacher: Mary Musolino

Lindell, Samantha

Project #93

Environmental, Research Proposal

How Does pH affect the Amount of Oyster Shell Deterioration?

The increase in carbon emissions since the Industrial Revolution has caused ocean acidification to become a large issue worldwide. Ocean acidification is the decrease of pH in an ocean due to the increase of carbon dioxide in the earth's atmosphere. It is important to study the effects of ocean acidification so scientists are able to predict trends, and to find ways to prevent ocean acidification from becoming an even greater problem in the years to come. One problem that has occurred because of ocean acidification is that the carbon dioxide ends up in the ocean to create carbonic acid that disintegrates the shells of many organisms, such as oyster shells. A question that can be asked is how does the change in pH due to carbonic acid affect the amount an oyster shell disintegrates? To carry this experiment out I will be testing at various points along the Long Island Sound. I will be asking oyster farmers about where the most active oyster farming areas are located, and I will take water samples from each area to test the pH. I will also classify how healthy each shell is based on its appearance. After analyzing the pH levels, I expect to find that the areas with the lowest pH (more acidic) will be the oyster shells that were also classified as being in the worst condition. I also expect to learn more about how increased carbon emissions acidifies the water, therefore making it inhabitable for many organisms. The significance of this research is that there are many species of shellfish that have been greatly affected by ocean acidification, and this has also been very detrimental to the shellfish industry.

Darien High School
Research Proposal, Science
Teacher: Christine Leventhal

Liu, Nicholas, A

Project #94

Research Proposal, Science, Environmental

Effectiveness of biofloculants on *Chlorella vulgaris*

As carbon emissions increase, increasing global warming, and peak oil, when the majority of accessible oil reserves have been depleted, draws closer, a renewable alternative to oil is needed. Third generation biofuels, derived from the transesterification of triglycerides in algae, seem to be able to fit this role, but current harvesting methods are energy intensive. Flocculation, where chemicals are used to make particles clump together, seems to be the most effective method for large-scale harvesting. However, metal salt flocculants have to be removed from the biomass afterward, and pH-induced flocculants can often damage cells and are therefore difficult to use. Thus, biofloculants, secretions from other organisms, seem to be viable and deserve more research. In this study, cultures of *Chlorella vulgaris*, an oleaginous alga, on BG-11 media will be treated with various flocculants. No flocculant and ferric chloride will serve as a control. The biofloculants tested will be *Cobetia marina*, a bacteria; *Skeletonema* sp., an alga, and *Aspergillus* sp., a fungus. The flotation efficiency, defined as the percent change between the optical density at 680 nm from before and after flocculation, will be recorded as a measure of the effectiveness of flocculation. The ferric chloride will likely have the highest flotation efficiency, as it has historically been effective, while the biofloculants are only possible candidates. A bar graph will be used. This experiment could provide insight into what biofloculants are viable for commercial use, which could contribute to the worldwide effort to produce biofuels in an economically efficient manner.

Darien High School
Teacher: David Lewis

Liu, Nicholas, S**Project #95**

Environmental, Completed Project

Open-source, In-field Smartphone Detection and Mapping of Waterborne Diseases via Time-Based Spectroscopic Sensing with a New 3D Printable Optical Interface

I noticed the dilemma in today's society where there are a large number of people who have access to smartphones yet don't have consistent access to clean water. This led me to think about how we can harness the spread of modern, consumer technology to address basic survival needs. Specifically, are smartphones a viable interface for spectrophotometric applications and can they be used to detect bacteria in water? Using a time-sensitive approach on a lab-grade spectrometer, I proved that changes in absorbance can be attributed to bacterial growth. Next, I developed 3D models and an Android app that would be used to accommodate the lenses and analyze the light data. I then verified the performance of my smartphone spectrometer against the lab-grade spectrometer by creating calibration curves from predetermined bacterial concentrations and comparing the two measurement systems. The smartphone spectrometer deviated from the Lambda 2 lab spectrometer consistently <5% on instantaneous absorbance readings, with peak-to-peak deviations of just 5 lux, proving its high granularity. Both systems were additionally within 3% of the actual colony counts, as counted on their agar plates. Not only does the smartphone spectrometer work for time-drive applications for bacterial detection, it is also highly accurate as a general-purpose spectrometer for instantaneous measurements. This project serves as a proof-of-concept that mainstream consumer technology can be adapted in a number of creative ways to scientific applications. The process of spectroscopy alone has many more promising applications beyond bacterial detection, such as measuring toxic compounds in blood samples. This project proves just how powerful the components on smartphones are, and the diverse ways in which they can be repurposed.

Greenwich High School
Completed Project, Engineering
Teacher: Andrew Bramante

Liu, Kathryn**Project #96**

Research Proposal, Science, Environmental

The effect of inoculating Rhizobium bacteria into Helianthus annuus L. to increase drought tolerance.

With the increasing threat of climate change, there is interest in alternative forms of fuels like biofuels. Sunflowers have high concentrations of oils that can be used as a biofuel, are a major food source, and an important agricultural crop. Drought has become a major issue for plants especially with the increase in global climate change. 10 sunflower plants will be grown for a total of 50 days using a hydroponics system. 8 plants will be inoculated with Rhizobium bacteria and after 20 days of growth, leaves will be collected and examined for chlorophyll content. Every 5 days, more leaves will be taken and examined. At day 35, the plants will be subject to drought stress until 50 days are reached. By inoculating Rhizobium bacteria, which help to fixate nitrogen, into Sunflower plants, then when plants are subject to drought stress, the drought tolerance of the sunflower plants will improve because the plant has a greater ability to resist drought. Sunflowers can be used in areas susceptible to drought stress and who need alternative sources of energy. Sunflower seeds produce more than 40% of oil and are widely grown in the United States. The oil from sunflower seeds can be used as a biofuel and produce fewer greenhouse gases. Sunflowers are not currently used as a biofuel because it is not cost effective. Sunflowers produce more oil than other plants and with the increase of drought tolerance, sunflowers may be more cost efficient than before.

Joel Barlow High School
Teacher: Katherine Nuzzo

**Livesay, Thomas
Schaaf, Summer**

Project #97

Completed Project, Science, Behavioral

Examining Eye Movement During Decision Making to Characterize Attention in People with Obsessive-Compulsive Disorder

Obsessive-Compulsive Disorder is a chronic disorder in which people experience excessive thoughts that cause repetitive actions. OCD individuals tend to struggle from indecisiveness and difficulties with simple decision making. We will investigate abnormality in attention processes by tracking eye movement. Specifically, whether fixation patterns of individuals with OCD are different from those in healthy individuals, and whether these differences may contribute to difficulties with decision making in OCD remains unclear. OCD and healthy individuals completed a simple decision task, choosing between a fixed payoff and lottery with a chance of a positive payoff. A Tobii T60 XL Eye Tracker was used. It is hypothesized that individuals with OCD will spend proportionally less time on the lottery visual stimuli than other parts of the screen, and therefore are less likely to integrate information about a choice, leading to poor decision making. Processed data will be evaluated and analyzed to determine hypothesis validity. In addition, we will conduct a literature review on current methods of analyzing eye-tracking data to inform our analysis strategies. The aim of this research project is to process and analyze these eye movement data to examine the differences in fixation patterns between individuals with OCD and healthy individuals. Since choices are often complex and made rapidly, they are typically affected by how much attention is paid to different attributes. If this project is successful, the results will allow for a better understanding of why a person with OCD struggles in simple decision making.

Amity Regional High School
Teacher: Deborah Day

Lodewick, Grace

Project #98

Completed Project, Science, Behavioral

The Extent to which Members Of Generation Z are Desensitized to Internet Advertisements

Members of Generation Z are those born between 1997 and 2012. Those in this specific generational age range have experienced an accelerated influx of technological advances in their adolescent lives. The purpose of this experiment is to find if members of Generation Z have experienced a desensitization to online marketing due to the increase in online content engagement found in the adolescent age range. Two groups of participants were asked to perform a mundane task, interacting with the chosen article, while viewing it through simulated media. This media contained several advertisements placed either on the periphery of the participant and/or interrupting the chosen task. Participants were then asked to complete a questionnaire pertaining to several details presented throughout the media in the form of advertisements. The data has been collected and analyzed both solely and in comparison to the other group. It is expected that the data will continue to show a higher desensitization, or diminished emotional responsiveness, to online marketing, among the members of Generation Z. The data collection has demonstrated the perception adolescents have of online advertisements and whether or not their use of technology has desensitized them. This experiment has been used to explore the psychological effect that increased exposure to online media may have when the results of the generation Z are placed in comparison to the control group. It has also explored whether or not use of technology has desensitized generation Z to the point where the marketing has lost its effectiveness.

Amity Regional High School
Teacher: Catherine Piscitelli

Lomax, Jessica**Project #99**

Research Proposal, Science, Health and Medical

The immune system and the lysogenic cycle

The immune system faces pathogens daily in the environment. Chronic viral infections are able to persist in the body for a prolonged period of time due to their ability to evade the immune response through the lysogenic cycle, which is when viruses hide dormant in the cell's DNA. There may be connections between the immune system and reactivation of the virus. Human subjects that are already infected with a chronic viral infection such as Epstein-Barr, Herpes Simplex Virus, or Varicella should be tested. By finding patients reinfected with Shingles for example, a before and after test could occur to find the immune response that may have caused the change. The Affymetrix microarray machine analyzes the gene expression, allowing insight to be found regarding the immune system. There could be a chain event occurring within the immune responses. Moreover, there may be a certain cell signalling event that promotes the "hibernation," of chronic viruses, thereby inducing the lysogenic cycle. More specifically, there may be certain immune responses that trigger the lysogenic cycle, which would be revolutionary in preventing recurrences of the virus. Through learning more about how the specific immune responses and signals are connected, new medicines will be able to be created through the new understanding of some parts of the immune system that were previously unknown. These new medicines can prevent the outbreaks of dormant viral infections.

Amity Regional High School
Teacher: Patrick Hughes

London, Philip**Project #100**

Completed Project, Science, Environmental

The Effects of a Constant Electromagnetic Field on the Health of Basil (*Ocimum basilicum*)

Research on magnetism is of growing interest. It is however, surrounded by much uncertainty as to its safety and biological effects. Both magnetisms scientific and medical applications are being studied in this experiment. It is investigating how electromagnetic fields (EMFs) affect the health of basil seedlings (*Ocimum basilicum*). This experiment will include two groups of three basil seedlings potted in six inches of soil. To create the EMFs, a transformer will power a solenoid created with copper wire (insulated to prevent overheating) wrapped around an iron nail. By stripping the transformers insulation and connecting the wires to the ends of the solenoid, an electrical charge will power the EMF. Three EMF generators will be inserted into the soil within one inch of each plant stem. A heat lamp will provide simulated sunlight for the plants twelve hour cycles and watered twice a week. Daily observations of the plants height, coloration and any visual differences such as leaf wilt, will be recorded with graphs and compared to color palettes. Anticipated results based on journal articles include differences in height and health based on established variables. Results are expected to favor the group exposed to the EMF. If this experiment proves EMFs to have a positive, debilitating, or no effect on the basil, these results can serve as a basis for further research into man-made and natural EMFs effects on biological systems. Results can be applied in many scientific fields and industries including biological research and potentially used outside of Earth's MF.

Amity Regional High School
Teacher: Deborah Day

Lord, George**Project #101**

Completed Project, Science, Physical Science

Comparing popular IaaS companies' CCS solution's performances across multiple benchmarks simulating the training of machine learning models to compare their cost effectiveness and efficiency.

The purpose of my experiment is to compare the cost-effectiveness and efficiency of several IaaS cloud computing services used for machine learning development to help save machine learning developers and companies time and money by allowing them to choose the optimal cloud computation service to train their model. To determine results satisfactory to my proposals purpose, I ran the same image classification benchmark by Tensorflow with several different machine learning models and argument configurations as my constant variable over various cloud computing solutions from multiple providers. Return output and time to completion were data. If the more expensive services cost less to complete the benchmark across the tests, then this would suggest support for buying pricier options over the cheaper options when on a budget for machine training. If the more expensive services take less time but cost more in total, this will be disproved and prove a gap between economic and efficient options in the market. There are many other results from data. The data from this experiment would be used in educated decisions for machine learning/CSS consumers in selecting a vendor for these services based off of the type of model they aim to train, their time and budget constraints, and market preference.

Weston High School

Teacher: Stacey Greenberg

Lowder, Scott**Project #102**

Research Proposal, Engineering, Physical Science

Using a Remotely Locking Container to Eliminate the Distraction of Phones While Driving

Using a phone while driving is a major safety concern. According to the National Safety Council, 1.2 million car crashes in 2013 involved drivers talking on the phone, and at least 341,000 involved text messaging. The distraction of phone apps is a major concern, but also the ,“fear of missing out,” or ,“FOMO,” is believed to be another reason it's so hard to resist texting while driving. The method involved for this project is to prototype a device where the only way the car starts is by locking the phone in a container installed into the car, as well as a charging cord connected to the phone to notify the car that the phone is locked away and to also validate that the correct phone is in the car. Thus far results are minimal, but I have begun learning how to use an Arduino so I can program an interlock, a sensor for verification of phone, and lock for the container. Furthermore, I've also purchased necessary components and parts needed for the prototype. Implications for this prototype include being installed by concerned parents in their driving teen's car, being a business requirement for companies such as FedEx or UPS for the safety of their workers, or for individuals concerned with their safety and inability to remove distractions of phone while driving.

Amity Regional High School

Teacher: Catherine Piscitelli

Lowe, Daniel

Project #103

Research Proposal, Science, Health and Medical

Unmethylated CG-Enriched Oligodeoxynucleotide with Anti-OX40 Antigens used as a means of Decreasing Tumor Size in a Lung Cancer

Today, cancer is a global epidemic, and a disease that takes many forms and that millions have to deal with on a daily basis. In the US alone, nearly 1.7 million people will be diagnosed with cancer this year and of those, 600 thousand will die. Previous studies have shown that unmethylated CG-enriched oligodeoxynucleotide (CpG) with anti-OX40 antigens, was effective in decreasing lymphoma tumor size and in some cases eliminating the tumor in preclinical trials. This study will attempt to determine if these results can be translated to other forms of cancer such lung cancer. To test this, 20 mice will be injected with 2-3 lung cancer tumors. The CpG solution will be injected into one of the tumors and monitored over a course of 4 weeks to determine whether or not the tumor, and surrounding tumors, have regressed, remained static, or increased in size. It is expected that not only will the size regress in majority of the tumors tested, but some will be completely eradicated from the mouse. This experiment could be replicated using other types of cancerous tumors with the results being compared. This proposed research could be an important starting point for the creation of a drug that could eventually be FDA approved and administered to people in the US and around the world.

Darien High School
Teacher: David Lewis

Lu, Brodey

Project #104

Completed Project, Science, Environmental

The Effect of Temperature on Zinc Uptake Rate of Water Hyacinths (*Eichhornia crassipes*)

Phytoremediation is the use of hyperaccumulator plants to absorb pollutants in an area. They can be used for the environmentally sound relief of heavy metal pollution in an area, a common problem. I researched how temperature affects the uptake rate of zinc, a metal found in water that can be harmful in large quantities, by the hyperaccumulator water hyacinth plant (*Eichhornia crassipes*). The hypothesis was that the zinc uptake will be fastest at 75 . I set up nine containers of plants and water in my house with three at 60 , 75 , and 90 . Two held water hyacinths while the third served as confirmation that decreases in zinc levels were due to phytoremediation. Temperatures in each container were regulated with aquarium heaters for consistency. Zinc levels were measured periodically using test strips. Results thus far show that the zinc uptake rates have indeed been following the hypothesized outcome. The zinc levels were lowest at 75 compared to the other two temperatures. The container at 85 had the second lowest levels, while the one at 65 still had the most amount of zinc in the water. A major implication of this experiment is getting a general idea of the optimal temperature to use water hyacinths for the phytoremediation of zinc in water. This can provide a cost effective and environmentally friendly way to remove heavy metals (specifically zinc) from water in an environment.

Amity Regional High School
Teacher: Catherine Piscitelli

Lu, Kevin**Project #105**

Research Proposal, Science, Behavioral

Creating A Predictive Model of The Effects of Mindfulness on Cognitive Performance Relative to Personality and Learning Style Factors

Mindfulness is a state of acute awareness to present experiences, and remains an omnipresent feature of religious and secular programs. Mindfulness is also equated to a state of optimal arousal (a measurement of neurological stimulation to physiological stimuli). The point of optimal arousal for any individual also changes relative to various personality factors. Thus, a predictive model of the effectiveness of mindfulness training relative to personality will be created. To achieve the outlined goal, 32 healthy volunteer participants of ages 15+ will be gathered at the Unilever, Trumbull facility and will take the '16 Personalities' online personality assessment. Afterwards, each participant will take half of the Modified Concentration Task (MCT) and Logical Memory Subtest (LMS). Half the participants will then be administered Kentucky Institute's Focused Breathing Exercise, and all will then complete the MCT and LMS before disbanding. Results from the experiment will be compiled into a predictive model in graph form. The growth in LMS and MCT performance (general cognitive performance) before/after the FBE will be compared to the distribution of the 4 general personality attributes from the '16 Personalities' test. Furthermore, any general performance increases between the groups administered/not administered the FBE will be noted, to observe the general impact of mindfulness training. The experiment's results will help decipher the relative benefit of mindfulness training on cognitive performance for various personality groups, which may enable future modifications on ways to effect optimal arousal for said groups. By measuring the effectiveness of mindfulness training in general, the experiment also may shed insight on means to create higher arousal and thus induce better cognitive performance.

Amity Regional High School
Teacher: Catherine Piscitelli

Lu, Raymond**Project #106**

Completed Project, Science, Health and Medical

Using Cotton Swabs to Administer Food Allergen Doses For Sublingual Immunotherapy

Food allergies affect over 15 million Americans and the main treatment is through immunotherapy. Sublingual immunotherapy is a method of decreasing symptoms to allergens and can lead to tolerance over time to certain foods. An alternate method using cotton swabs to administer these doses can be safer and more convenient for patients. However, it is unclear how consistent the dosage is when given on a cotton swab. This experiment will determine the deviation in masses of proteins when dipped and dried on a cotton swab. Sesame, peanut, milk, and egg solutions will be studied. Forty cotton swabs will be dipped into each allergen and dried for 10 hours at 104°. Each swab will then be massed on a high precision scale. Diffusion rates into non distilled water will be calculated for all allergens and compared. Data will be analyzed through Excel to determine standard deviation and p-values of all 4 allergens. Currently, data has shown a relatively small standard deviation in peanut and milk groups (0.007 and 0.008 respectively) and diffusion rates are predicted to be significantly different among foods. Cotton swabs can encourage more people to do immunotherapy because it is safer and more convenient than traditional means. If the deviation of protein doses on cotton swabs is low enough, this can provide data to support an innovative and convenient method of administering sublingual doses for allergy immunotherapy.

Amity Regional High School
Teacher: Deborah Day

Luo, Jessica

Project #107

Completed Project, Science, Health and Medical

Identification of Leading Genetic Causes for Dementia Using Data Analysis

Currently, dementia, a chronic, progressive disorder of the mental process of the brain, remains incurable, making research on dementia all the more important. In order to help create a better understanding for researchers, the project will be dedicated to identifying the leading genetic causes for dementia using data analysis. First, multiple data sets from various resources from online free databases of genetic expression of patients with and without dementia will be researched and compiled. After a wide selection of information have been assembled, they will be organized into tables and graphs to help classify and clearly identify the data. Finally, the data will be carefully analyzed by trying to look for any correlations it might have with dementia. In past studies, it has been shown that many patients with dementia are likely to be weak and susceptible to infections and illnesses when they reach the later stages. Therefore, it was hypothesized that genetics relating the immune system may be a leading risk factor for dementia. In addition, because dementia is a mental disorder, it was anticipated that genetics that damaged brain cells may also be another cause. With the knowledge gained as a result of this experiment, scientists will be able to create a better understanding of dementia. If the causes for this disorder is correctly identified, a more accurate and effective treatment will be developed based off of specific genetics instead of random testing. However, this project might also confirm and support data that has already been found in previous studies.

Amity Regional High School
Teacher: Deborah Day

Luo, Ningxin

Project #108

Completed Project, Science, Health and Medical

Examining the Roles of Sodium Chloride on T and B Cell Function in Multiple Sclerosis

Multiple Sclerosis (MS) is a disease characterized by destruction of myelin. Sodium chloride (NaCl) drives proinflammatory functions in T-cells which attack protective myelin. Another environmental factor is dietary fatty acids. While long chain fatty acids (LCFA) promote proinflammatory cytokines in T-cells, short chain fatty acids (SCFA) mediate autoimmunity. Although scientists have explored pathogenic T-cell functions, B-cells continue to be understudied despite research indicating a significant role in MS. This study investigates whether NaCl in conjunction with fatty acids can prime pathogenic T and B-cell function. Because NaCl and LCFA drive inflammation, and B-cells act as antigen-presenting cells for T-cell activation, it is hypothesized that NaCl and LCFA will exacerbate expressions of proinflammatory cytokines IFN- γ and IL-17. SCFA drives regulatory phenotypes in T-cells; therefore, it is hypothesized that they will affect B-cells similarly. Extracted T and B-cells will be cultured in different settings: control without additives, only NaCl, only fatty acids, and both NaCl and fatty acids. qPCR and ELISAs will yield relative gene expression and protein concentration in treated and untreated samples, answering whether different conditions affect pathogenic function. qPCR data will be analyzed to yield relative gene expression in comparison to a control gene. From the ELISA data, a linear regression equation is used, answering whether different treatment conditions result in different levels of pro and anti-inflammatory cytokines. Living in westernized countries has severe consequences on lifestyle and disease susceptibility. This study contributes to a broader understanding of environmental factors and its link to autoimmunity.

Amity Regional High School
Teacher: Deborah Day

Luo, Margaret**Project #109**

Completed Project, Science, Health and Medical

The Effect of ATP Synthase Dimers on Cristae Formation

The mitochondrion is a cellular organelle which generates cellular energy, also called ATP (adenosine triphosphate) using enzymes called ATP synthase. These enzymes are arranged in dimer rows on cristae, which are the folds of the inner membrane of the mitochondria. These folds allow more ATP synthase molecules to fit into the inner membrane of the mitochondrion. Previous studies have shown that as organisms age, their cells produce less energy and the number of cristae in their mitochondria decreases. The purpose of this project is to find out whether the ATP synthase amount in mitochondrial inner membranes is the determining factor for cristae formation. To test this, we have imaged mouse embryonic stem cells by using electron microscopy. Two different types of cells were used: wild-type cells which served as control and CRISPR-Cas9 mutated cells, which had significantly reduced amount of ATP synthase in its mitochondria. It is hypothesized that the mitochondria with reduced ATP synthase will also have less cristae. This was tested by counting the number of cristae in each sample under SEM (scanning electron microscope) through ImageJ, a software used to do data analysis. My part in this study was to evaluate the images of mitochondria provided by my mentor, Dr. Nelli Mnatsakanyan. The data was analyzed by comparing the average number and quality of the cristae in each sample. It is expected that the hypothesis will be supported and that the amount of ATP synthase is the determining factor for the amount of cristae in a mitochondrion.

Amity Regional High School
Teacher: Deborah Day

MacKenzie, Ethan Project #110

Research Proposal, Science, Environmental

The Discovery and Conservation of Bog Turtles Through eDNA

The bog turtle is the rarest turtle in Connecticut which means it is critically endangered due to climate change, predators, and the illegal animal black markets. I am interested in this because I believe that the protection and conservation of the species on our planet should take high priority. The methods that I have been researching to help with the conservation of bog turtles is the use of eDNA. From my research I now know that bog turtles are incredibly rare, but with the help of eDNA, areas can be tested to figure out if they have a population in that area and if they do then they can be observed for data. I expect to find very few areas where the bog turtle actually currently lives in due to its rarity in the state. If an area is found I will start observing that said area using my camera equipment and journals to write what I have found. It is very important work to protect and conserve a species, especially one as important as the bog turtle which is leaning towards extinction. It should be a high priority to people and it should be understood that we all have to put in some effort to protect a species such as this.

Ridgefield High School
Teacher: Ryan Gleason

Malik, Aamnah

Project #111

Completed Project, Science, Health and Medical

Analyzing the Fibrosarcoma Tumor Growth of BALB/c Mice with Various Treatments

Mouse tumor models are used to evaluate the effects of a drug or vaccine on cancers. Mice can be immunized using vaccines, and are then given time to develop an immune response against a specific tumor using the vaccine. Then, these mice are tumor challenged. This is when cancer cells are introduced to the mouse. Based on whether the vaccine helps the mice develop a strong immune response, the mice may be able to fight these cells. If, and how large of, a tumor forms, will indicate how effective the vaccine was. This project will investigate fibrosarcoma tumor growth in BALB/c mice treated differently. The independent variable is the treatment received, and the dependent variable is tumor growth. One group will be treated using phosphate-buffered saline. This is the control because it maintains a constant pH and has an ion concentration that matches that of human and mouse body fluids. The experimental groups will be treated with different vaccines. One vaccine will contain dendritic cells and a neoepitope, while the other vaccine will replace the same dendritic cells with macrophages. It is hypothesized that the vaccine containing the dendritic cells will be more effective. The experiment will be conducted by my mentor, Dr. Pramod Srivastava, Ph.D., M.D. and Hakimeh Ebrahimi Nik, Postdoctoral. The student will analyze the data, and graph the average growth rate of the tumors in each group of mice. Results will support whether the vaccines can be considered to help develop immunity to tumors.

Amity Regional High School
Teacher: Catherine Piscitelli

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Mansourian, Emma

Pardo, Taryn

Project #111

Research Proposal, Science, Health and Medical

Differentiating Donor Age Groups Based on Raman Spectroscopy of Saliva for Forensic and Medical Purposes

Raman Spectroscopy is a vibrational spectroscopic technique that measures emitted wavelengths from an analyzed substance. In previous experiments, Raman Spectroscopy has been successful in determining an individual's race, sex, and chronological age using a variety of bodily fluids. While blood samples have been used to determine an unknown individual's age, the analysis of other bodily fluids to determine an individual's age has yet to be tested. The purpose of this experiment is to determine if Raman Spectroscopy is a successful method of determining an unknown individual's chronological age from a human saliva sample. In this experiment, 45 human saliva samples will be obtained and analyzed from a medical center. The samples will include 10 newborn, 15 adolescent, and 20 adults. The samples will be analyzed through the Raman Spectroscopy technique as well as a Support Vector Machine (SVM). All samples will be cross validated, or run through the SVM to calibrate it, and 10 donor samples will be selected at random to be externally validated through Raman Spectroscopy. The predicted results of this experiment are that the Raman Spectroscopy will be successful in determining the correct age category for each unknown sample. This is because the Raman Spectroscopy will categorize the samples based on the levels of DNA methylation and telomeres found in the saliva. This research is critical to forensic scientists because it will provide a new technique for identifying the key characteristics of unknown individuals using saliva found at a crime scene and potentially determining or eliminating suspects.

Darien High School
Teacher: Christine Leventhal

Marin, Audrey**Project #113**

Completed Project, Engineering, Health and Medical

Using Short Message Service (SMS) and a MPU-6050 Accelerometer and Gyroscope To Reduce the Effects of the Suffocation Aspect of Sudden Infant Death Syndrome (SIDS)

Sudden Infant Death Syndrome (SIDS) is the unexplained death of an infant due to the cessation of breathing. According to the Centers for Disease Control and Prevention (CDC), 900 infants died in 2016 due to accidental suffocation or strangulation in bed. Many of these cases are a result of children sleeping in dangerous positions. The goal of this project is to create a prototype that monitors infants' sleeping position and contacts a cellular device when it becomes dangerous. An Arduino Microcontroller, GSM shield, SIM card, MPU-6050 Accelerometer and Gyroscope, cellular device, 9-volt battery, and a baby doll will be required. The MPU-6050 will be attached to the one side of the doll in the center of the child's chest and will be programmed (utilizing the GSM shield) to send an SMS to the cellular device when a set threshold is achieved. An artificial infant will be used for the purposes of testing. The doll will be manually rotated with the sensor attached. The positions at which the phone is contacted will be recorded (using both photos and written observations). The expected result is that an SMS is sent to the cellular device when the child is rotated to an unsafe position. Future developments of this prototype include creating an application to receive data on the infants' position, creating a wireless sensor network (WSN), and miniaturizing the prototype. With these developments, this device could save hundreds of infant lives per year.

Amity Regional High School
Teacher: Deborah Day

Marino, Collin**Project #114**

Completed Project, Engineering, Health and Medical

A Versatile, Genetic-Based Cancer Treatment Capable of Selectively Killing Cancerous Cells with an Affinity for Single Mutations

One of the largest obstacles involved in the development of cancer treatments has always been the diverse nature of cancer. However, the one thing which intrinsically defines cancer is the presence of a few mutations which distinguish that tumorigenic cell from the rest of the host's cells. The purpose of this research is to exploit this fact by designing a system capable of detecting any given mutation and killing all the cells which contain it. In order to achieve this, an RNA-ligating deoxyribozyme was modified so that it is only capable of functioning in the presence of the mutated RNA. In order to show that this system functioned as intended, it was told to target a region of RNA which codes for a protein known as hTERT and to toggle the production of GFP instead of killing the mutated cells. This meant that if the system was functional, the cells containing the hTERT RNA would appear green under fluorescent-microscope upon exposure to the system. When the system was told to selectively produce GFP in the presence of hTERT-mRNA, it was seen that only the cell line which was positive for hTERT showed GFP expression upon exposure to the system. Furthermore, when a synthetic fragment of the hTERT-mRNA was transfected with the system, the hTERT negative cells then proceeded to produce GFP. This implies that it truly was the system's detection of the hTERT ligand which toggled the GFP production, and not any other property of the two differing cell lines. This system has several implications which branch throughout most of the world of molecular biology. The most prominent application is in regards to cancer where the system would be told to detect a mutation specific to that patient and to toggle the translation of a cytotoxic protein in its presence.

Greenwich High School
Teacher: Andrew Bramante

**Marshall, Mary
Connolly, Emma Rose
Novak, Sam**

Project #115

Research Proposal, Science, Environmental

What's Really in the Mianus? Using eDNA to Determine the Effect of Industry on the Pollution Levels and Species Found in the River

Bodies of water adjacent to pollution sources need to be carefully monitored. This research deals with the Mianus River. The study was initiated because it was observed that the river has locations that appear pristine, but also locations adjacent to industry, such as buildings and gas stations, that appear murky and foamy. It is hypothesized that these latter locations will have poorer water quality compared to the pristine locations. To test this hypothesis, water will be collected in Nalgene bottles at four targeted sites along the river and filtered through environmental DNA (eDNA) filters back at the lab. DNA will be extracted and the bacteria, fish, and macroinvertebrates present will be analyzed to determine the water quality at each location. In addition, dissolved oxygen, nitrogen, and phosphorus will be tested and analyzed. It is believed that when analyzing data from the eDNA testing at the four locations, the results will demonstrate that more pollution-tolerant organisms will be present at locations where higher industrialization is found. It is also believed that the dissolved oxygen will be lower and the total nitrogen and phosphorus will be higher at these locations when compared to the more pristine locations. If the hypothesis of this study is supported, research will begin at other areas along the Mianus River and throughout the Long Island Sound to determine the prevalence of pollution throughout the region.

**Sacred Heart Greenwich
Teacher: Mary Musolino**

**Massello, Bianca
Batal, Olivia**

Project #116

Completed Project, Science, Environmental

Studying the Environmental Quality of the Gowanus Canal through the Analysis of Macroinvertebrates

The Gowanus Canal, located in Brooklyn, NY, has been used both commercially and industrially. The purpose of this study is to assess the environmental quality of the water in the Gowanus Canal through the analysis of macroinvertebrates. By analyzing the number of pollution tolerant and pollution sensitive macroinvertebrates in the canal, we will be able to assess the severity of the pollution. It was hypothesized that mainly pollution tolerant organisms would be found due to the level of pollution in the canal. Many aquatic species are sensitive to pollutants and will not be found in polluted waters. The greater the pollution, the lower the species richness since only a few species are pollution tolerant. Twenty four samples from the Gowanus Canal were obtained and identified through identification charts. Each one was determined to be either pollution tolerant or pollution sensitive. DNA barcoding was also attempted for identification purposes but was not successful. It was expected that the majority of the macroinvertebrates collected and analyzed would be pollution tolerant, such as aquatic worms and leeches. This proved to be the case because the following pollution tolerant organisms were among those identified: snail, water beetle larvae, shrimp, mosquito pupa, crab, scud, freshwater worm, pouch snail, aquatic worm, and leech. The species that are pollution sensitive, such as stonefly nymphs and water fleas, were not found in the canal due to poor water quality. This study demonstrated the issues facing the Gowanus Canal and highlight the clean-up work that is needed at the site. It is believed that the large collection of pollution tolerant macroinvertebrates found demonstrate how polluted this canal really is and that much work is needed to save it. It is hoped that the knowledge obtained in this study will accelerate future clean-up efforts.

**Sacred Heart Greenwich
Teacher: Mary Musolino**

McCloskey, Avery
DiBiase, Gaby
Ulme, Kellie

Project #117

Completed Project, Science, Health and Medical

Using Microbiome Analysis to Determine the Effectiveness of a Unique Ceramic Water Filter

It is estimated that 780 million people in the world are without clean drinking water. This study is designed to help solve the problem of impure drinking and cooking water in developing countries by creating and testing a novel porous ceramic filter. It is hypothesized that this affordable and easy-to-use filter will help people in developing countries clean their water and decrease the many health problems caused by impure water. Several specialized porous filter pots that would filter water through its microscopic holes were created. Not only did the water filter through the porous ceramic, but the pots' capabilities were enhanced by the additional features incorporated in the pot. We tested effectiveness by filtering pond water through the differently designed porous filters, and then using e-DNA filters and microbiome diversity analysis to determine the reduction in harmful bacteria. It is expected that the ceramic filter pot with the highest level of enhancement will reduce bacteria and other microorganisms the most, proving to be the most effective. The results of the study are still underway. This study could demonstrate an easy and affordable solution to reduce bacteria and other contaminants from drinking water in areas of the world that are in the greatest need of water purification.

Sacred Heart Greenwich
Teacher: Mary Musolino

McNeill, William

Project #118

Research Proposal, Science, Environmental

The Effects Mating has on the Migration of Great White Sharks in the Pacific Ocean

As of right now, Great White sharks movements are barely known and are far from being understood. Sharks across the world are victims of being caught as bycatch and getting killed for their fins. Tracking sharks and figuring out whether mating is occurring during migration could help set up conservation areas to protect sharks. My proposed research will involve tagging female sharks in the Pacific Ocean. Specifically, I want to use pop up archival satellite tags to track the location of the sharks. The female sharks will be implanted with tags and given an ultrasound. Then will be released and will be monitored. Upon return from their seasonal migration, they will be given another ultrasound to prove if they are migrating to a specific location to mate. I hope to find a correlation between the migratory behavior of the female White sharks and mating. In my results I expect to see that the sharks are migrating offshore, mating, then returning to coastal areas to give birth seasonally. With my results from the proposed research I would work to help prove the migration pattern of great white sharks in the Pacific Ocean. If the migration patterns are proven, then conservation areas can be set up to protect the White sharks from being hunted are caught as bycatch.

Ridgefield High School
Teacher: Ryan Gleason

McTigue, Katherine

Project #119

Research Proposal, Engineering, Health and Medical

Testing RgIA4 on Mice to Treat Pain and Replace Opioids

Experiments using Cone Snail venom (CSV) have shown a decrease in pain perception when injected into mice. Replacing narcotic pain medication and preventing further abuse of opioid medication, which in turn is the cause of tens of thousands of overdose deaths each year, is the goal of CSV research. Nicotinic Acetylcholine Receptors (nAChRs) are receptor polypeptides in the Central Nervous System (CNS) that respond to a peptide called RgIA4 derived from the Cone Snail, *Conus regius*, found in the Caribbean. This study will test to see what will happen when different amounts of RgIA4 is injected into mice with muscle pain. 9 mice will be used in this experiment, 3 for each amount of venom tested. 3 will be injected once a day everyday for two weeks with 15 µg/kg, another 3 will be injected with 75 µg/kg, and the last 3 will be injected with 150 µg/kg. If more RgIA4 is injected into the mice, then there will be a clear decrease in pain perception because the nAChRs in the CNS will be blocked more effectively by the peptide when it is potent. This can replace current methods of treatment, like opioids, that can lead to addiction in patients. It is important to test properties of CSV, such as RgIA4, on mice with neurological diseases so that researchers can better understand pain and the various uses of non-toxic components of venom to later apply their findings on humans.

Darien High School

Teacher: Christine Leventhal

Mills, Ethan

Project #120

Research Proposal, Science, Environmental

The Effects Climate Change contributing to the degradation of high altitude aspen populations

Aspen degradation is a growing problem in regions where they grow. This is clear in the appearance and amount of death within the trees. I noticed these effects while in the Gunnison National Forest, which has experienced these changes. As it has potential for economic and environmental effects, towns like Crested Butte, CO worry about a decrease in visitor revenue as a result of the decline and the displacement of the many species which require its protection. My proposed experimentation will use different sensory technologies in order to test how the growth of Aspen trees is related to and coincides with levels of certain natural commodities which can be affected by climate change. These would include amounts of light, precipitation, humidity, and wind, as well as external and internal temperature. These can be tested for by using the information provided by a Acurite weather monitoring station, individually attached biometric tags which give internal and external temperature readings, and quantum sensors which track quantities of visible light. The hypothesized results would include a strong correlation between the Aspen trees growth and a significant change of one of the stated variables. This is expected due to the relationship between these factors and plant growth, which gives good reason to the idea of a relationship between the factors and Aspen degradation. The results of this experimentation could inspire new methods of high altitude plant protection, especially for organisms like the Aspens which provide many species shelter and add to the economy.

Ridgefield High School

Teacher: Ryan Gleason

Mohanraj, Prastik

Project #121

Completed Project, Engineering, Physical Science

Novel Organic Synthesis of Usnic Acid Derivatives with Tumoricidal Properties

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

Engineering and Science University Magnet School
Teacher: Roger Rushworth

Mu, Aurora

Project #122

Research Proposal, Physical Science

Comparison of Polymeric Substrates Parylene C and Polyimide for Thin Film Glassy Carbon Electrodes

Brain computer interfaces allow paralyzed people have limb restitution, as well as control external robotic arms. However, neural electrodes have short life spans, as they deteriorate in brains. Glassy carbon is a new material that is more biocompatible and biostable, as well as have superior electrochemical properties. The purpose of this experiment is to fabricate a glassy carbon electrode, and test in vitro to analyze the potential long term use and implementation. A glassy carbon microelectrode will be created with a typical polyimide substrate. Then, for in vitro testing, brain and inflammatory tissue will be cultivated around the electrode. Cells will be analyzed for histological properties, cytotoxicity, and inflammatory reactions. Long term stability will be analyzed after allowing the tissue to grow for 8 weeks around the electrode. The cells will undergo accelerated aging to mimic long period of times. This project will test the functionality of a glassy carbon electrode. The end goal is to find compatible material and architecture with glassy carbon that would best improve the application of the material in neural implants. This research will improve the durability of neural implants, thus paving way for BCIs. People with paralysis or loss of limbs can use the improved implants to communicate or move limbs, making day to day lives easier. In addition, glassy carbon electrodes could be applied in not just paralysis treatment, but in any field of science, as the electrode will be able to pick up signals from the brain and translate them into commands.

Ridgefield High School
Teacher: Patrick Hughes

Muchhal, Aria

Project #123

Research Proposal, Science, Health and Medical

A Comparative Analysis of the Efficacy of Gene Therapy Hbbth-4 Mouse Models Using Evolved Synthetic AAV Variants

Beta-thalassemia anemia is an autosomal recessive disease characterized by erythrocyte deformation and anemia. While gene therapy opens new doors for patients with Beta-thalassemia, excluding criteria in trials prevent 70 percent of patients from participating due to their anti-Adeno-Associated Virus (AAV) Neutralizing Antibody titers (NABs). A proof-of-concept study evolved synthetic AAVs to evade the patient's immune response, thereby allowing for the therapy. This experiment will test the efficacy of gene therapy with the original AAVs and new antibody-evading AAV variants harboring synthetic antigenic footprints on Beta-thalassemic mice with and without NABs. Twenty male Hbbth-4 mice will be divided into sub-cohorts of five. The first group will receive gene therapy with the original AAV without NABs. The second group will receive the same but will have NABs. The third will have synthetically evolved AAVs with NABs, and the fourth will have synthetically evolved AAVs without NABs. Efficacy will be determined through percent change in sickled erythrocytes per microliter of blood. The results will show a slight decrease in efficacy in groups three and four and a sharp decrease in group two. It is expected that gene therapy will be most effective in group one, but therapy using evolved AAVs will be more effective than the original on mice with NABs. This research could lead to a reduction in excluding criteria for gene therapy and could be applied to all AAVs. It could also lead to research and developments in all antigen circumvention, including blood and bone marrow by synthetic evolution.

Darien High School
Teacher: David Lewis

Murali, Aniruddha

Project #124

Completed Project, Engineering, Health and Medical

Non-invasive, Early Detection of Invasive Ductal Carcinoma (IDC) via Deep Convolutional Neural Networks Using Breast Cancer Histology Images

Breast cancer is responsible for causing the greatest number of cancer-related deaths among women, impacting 1.5 million women every year (WHO). Breast cancer is the most common form of cancer in women. Invasive ductal carcinoma (IDC) is the most common form of breast cancer, representing 80 percent of all breast cancer diagnoses. One way to reduce the number of deaths caused by breast cancer is to utilize artificial intelligence for early diagnosis to detect the presence of a malignant tumor before the tumor gets too harmful. In this study, the deep learning framework used were convolutional neural networks (CNNs). The model creates the convolutional neural networks utilizing the Keras library in Python and a dataset from Case Western Reserve University consisting of over 270,000 images of patches of breast cancer specimens. The convolutional neural network achieves 86-88% accuracy in diagnosing breast cancer. Previous studies have produced algorithms that demonstrate over 90% accuracy in cancer diagnosis, much more than today's standard of 80% accuracy. While these algorithms generally yield high accuracy, they do not take into account the bias from human error, so the validity of such models are questionable. Contrary to the traditional approach of hand-crafted feature extraction methods, CNNs learn useful features directly from the training image patches by the optimization of the classification loss function. Therefore, CNNs can more accurately detect breast cancer at earlier stages, giving patients enough time to get the treatment needed to save their lives.

Staples High School
Teacher: Karen Thompson

Nemec, Grace**Project #125**

Research Proposal, Science, Environmental

The Effectiveness of Granite, Obsidian, and Diorite in Reducing the Levels of Carbon Dioxide in the Atmosphere

Global warming is a growing issue affecting environments, humans, and animals. Carbon dioxide is the leading factor of climate change and the United States is the second country with the largest carbon dioxide emissions. In order to protect our planet, we must remove excessive carbon dioxide in our atmosphere. In this study, different porous rocks will be tested to determine if they may be used to remove carbon dioxide from the atmosphere. It is hypothesized that granite will decrease levels of carbon dioxide the most due to its porosity. Obsidian and diorite will absorb carbon dioxide, but will not reduce it as significantly because of the limited number of pores. The independent variable is the type of rocks tested and the dependent variable is the amount of carbon dioxide absorbed by the rock. Through a carbon dioxide generator and monitor, the amount of carbon dioxide in air will be monitored and graphed to show carbon dioxide capture. It is expected that granite will help reduce carbon dioxide emissions, thereby helping the environment. Other rocks such as obsidian and diorite will be successful but in a more limited capacity. The reaction of carbon dioxide after it has been dissolved in water with these rocks, designed to lock away the carbon dioxide in another form, will also be investigated. The findings would be a breakthrough for global climate change. The G20 Summit has focused on the environment and removing carbon dioxide from the atmosphere. These results could provide an avenue for further research and lead to a practical application of the findings. Porous rocks as absorbers of carbon dioxide could allow for the absorption and removal of carbon dioxide in the atmosphere and reduce global warming in the future.

Sacred Heart Greenwich

Teacher: Mary Musolino

Ng, Marcus**Project #126**

Research Proposal, Science, Environmental

Impact of Pesticides on Seaweed Farming

An increasing world population demands the need for higher crop yield which can be accomplished with the aid of pesticides. Because of runoff from rain, snowmelt, or draining, these pesticides end up in the ocean and threaten the organisms living there. This includes the seaweed in seaweed farming which is a valuable source of nutrients for a growing world population. Not only does it provide a source of food but also a source of income for many people. In this experiment I will simulate seaweed growing conditions using four different tanks. Each will have the same setup of a seaweed farming technique and three of the four tanks will contain pesticides. All conditions of the tanks will be identical to each other and will be maintained throughout the experiment. The overall growth of the seaweed grown in the non pesticide tank will be compared to the overall growth of seaweed grown in pesticide contaminated water. Pesticides are expected to stunt the growth of seaweed because they are soluble in water which can affect the seaweed's absorption of nutrients. Due to advance medical technology, a growing world population requires more crops and nutrients. Seaweed farming has become an important source of agriculture, especially in Asia where many people rely on it as a source of income. There is extensive research on how pesticides affect humans, however there is little on how pesticides affect crops, specifically seaweed.

Greens Farm Academy

Teacher: Mathieu Freeman

O'Connor, Erin**Project #127**

Research Proposal, Science, Environmental

Using Kaolin (Aluminosilicate Clay) to Assist Crops under Conditions of Abiotic Stress

Previous experiments have shown that a kaolin (aluminosilicate clay) foliar spray has insecticidal benefits for crops and therefore may be an alternative to traditional pesticides. This study will determine the effectiveness of kaolin as a foliar coating for abiotic stressors such as droughts and extreme temperatures for crops such as tomato, beans, and radishes. The different plant crops will receive the following treatments: no foliar coating (control), a wax foliar coating, and foliar applications of kaolin at 1.25%, 2.5%, and 5% (weight/volume).

One set of plants will be watered regularly and one set will only be watered intermittently to experience drought conditions. Plant growth and health and crop yield will be documented throughout the study. Other abiotic stressors that will be tested in a similar manner are extreme temperatures and excess light. It is expected that the kaolin foliar sprays will assist in drought protection as follows: the 1.25% spray will result in a 10% reduction in transpiration, the 2.5% spray will result in a 20% reduction in transpiration, and the 5% spray will result in the greatest reduction in transpiration at 40%. The plants exposed to extreme temperatures and excess light will also experience similar benefits with the kaolin foliar spray. The findings of this study will show that the use of the kaolin sprays to create a foliar film can be an alternative tool for protecting crops that experience abiotic stressors such as drought and extreme temperatures. Future research will also be conducted on other foliar sprays such as seaweed extract.

Sacred Heart Greenwich

Teacher: Mary Musolino

O'Connor, Catherine**Project #128**

Research Proposal, Science, Health and Medical

Toward a Synergetic Treatment: Inhibition of PARP in Combination with FOLFIRINOX in BRCA+ Pancreatic Ductal Adenocarcinoma

Projected to rise to the second-leading cause of cancer-related deaths by 2030, pancreatic cancer devastates 50,000 Americans each year. Radiation and chemotherapy have repeatedly failed to treat pancreatic cancer successfully due to the desmoplasia, hypoxic microenvironment, and heterogeneous genetic landscape characteristic to the tumors. Prior research has identified BRCA mutations to drive the progression of pancreatic cancer. When a BRCA mutational event occurs, the cell becomes unable to utilize homologous recombination for DNA repair. Veliparib is a chemical agent that halts base excision repair through inhibition of the critical protein, PARP. Deficiencies in both major DNA repair methods, homologous recombination and base excision repair, leads to the loss of genomic integrity, which induces cell death. Therefore, since FOLFIRINOX is the most potent chemotherapeutic agent available for pancreatic cancer, it is hypothesized that the administration of FOLFIRINOX in synergy with Veliparib will effectively attenuate tumor metastasis in a BRCA+ mouse model. To confirm this hypothesis, a patient-derived cell line will be utilized to induce the cancer. Tumor progression will be monitored using RECIST assessments and evaluated through the employment of a Simon two-stage design. Survival time of mice will be analyzed with Kaplan-Meier curves. The projected loss of genomic stability within the cancer will lead to cell death, and thus reduction of the tumor. If the hypothesis is confirmed, the prospect of an innovative treatment that exploits pancreatic cancer's mutations to kill its own tumor cells will offer hope to the multitude of people who suffer from this lethal disease.

Darien High School

Teacher: Guy Pratt

O'Connor, Colby**Project #129**

Research Proposal, Science, Physical Science

The Effect of Non-Newtonian Fluids on Traumatic Brain Injuries (TBIs)

Does a capsule full of slime polymer effect the force distribution of helmets on children's brain injuries? Brain injuries affect children's intellectual ability, health, and behavior, and we need a way to prevent this while still being able to enjoy healthy activities like sports. To accomplish this, using a Riddell youth football helmet, a polyester capsule full of slime polymer will be placed near the frontal lobe in the helmet. Next, 100-pound weights in the form of sandbags would be dropped on both the control helmets without the capsule and then the helmets with the capsule. The force distribution of the weight would be tested by placing 5 Interlink 402 force-sensitive sensors throughout the inside of the helmet at the contact point. It is hypothesized that after 5 trials, if someone was to drop a weight on a helmet with a capsule of slime polymer, then it would reduce the force distribution more than a control helmet. The projected outcome of this is that the helmets with the slime polymer will have a lesser force distribution, and therefore can reduce the number of concussions if young adolescents use them. Furthermore, concussions are the leading sports injury and new helmets provide little protection to prevent them. All in all, the absorption of force from the weights would minimize the force distribution throughout the helmet with slime and cause a lesser force distribution. So, therefore, help prevent traumatic brain injuries in young adolescents participating in sports.

Amity Regional High School
Teacher: Deborah Day

Ota, Hannah**Project #130**

Research Proposal, Science, Behavioral

The Effects of Music on the Heart Rate of Equus Caballus

Multiple studies have been conducted to study the effects of music on various species of animals and is shown to successfully lower the heart rate. In this experiment, the heart rate of horses will be studied in response to various genres of music. These will include classical, rock, rap, and country. The purpose of this experiment will be to see if music can will raise the heart rate of horses to improve their performance without the negative effects of added stress. Increased heart rate is something that is sometimes desired for conditioning and training purposes and given the evidence that music can lower heart rate, it is possible that it can raise it as well. Each type of music will be played, on different days, for three different horses while they are being groomed, saddled and warmed up. Their heart rate will be measured after each step. The horses will then be timed as they walk, trot and canter 40 meters.

Joel Barlow High School
Teacher: Paul Testa

Paragas, Parker

Project #131

Completed Project, Engineering, Health and Medical

Creating an App That Suggests Song Playlists Based on Leg Length/Cadence and Genre Preference

Many distance runners run with music simply for enjoyment. However, synchronizing to a beat during running, a process called auditory-motor synchronization, helps regulate and maintain pace, and can improve running economy. The purpose of this project was to create an app that will suggest songs based on the cadence and genre specified so that the user can sync their cadence with a song that they enjoy for the whole run. My application allows users to create a custom playlist using the songs from other playlists so that they can run listening to all of their favorite songs regardless of the playlist it may have originated from or add songs to the app if their favorite songs aren't on the app already. The added songs would have their tempo analyzed and would be placed in the user's custom playlist. The song's tempo wouldn't change throughout the run because helping runners sustain their cadence is one of the main purposes of this app. The app will be created using the website thunkable.com, an app inventor, and will be tested by several students on the Amity High School Track Team using Thunkable the app version. The app gained the pre input songs from records, CD's as well as other apps such as Spotify and iTunes and were ran through equations made by the student researcher. The app won't reach the App Store, however, proof of concept was achieved.

Amity Regional High School
Teacher: Catherine Piscitelli

Park, Hoon

Project #132

Completed Project, Science, Physical Science

Does the Mpemba Effect Really Defy the Laws of Thermodynamics? - Testing the Mpemba Effect

Hot water can turn into ice before cold water. This phenomenon is the Mpemba effect: a topic yet to be clearly understood due to its bizarre nature that seems to defy the Laws of Thermodynamics. By recreating this phenomenon, this lab will provide a possible explanation of how the Mpemba effect is possible under Newton's Laws of Thermodynamics. Factors such as supercooling and latent heat will be observed to "justify" the Mpemba effect. Different temperature water will be cooled and frozen using a freezer. By logging the temperatures every minute for a few hours, factors such as latent heat and the Newtonian cooling ratio will be analyzed. Differently categorized results will be compared with each other to test the speed of freezing under different conditions. Supercooling enabled the delay of latent heat as the temperatures went down below 0. Hot water had a relatively short delay before the conversion, starting latent heat at a faster pace than of cold water. During latent heat, hot water's crystallization took less time than for cold water to turn into ice. Cold water took a long time to convert into ice, while hot water finished latent heat much quicker. It is possible for hot water to turn into ice before cold water. While supercooling did not enable hot water to start latent heat before cold water as hypothesized, it still showed the possibility of hot water freezing before cold water, justifying the Mpemba Effect.

Choate Rosemary Hall
Teacher: Ben Small

Pashankar, Sana**Project #133**

Completed Project, Science, Health and Medical

Impact of Method of Survivorship Care Plan Implementation on Health Behaviors of Childhood Cancer Survivors

Research on childhood cancer survivors has found that this population is deficient in adhering to healthy behaviors. A survivorship care plan (SCP) is used to improve adherence by reinforcing healthy behaviors. In this study, we were investigating if health behaviors of childhood cancer survivors would be affected by how SCPs were administered: through a primary care physician (PCP) or a specialized cancer center. The independent variable is the method of SCP administration. The dependent variables are physical activity, sedentary time, and servings of fruits and vegetables. Participants will be randomized into two experimental groups. Both groups will receive a SCP, however, participants in one group will be told to follow up with their PCP. Participants of the second group will be scheduled to attend the HEROES clinic, the specialized cancer center at YNH. All participants will give a baseline and a post-SCP survey. Descriptive statistics will be conducted to describe patient characteristics, as well as McNemar's test for paired samples and paired t-tests to compare health behaviors pre and post SCP. We hypothesize that patients who are administered the SCP through the HEROES clinic will experience improved health behaviors. This study is important for childhood cancer survivors because maintaining healthy behaviors post-treatment could deter other health complications from arising. Although different from our hypothesis, we ideally hope to find similar results from both experimental groups in order to conclude that both PCPs and specialized cancer centers are sufficient in ensuring that survivors adhere or improve in their health behaviors post-SCP.

Amity Regional High School
Teacher: Deborah Day

Patel, Armaan**Project #134**

Completed Project, Science, Health and Medical

The Effect of Clinical Depression on the Opioid Dosage of Chronic Pain Patients

Clinical depression is a major disease in the U.S, affecting 6.7% of adults, according to the World Health Organization. In this study, the primary question is, "How does clinical depression affect opioid dosage in chronic pain patients?" The independent variable is whether or not the patients have clinical depression. The dependent variable is their opioid dosages (in morphine milligram equivalent, a dosage measurement scale). The control group contains patients without clinical depression. It is hypothesized that patients with clinical depression will have higher opioid dosages than patients without clinical depression. Data is being collected by the administration of a questionnaire called the Opioid Risk Tool (ORT). Patients are informed beforehand that the data will be used anonymously in a high school science study. Additionally, the patients give written consent after they are given a consent form which says that they can withdraw their data from the study at any given point of time. The medication history of each patient, provided at the consent of the patients, will be analyzed to assess the levels of opioid dosage use of each patient in relation to each patient's history of depression. This data will be graphed using scatter plot(s) with linear trend(s) and possibly bar graph(s). The projected result of this study is a positive trend between clinical depression and increased opioid dosages.

Amity Regional High School
Teacher: Deborah Day

Patel, Ashwini**Project #135**

Research Proposal, Science, Health and Medical

Inhibition of FOXM1 in Invasive Mucinous Adenocarcinoma of the Lung

Though lung adenocarcinomas are the most common type of lung cancer, pulmonary invasive mucinous adenocarcinoma (PIMA) only consists of 5% of all lung adenocarcinomas. However, PIMA is associated with a poor prognosis and does not have effective treatments. Forkhead box protein M1 (FOXM1), an oncogenic transcription factor, is overexpressed in tumors, especially in pulmonary invasive mucinous adenocarcinoma. FOXM1 is known to promote tumor cell proliferation and progression by the regulation of genes associated with cell cycle progression and cell proliferation. However, there is no effective way to suppress FOXM1 pharmacologically in vivo. To study the possibility of suppressing FOXM1 in PIMA, FOXM1-specific siRNA and a control siRNA will be administered into samples of human PIMA lung tissues. Through the encapsulation of the polyethylenimine-based cationic polymer, or PEI, it will be determined as to whether fluorescently labeled siRNA remains within the PIMA cells after injection. If it does remain, further administrations of PEI-encapsulated anti-FoxM1 siRNA will be tested to conclude if it affects the expression of FOXM1 levels in PIMA. The predicted results are that anti-FOXM1 siRNA will be functional when administered into PIMA in vivo, giving it the potential as a treatment for pulmonary invasive mucinous adenocarcinoma, thereby improving the prognosis and overall outcome of patients.

Darien High School
Teacher: David Lewis

Paul, Akanksha**Project #136**

Completed Project, Science, Environmental

The Influence of Sediment Compaction and Nutrient Treatment on Salt Marsh Plant Growth

Salt marshes are coastal wetlands that provide storm and erosion buffers, nitrogen sinks, and countless marine habitats. Despite protective measures, they have been rapidly declining worldwide. Recent studies indicate that marshes near the mouth of the river have more compact sediments and lower ambient nutrient concentrations, limiting the growth of marsh cordgrass by restricting nutrient uptake and ultimately root growth. Independent variables include sediment compaction (varying degrees of firmly or loosely packed) and nutrient additions (ambient or 5g fertilizer 14:14:14 NPK). The dependent variable is the above- and belowground plant biomass. Compaction will limit above- and belowground biomass growth, and nutrient additions may alleviate the negative impact of compaction on above-ground biomass without improving belowground biomass, which is important for stabilizing marsh banks and preventing marsh loss. Greenhouse experiments will be conducted to examine seedling survivorship and growth on compact and softened sediments with or without added nutrients. Seedlings and sediment cores will be collected from one field site with compact soil and kept in a greenhouse in running seawater. Twelve seedlings will be transplanted into 3 sediment treatments (naturally compact, softened, softened and repacked). Half of these will receive ambient or enhanced nutrients using the chosen fertilizer. After 3 months, the above- and belowground biomass of the plants will be measured and the data will be analyzed through Analysis of Variance. These findings may then identify conservation techniques and factors that are and aren't contributing to marsh loss.

Amity Regional High School
Teacher: Deborah Day

Pereyra, Jonah**Project #137**

Research Proposal, Science, Environmental

Sunscreens and their Effect on Coral Reefs

Rising CO₂ levels within the atmosphere are causing ocean temperatures to rise. The higher temperatures cause coral to expel the photosynthetic algae living within their tissues that provide them with energy; as a result, they die. Many factors cause this phenomenon. However, a lesser known factor is the toxic effects of chemicals, such as oxybenzone, in sunscreens. This project will analyze the impact of toxic sunscreen chemicals on the coral as well as the effect of natural chemicals such as zinc oxide. First, multiple coral samples of varying species from their natural environment will be collected and brought to a lab setting. The samples would then be exposed to different levels of oxybenzone, zinc oxide, and other chemicals found in sunscreen in order to elicit a bleaching response. The expelled algae will be collected and counted as a means of data collection. It is expected that the coral exposed to chemicals will exhibit varying levels of bleaching, with oxybenzone eliciting the highest and most deadly response. The corals exposed to zinc oxide will exhibit little to no bleaching response. These findings would support that zinc oxide based sunblocks are the least damaging to the coral and the environment that surrounds it. If the experiment shows zinc oxide to be less damaging, then this could be used to bolster movements to increase public awareness and encourage action to ban the toxic chemicals. It is imperative to give coral any possible advantage in order to survive this growing deadly threat.

Ridgefield High School
Teacher: Patrick Hughes

Pittaro, Claire**Project #138**

Research Proposal, Science, Health and Medical

Using the Anti-inflammatory Phosphodiesterase Inhibitor Ibudilast as a New Treatment for Opioid Addiction

The opioid crisis has gotten worse over the past several years, with the rate of opioid overdoses increasing and more people developing addictions. It is important to study this field of research because the treatment processes currently used are not always effective. It is hypothesized that the anti-inflammatory agent ibudilast, a phosphodiesterase inhibitor that has been shown to help with alcohol addiction, will also help reduce the dependence on opioid medications. For this experiment, anti-inflammatory ibudilast will be tested to determine if it helps with addiction symptoms. A model worm commonly used in research, *C. elegans*, will be grown and four groups will be formed. One group will given no medication or ibudilast and one group will just be given just ibudilast. The last two groups will be given appropriate levels of opioid medication. One of these opioid groups will also be given ibudilast. The behavior of the *C. elegans* worms in all groups will be noted, including the number of movements and thrashes within a given timeframe over an extended period of time. Lifespan will also be recorded. It will be especially important to compare the worms given ibudilast after opioid medication to the worms that were not given any treatment after the opioid medication. It is expected that improvements, measured by a reduction in thrashing levels of the *C. elegans* worms and increased lifespan, will be noted in the group administered ibudilast after the dose of opioid medication when compared to the opioid group without ibudilast. The results of this study will be important in order to help reduce an individual's dependence on opioid medication and to help with the opioid crisis in general.

Sacred Heart Greenwich
Teacher: Mary Musolino

Prabhu, Varun

Project #139

Completed Project, Engineering, Behavioral

Creating An AI Program To Generate Controversial Statements and Respond Respectfully To Model Civilized Arguments

Many people's casual conversations, or the the reply section of a post online, can quickly turn into an argument, filled with personal attacks, especially in today's world where someone can hide behind a phone or computer screen. To counteract to this problem I have made a program that can be served as an educational tool for people when arguing or debating to keep it civil and respectful. There were 3 main stages to this project. The first was to look at similar programs and applications. This gave me a base for what I could do to make this project. The second stage was where I started coding the project. In this, I used Microsoft Azure's library to make, "trigger words," in the program that would call for certain prompts. I used JavaScript to code this project. This stage took the longest time out of all. Finally, the third stage was where I tested the program, and analyzed the feedback from the trials experimenting with it. I analyzed how the conversation went, and if the program was able to use the correct prompts, it would be recorded as positive data. The data so far is mediocre. This program could be used with people who have trouble communicating, and people on the autism spectrum, but the goal is for it to be able to help anyone, as a small-scale version of an idea and tool that can be greatly expanded on in the future.

Amity Regional High School
Teacher: Catherine Piscitelli

Qin, Andrew

Project #140

Research Proposal, Science, Health and Medical

The influence of heat levels upon the effectiveness of magnetic hyperthermia

Cancer has long been established as a widespread disease, claiming the lives of about six hundred thousand people each year. Hyperthermia is a promising cancer treatment that involves denaturing cell structure and proteins within cancer cells through the use of high temperatures. The proposed experiment will determine the effect of increasing temperature levels in hyperthermia on cancer cells. Microscopic iron particles called magnetic nanoparticles will be situated in alternating magnetic fields, creating rapid vibrations that will produce heat that affect the sample of cancer cells. By changing the intervals between alterations in the magnetic field, variation in vibration speeds, and therefore temperatures, can be produced. The effect of these differing temperatures will then be tested on osteosarcomas, or bone cells affected by cancer. Based off previous research, hyperthermia will increase in effectiveness in relation to increasing temperatures. The results will yield a sharp increase in effectiveness at temperatures slightly higher than normal body temperature, and then stay at a relatively consistent effectiveness at extreme temperatures. Studies have shown that hyperthermia has potential to differentiate surviving cells after treatment, as well killing cancer cells, making it possibly more effective than other standardized treatments. If strategies to increase the effectiveness of hyperthermia are further studied, then hyperthermia bears the potential to become a widespread therapy to treat cancer.

Darien High School
Teacher: David Lewis

Rai, Aditya**Project #141**

Research Proposal, Science, Health and Medical

The Potential of Venoms Integrated Into Anticancer Medications

Today, 1 million individuals are diagnosed annually with cancer and patients have little to no biomedical options. With this predicament, scientists are looking for substances that contain diverse and unique components, and venom fulfills all of these requirements. The *Naja kaouthia*, and *Vipera russelli* are both snakes that produce physically complex venoms, that may serve as possible cures to lethal diseases. It is hypothesized if venom derived from snakes are used on experimental models possessing different kinds of cancers, then the venom will reduce the growth of the cancers with angiogenesis inhibiting factors. In order to accurately display the venom's potential effectiveness, the venom's toxic activity, as well as anti-cancer potential against variations of cancers, will be determined. To test this, rare cancers (sarcoma, carcinoma, and leukemia) will be induced into mice to see how the venoms behave in live models. In this experiment, 40 mice will be separated into groups of 10, with each cancer being induced to allow for successful development of the cancerous cells/tumors. Then, each venom will be administered daily, based on its lethal dose, to the mice and after an extensive period of time, scientists will overlook the regression in cancer growth. Tumor regression will be due to these substances attaining angiogenesis inhibiting factors, as well as being directly correlated with encouraging apoptosis. With this experiment, it is foreseen that a medication containing these venoms may be integrated into clinical use and potentially be a cure for a few lethal forms of cancer.

Darien High School
Teacher: David Lewis

Raissi, Siavash**Project #142**

Completed Project, Science, Health and Medical

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

Cystic fibrosis (CF) is a chronic, inherited disease of the secretory glands, which when affected, creates a viscous mucus, harming the lungs, pancreas, liver, and reproductive organs. CF is characterized by hyper-inflammation and its inability to efficiently resolve chronic lung infections, eventually resulting in death. It is caused by a mutation in the CFTR gene. It is unknown how mutations in the CFTR gene affect M1 and M2 macrophages that originated from THP-1 cells. In this study, the presence of CFTR will be the independent variable, while the extent of polarization of M1/M2s will be the dependent variable. THP-1 cells will be treated with an interfering RNA to knockout the CFTR gene, while a control group will not. The cells will be converted to M1s and M2s and flow cytometry and RNA supernatant data will be collected using qPCR. Anticipated results would suggest that the M2 macrophages will have a decreased production of anti-inflammatory cytokines such as IL-10 and IL-6, as well as a decrease in cell markers CD163 and CD86, which are typically used to identify M2s. These methods will be carried under the supervision of Dr. Hasan Oz, as well as my mentor, Professor Emanuela Bruscia. The findings could help establish a model system for the use of THP-1 cells as a replacement for blood monocytes when studying the effects of cystic fibrosis, as well as the impact of CFTR on different types of macrophages.

Amity Regional High School
Teacher: Deborah Day

Roth, Annabel**Project #143**

Research Proposal, Science, Health and Medical

Genetic and Cell-Based Study of Infantile Myofibromatosis to Develop a Targeted Treatment

Infantile Myofibromatosis (IMF) is a rare, inherited autosomal dominant disease characterized by the growth of solitary or multiple nodules in skin, muscle, subcutaneous tissues, bone, and sometimes viscera. IMF results from mutations in the Platelet-Derived Growth Factor Receptor Beta gene (PDGFR-). A new IMF patient with a previously undescribed PDGFR- mutation, Phe864Leu (c. 2590T>C), was recently identified. With the ultimate goal of treatment, this study will investigate the effect of this specific PDGFR- mutation on cell growth and behavior. The growth of BaF3 cell lines engineered to express this PDGFR- mutation will be compared to control cells to help establish if the mutation is either a gain or loss of function. Western blot analysis of cell lysates will be used to investigate which proteins in PDGFR-'s signaling pathway are activated/inhibited by the mutant protein. Based on the outcome, additional experiments to better characterize the mechanism of activation/inhibition are planned. The hypothesis is that mutant PDGFR- will increase cell proliferation, when compared to control cells. Based on this, I believe that at least one protein in the PDGFR- signaling pathway will be differentially phosphorylated. Western blot analysis will confirm or reject this hypothesis and, if the hypothesis is correct, pinpoint the proteins differentially affected. Data supporting or rejecting our gain-of-function hypothesis will be important to better understand candidate treatments for this disease since both inhibitors and activators of PDGFR- are known.

Greens Farm Academy
Teacher: Mathieu Freeman

Salvatore, Jenna**Project #144**

Research Proposal, Science, Environmental

Suppression of Tumour Growth as Pertaining to Pancreatic Cancer by Means of Monogalactosyl Diacylglycerol Formation

Anything aiding in pancreatic cancer treatment is beneficial. Spinach has a property that increases the cytotoxic effects of radiation on pancreatic cancer cells. Combined with radiation, the monogalactosyl diacylglycerol in spinach can be an effective therapeutic strategy for suppressing tumor growth. Photosynthetic processes use carbon dioxide from the air. The air pollution problem may affect the use of spinach as a therapeutic strategy through its effect on MGDG production. Spinach will be grown in two terrariums, one as a control and the other with a high concentration of CO₂ in the air by adding carbon dioxide into the space. The spinach will be harvested after growth and its lipids will be separately extracted and evaluated by a mincing and macerating process involving isopropanol, chrofome, and methanol. The amount of lipid produced from each spinach group will be compared. In comparing the amount of lipid formed depending on the environment, it can be concluded how carbon dioxide in the air affects lipid formation. This research allows a peak into the future by seeing how the environment can affect other things, including our own wellbeing and treatment, as is the case with spinach and radiation therapy.

Joel Barlow High School
Teacher: Katherine Nuzzo

Samal, Arushi

Project #145

Completed Project, Science, Health and Medical

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

Chronic Obstructive Pulmonary Disorder (COPD), is the third leading cause of death in the United States today, and is characterized by difficulty breathing due to inflammation and a buildup of mucus that constricts the respiratory tract. Prolonged exposure to cigarette smoke has been proven to be a leading cause of COPD. The epithelial monolayer, the layer of cells that line the airway, serves as the barrier between outside pathogens and the lung tissue itself, and are held together by adherens junctions that maintain the integrity of the monolayer. The barrier is characterized by several different types of cells including clara cells, goblet cells, ciliated cells, and basal cells. These cells work together to create a chemical and physical barrier from pathogens. The key protein in this junction is E-Cadherin because E-Cadherin dimerizes to bind to itself, therefore this experiment aimed to better understand the mechanism of E-Cadherin. Previous clinical data looking at cigarette smoke and the barrier function has shown that fucosyltransferase-2 (FUT2) can affect the function of E-Cadherin. FUT2 adds fucosyls, or sugars, to the protein in question which can change the binding ability of E-Cadherin. In this experiment, a nickel-binding assay was used in order to investigate the binding of E-Cadherin to itself, both with the presence of fucosylations from FUT2, and without. The data has shown that E-Cadherin has increased binding in the presence of FUT2 demonstrating that FUT2 has a molecular effect on E-Cadherin.

Darien High School

Teacher: Christine Leventhal

Sandhu, Arshdeep

Project #146

Research Proposal, Science, Health and Medical

The Effect of Long Non-coding RNAs on Genetic Mutations, Specifically Cancer

Genetic mutations, like cancer, have caused many people around the world to suffer. These mutations generally have no available cure that allows for the total eradication of the tumor without any other secondary complications. Non-coding RNAs (ncRNA), a type of genetic assistant that do not code for any proteins, but instead help the protein to act in a specific way. Noncoding RNAs can potentially be used to stop tumorigenesis, thereby stopping further spread of cancerous cells in the human body. The experiment would be performed by studying the effects of specific ncRNAs, such as XIST or MALAT1, on types of genetic mutations in a lab setting. These types of ncRNAs would then be manipulated to act in an opposing way in order to hinder the proliferation of cells within the human body. The results are expected to show that the molecular interactions through ncRNAs in particular cells can be manipulated to create more effective prognoses, diagnoses, and therapeutic strategies. These findings would be able to show that through manipulating the RNAs in the cell, the ncRNAs can hinder cell proliferation and tumorigenesis. If the findings are shown to prove that ncRNAs can be manipulated within the genome to hinder cell proliferation, then they can be implemented to further cancer research. It would aid researchers in finding a proper way to deliver cancer inhibiting drugs equipped with ncRNAs into the human body. Through the success of this research, scientists will be able to cure numerous cancers, therefore saving lives.

Ridgefield High School

Teacher: Ryan Gleason

Satish, Anika**Project #147**

Research Proposal, Science, Environmental

Estimating Ice Thickness Using a Bayesian Model and Satellite Image Data

Ice sheets contain enormous quantities of frozen water which if melted could raise the sea level by at least 60 meters. Satellite datasets provide an aerial view of these ice sheets, however, they do not measure their thickness. Using mathematical models will lead to a more accurate determination of the ice sheets' thickness. This study explores how a mathematical model could be created to predict the correlation between ice sheet thickness and sea level. Satellite radar altimetry data covering two time periods of three years each will be used as the basis for this experiment. Using knowledge of multiple variables that affect ice thickness, a Bayesian Model will be developed to run on the data to determine ice sheet thickness, and the corresponding sea level. The uncertainty and accuracy of the model will also be analyzed through a comparison with observed data entries. It is predicted that if ice mass thickness has a decreasing trend, then there will be a corresponding increasing trend in sea level. It is also predicted that there will be very little uncertainty between actual data entries and the model's outcomes. This study will allow researchers to predict ice mass thickness and sea level in other regions of ice sheets, and consider the global effects of an increase in sea level. It will also lead to the creation of more efficient mathematical models to analyze large, unknown datasets more accurately in other areas of scientific research.

Darien High School

Teacher: Christine Leventhal

Scheggia, Fatima**Project #148**

Research Proposal, Science, Health and Medical

The Effect of Vitamin B9 on the Health and Lifespan of *Armadillidium vulgare*

Vitamin B9, or folate, is found in supplements and in foods such as spinach and other green vegetables. This vitamin is essential for optimal brain and nerve function but has not been connected to increased lifespan. This project's purpose is to find out if vitamin B9 can improve overall health and extend lifespan in *Armadillidium vulgare*, the common pill bug. It is hypothesized that the lifespan of the pill bug will increase with consumption of Vitamin B9-rich foods. The two variables that are being observed are vitamin B9 supplements and vitamin B9-rich foods. A typical pill bug diet will be used as a control. Pill bugs will be observed initially and then after being given either the B9 diet or control diet. Health in terms of movements and lifespan over a 6-month period will be documented. It is expected that the pill bugs consuming the vitamin B9 supplements will move the least and have the shortest lifespan of the variables tested due to the concentration of the supplements. It is also expected that the pill bugs on the vitamin B9 food diet will move the most and have the longest lifespan compared to the control. The experiment will likely show the importance of eating foods rich in vitamin B9 to improve health and increase lifespan. This research will lead to testing vitamin B9 on other organisms as well as testing other parameters of health in addition to lifespan and movement. In the future, additional nutrients not commonly linked to increased lifespan will also be tested.

Sacred Heart Greenwich

Teacher: Mary Musolino

Schmidt, Lana**Project #149**

Research Proposal, Science, Environmental

The Influence of Hypoxia on the Adaptation of *Acartia hudsonica* Caused by Predation

Rising levels of CO₂ within the earth's atmosphere have significant detrimental effects on the marine ecosystem. CO₂ dissolves in the Long Island Sound and causes hypoxia which leads to drops in pH. This acidic environment impairs the health and the ability to thrive of Copepods. The adaptation patterns of Copepods may help to predict and accommodate the future of this and similar species. Adaptation is seen either as within generation or transgenerational plasticity. Copepods can detect kairomones released by their predators, northern seahorses, and use these cues to predict danger. Copepods are gathered from Greenwich, Connecticut where there are high hypoxia levels from the higher CO₂ admissions and Groton, Connecticut where there are low hypoxia levels because the water is able to flush out with the Atlantic Ocean. Copepods from Greenwich and Groton are placed in both saltwater tanks with and without kairomones collected from seahorses. The kairomones are meant to induce adaptation in the copepods by hormonally warning them of danger. The adaptation of the Copepods is measured in the age of and size at maturity and the size of the first clutch. The Copepods from the higher hypoxia levels in Greenwich will experience weaker within generation and transgenerational adaptation than the copepods from lower hypoxia levels in Groton. This is caused by the compromised health of the copepods due to the lack of oxygen from the increased hypoxia. This information helps scientists to understand the effects that increasing carbon dioxide has on parts of our world's ecosystem.

Darien High School
Teacher: Guy Pratt

Scully, Peter**Project #150**

Completed Project, Science, Physical Science

The Effect of Different Solvents on a Graphene-Based Foam's Conductivity Under Pressure

A composite, consisting of a percolating network of spheres made out of graphene, the thinnest, most conductive known substance, surrounded by butyl acrylate, was synthesized. This composite's conductivity varies with pressure and it has selective solvent absorption, preferring hydrophobic substances. To determine the mechanism responsible for the variation, this experiment will test the composite's resistance under varying pressures and in solvents that are hydrophobic and hydrophilic with varying ionic strengths. The experiment will consist of the resistance of the foam being measured on fifteen second intervals under all combinations of five different weights or no weight and various solvents or no solvent. These solvents will be vegetable oil and aqueous solutions with molar concentrations of 0.1M to 2.0M NaCl and CaCl₂, giving the solvents different ionic strengths. There will be three trials for each combination. Data will be analyzed using regression analysis to determine the typical resistance over time for each combination. These regressions will be compared to each other based on solvents' ionic strengths and pressures, as well as if a substance is hydrophobic. Anticipated results are a correlation between composite resistance and a solvent's ionic strength and between resistance and pressure placed on the foam. The results of this experiment will enhance understanding of the mechanism responsible for the change in resistance with deformation and overall knowledge of the composite's electrical, structural, and pressure-related properties. This will help to develop more specific applications for the composite in various fields, including those of electronics and pressure sensing.

Amity Regional High School
Teacher: Deborah Day

Scura, Lucie**Project #151**

Research Proposal, Science, Environmental

The Effect of Invasive Plant on Nectar Quality for Bumble Bees

The impacts of invasive plant species are economically detrimental, costing 1.4 trillion dollars globally, and straining native plants' reproduction. Overall, 87.5% of all angiosperms are animal pollinated and as such require pollinator attention for reproduction. The presence of the invasive plant, *Berberis thunbergii*, has been correlated with lower soil quality and protein content in the nectar. In order to measure the nutritional quality of the nectar, the size and activity of ovaries in bumble bees, *Bombus terrestris* will indicate protein amounts. The purpose of this study is to investigate the effect of the invasive plant *Berberis thunbergii* on the protein content for bumble bee *Bombus terrestris*. Higher levels of dietary protein effect ovary size and activity by reducing the time to initiate and increase egg-laying rates in queen-less worker bees. Bumble bees will be placed in plexiglass cages with flowers from invasive and native plants with the same environmental conditions as those in bumble bee colonies, and liquid feeders will be placed with 25% sugar syrup to keep sugar amount consistent. A calculation of weight difference, number of bees showing ovary activation, ovary length, number of oocytes, and oocyte length indicates protein content obtained from the nectar of *Berberis thunbergii*. It is anticipated that there will be a decrease in ovary activity and size due to the decreased nectar quality shown in invasive plants, and thus a decrease in protein content. The expected results will provide additional insight into the effect of invasive plants on pollinator-plant interactions.

Darien High School
Teacher: Christine Leventhal

Seymour, Anna**Project #152**

Research Proposal, Science, Environmental

Effects of Ecotourism on Corticosterone Levels of the Southern Stingray, *Dasyatis Americana*

Southern stingrays, *Dasyatis Americana*, are the center of the growing ecotourism industry at Stingray City Sandbar (SCS), Grand Cayman. At SCS, people can swim, feed, and interact with the stingrays. SCS is one of the most popular and visited marine wildlife interaction sites in the world with hundreds of visitors daily. The growth of ecotourism worldwide brings concerns about the effects of such activities on the animals and their ecosystems. The stingrays will be tagged using PIT tags, have blood samples taken, and released. Testing the blood samples for the stress hormone corticosterone, to determine stress levels and their overall health. Using the blood samples from 80 stingrays (40 at SCS and 40 at the control site) to test the hypothesis that ecotourism has increased the corticosterone levels of stingrays at SCS relative to wild animals at control sites. Examination of blood tests showed the stingrays at SCS had significantly higher corticosterone levels than those at the control site. The wild stingrays exhibited low amounts of corticosterone, compared to the stingrays at SCS that exhibited a range from medium to high amounts of corticosterone. Ecotourism has affected corticosterone levels of the stingrays at SCS compared to the individuals at the control site. High-stress levels have a negative impact on the overall health of stingrays, this was exhibited at SCS. Broader ecosystem effects from tourism is a concern. These results will help to determine how ecotourism operations are managed going forward in regards to the health and well-being of the animals.

Darien High School
Teacher: Guy Pratt

Shabet, Sarah

Project #153

Research Proposal, Science, Health and Medical

Efficacy of Atezolizumab on Non Small-Cell Lung Cancer

Lung cancer is the leading cause of cancer death worldwide and 80% of lung cancer diagnoses are NSCLC. Can the effectiveness of Atezolizumab in SCLC be applied to NSCLC? For this double-blinded test, randomized, placebo-controlled test, the patients will be randomized to be administered placebo or Atezolizumab. They will receive one 1200 mg dose on the first day of every 21-day cycle until they have unacceptable toxic effects or no further clinical betterment. Progression-free and overall survival will be measured. Atezolizumab is an antibody that binds to PD-L1, a protein found on cancer cells that binds to T-cells and placates them; Atezolizumab interrupts this exchange and tells the immune system to attack the cell PD-L1 is attached to. PD-L1 is located on the cells in SCLC and may also be found on NSCLC cells. The median overall and progression-free survival will be recorded. These findings would open the door to allowing NSCLC patients to other treatment options and increase worldwide cancer survival rates. Other drugs shown to work on specific cancers can be tested to see if they are effective on other types as well. There could be drugs that were previously thought to be limited to a certain cancer that can be used to treat other cancers.

Darien High School
Teacher: Christine Leventhal

Shortt, Zachary

Project #154

Research Proposal, Science, Environmental

BioPlastics Effect on Environment

Plastics are killing our oceans. The bioaccumulation of plastics in marine animals is not only detrimental to their health, it is also harmful to humans because we consume fish. Over 10% of our plastics end up in the ocean, and they will essentially never break down. New PHA plastics are being made which are bio-derived, and synthesized to be compostable, and break down into harmless substances of biomass, carbon dioxide and water. My experiment is to test the effect of the "harmless substances" on the marine environment. The end goal is to find an eco-friendly plastic for daily use. I will test how the addition of biomass, carbon dioxide and methane gas affects the ocean. I will analyze the total amount of byproducts released by these plastics' biodegradation with the assumption that plastic use stays constant, but is entirely PHA's. I will use past studies to see how these byproducts affect the ocean, and to what degree. This will be tested in a variety of PHA plastics to determine which would be the best PET plastic replacement for the future.

Joel Barlow High School
Teacher: Paul Testa

Silbert, Jacob

Project #155

Completed Project, Science, Environmental

Assessing the Rate of Degradation of Sulfamethoxazole in Backyard Soil

Studies on domestic animals have shown that around 70%-80% of a given antibiotic may pass through their digestion unmetabolized and be excreted into the soil. These deposited drugs may spread throughout an ecosystem, cause the contamination of water sources, and lead to the rise of antibiotic-resistant bacteria, or “superbugs.” The research question is: How long does it take for a given amount of the antibiotic sulfamethoxazole to degrade in soil? This experiment will stimulate sulfamethoxazole degradation in test tubes filled with different qualities of soil mixed with 1 mL dimethyl sulfoxide (organic solvent) and water. Each trial will be left to wait for a determined amount of time before being mixed with ethanol, which will extract the sulfamethoxazole. The sulfamethoxazole aliquot will be put through LCMS analysis to determine the sulfamethoxazole concentration. Data will be recorded in a spreadsheet. It is predicted that the natural soil trials with 0.5 mL water (aerobic) will degrade the most sulfamethoxazole. This prediction is based on the fact that both aerobic and anaerobic bacteria exist in natural soil, which both aid in compound degradation. Implicitly, it is expected that the sterile soil trials will demonstrate the least degradation of sulfamethoxazole. The results of this experiment could provide evidence of the risk of antibiotic-resistant bacteria in suburban environments. Additionally, the results might give reason to suggest the lowering of veterinary antibiotic dosages. Lastly, the different experimental groups might demonstrate which climates or environments are most susceptible to a superbug outbreak.

Amity Regional High School
Teacher: Deborah Day

Sinha, Devansi

Project #156

Research Proposal, Science, Health and Medical

p53 Gene Therapy in High Grade Serous Ovarian Cancer

p53 is a vital gene present in the human body, and is responsible for tumor suppression through the process of apoptosis. In some cases, mutations in p53 can arise, causing the growth of a tumor. One type of cancer where 96% of cases have mutations in p53 is High Grade Serous Ovarian Cancer (HGSOC). By using gene therapy to target a specific mutation within p53, p53 could possibly be reactivated in the body, and target the tumors present. The experiment would be performed by taking cell lines with a specific mutation. That mutation would be targeted with treatment that would either inhibit or repair the function of the mutation. If possible, the experiment will further advance to in vivo treatment to target metastasis and restore the activity of p53. The results are expected to show a decrease in the proliferative activity of the cell lines, and the repair or inhibition of the specific p53 mutation. In vivo, tumor size is expected to decrease with metastasis being targeted, and the activity of p53 is expected to be restored. If the hypothesis of this experiment is proven correct, then this information could be used to target cases of HGSOC with that specific mutation in p53. Although only a small portion of cases specific to that mutation could be treated, it would be a start to finding effective treatments for patients with HGSOC that do not include chemotherapy, or invasive surgeries.

Ridgefield High School
Teacher: Patrick Hughes

Slanski, Abigail**Project #157**

Completed Project, Engineering, Health and Medical

Engineering an Anticoagulant Catheter Using a Bioinspired Approach

Intravascular catheters are tubes inserted into a vein/artery to monitor blood, deliver medications and fluids, and more. However, the interaction between blood and catheters causes platelet activation, leading to blood clot formation (thrombosis). Currently, catheter related clotting is treated by flushing the catheter with anticoagulant drugs, which poses risks and has limited success. This project will create a catheter that will reduce the chances of clotting by functionalizing them to release Nitric Oxide and coating with a hydrophilic polymer. NO is created within blood vessels that inactivates platelets. Additionally, using hydrophilic coatings has been shown to create a barrier between the device surface and the components of a blood clot. A polyurethane catheter prototype will be fabricated using a spin casting platform. It will incorporate the NO-generating material diazeniumdiolated dimethyl-1,6-hexadamine and be coated with Poly(carboxybetaine). To confirm NO release, it will be tested in a Nitric Oxide Analyzer. The Poly(carboxybetaine) coating will be confirmed through fourier-transform infrared spectroscopy. The catheter's effectiveness will be tested by measuring the absorption of fibrinogen, a protein that interconnects platelets within clots. The catheters will be submerged in fibrinogen solution, and data will be collected using an enzyme linked immunosorbent assay. Absorption from experimental catheters will be compared to standard catheters. It is predicted that modified catheters will absorb less fibrinogen, indicating a device less prone to causing thrombosis. This project will create a safe and effective solution to the high rates of blood clotting caused by catheter use.

Amity Regional High School

Teacher: Deborah Day

Spallone, Christian**Project #158**

Research Proposal, Science, Environmental

Testing the Effectiveness of the Raspberry Pi Sense HAT in Comparison to a Traditional Weather Station

Emerging countries lack accurate information regarding weather and climate. These gaps in knowledge prevent proper preparation for meteorological events and limit weather awareness in specific regions. Without proper recognition of future weather patterns, threatening conditions become more common occurrences, especially in the face of climate change. An inexpensive weather station will be developed using the Raspberry Pi computer and its popular add-on, the Sense HAT. The effectiveness of the device will be tested in comparison to a heavily researched and reputable station produced by Acurite. If meteorological data collected during the same time period aligns similarly between the two systems, the Raspberry Pi station will be deemed effective. The results of the data collected by the Raspberry Pi and the Sense HAT are expected to display similarities to that of the Acurite station. The hardware quality of the two systems hold several parallels, but the Raspberry Pi station will have to be monitored for potential biases, including temperature. The proposed research will introduce an additional use for the Raspberry Pi computer and the Sense HAT. If the station is able to gather weather data efficiently, it will enable scientists to implement small stations in areas which lack sufficient observational data. With this information, citizens of these regions can adequately prepare in advance of a dangerous weather event, therefore saving lives. The data will also add to the global bank of climate information, allowing for a more accurate modeled representation of our future world.

Ridgefield High School

Teacher: Ryan Gleason

St. Jean, Abby**Project #159**

Research Proposal, Science, Behavioral

Art Therapy With Adolescents With Depression

Depression is a common mood disorder affecting the way one thinks, acts and works. Depression in adolescents, specifically, is an issue that is becoming increasingly prevalent in society. Mental illnesses like depression are commonly treated with medication. Depression is most commonly treated with antidepressants, however, antidepressants have many negative side effects which often outweigh the positive effects. Some of these side effects include nausea, fatigue, insomnia, blurred vision, loss of appetite, and increased anxiety. An alternative method to treating depression with medication is art therapy, which involves the use of art to help patients express their thoughts and feelings. The purpose of this study is to determine the efficiency of treating depression in adolescents, ages 13 to 18, with art therapy as opposed to medication. It is hypothesized that the symptoms of depression in adolescents will decrease through the use of art therapy. The Beck Depression Inventory-II will be used to measure levels of depression before and after the 6 sessions of art therapy over the course of 6 weeks. Art therapy represents a more beneficial method for treating depression that allows patients to ultimately reduce the symptoms of depression without the use of commonly administered medications and their associated side effects.

Darien High School

Teacher: Guy Pratt

Su, Allison**Project #160**

Completed Project, Science, Behavioral

The Perceived Impact of Migraine

Migraine is a severely disabling and unpredictable disease that is unique for every person who has it. It has significant effects on many aspects of people's quality of life and is stigmatized because people believe migraine patients exaggerate their condition. The purpose of this project is to explore people's understanding of the impact of migraine on patients' lives. A survey and consent form were created. The consent forms were handed out to students and staff at Amity Regional High School. Participants were surveyed individually in person for more reliable responses that may not be gained from a private survey. All surveys had the same questions for comparison, but the survey for participants with migraine also contained additional questions about their experience with migraine. Different comparisons were made, including one of the answers of people with migraine and people without it. The results show the level of understanding different groups of people have relating to the impact of migraine on patients' quality of life. Projected results are that people with migraine or those with a family member with migraine have a better understanding of its impact. The conclusion can be used to create a website to educate various groups of people on the data collected. This can change people's comprehension of the disease and reduce stigmas of migraine. It can be beneficial to the workplace, where employees with migraine may be affected during their jobs. By reducing stigmas, life may improve for migraine patients and those they work with.

Amity Regional High School

Teacher: Catherine Piscitelli

Sugarmann, David**Project #161**

Completed Project, Science, Health and Medical

Investigating the Relationship Between Ulnar Collateral Ligament Damage and Average Spin Rate (RPM)/Speed (MPH) of the Ball Thrown

The ulnar collateral ligament (UCL) connects the humerus and the ulna, which meet at the elbow. Since the UCL is critical for proper functioning of the arm, the question that will be studied is, "Is damage to the Ulnar Collateral Ligament in the elbow correlated to the average spin rate and/or speed of the ball thrown by a baseball pitcher?" Twenty-five pitchers who have had UCL damage (Group A), and 25 pitchers who have not had UCL damage or any other substantial arm injuries in their careers will be used for this study (Group B). For both groups, the average spin rate of the ball in rotations per minute and the average speed of the ball thrown in miles per hour will be measured. For each pitcher, 500 randomly selected pitches will be used. The average spin rates and speeds for each pitcher in Group A will then be compared to their respective values in Group B. Data will be statistically analyzed, mainly with ANOVA and paired t-tests, for any trends and patterns between the two groups. It is hypothesized that spin rate and speed will both be strongly correlated with pitchers suffering UCL damage during their careers. This study could have important implications for MLB pitchers. When MLB pitchers tear their UCL, it often has detrimental effects on the pitchers. If a correlation is present, this study will provide valuable information that can be used in future studies to determine if this correlation is in fact a causation.

Amity Regional High School
Teacher: Deborah Day

Sun, Matthew**Project #162**

Research Proposal, Science, Environmental

Effects of Sulfides on Atmosphere

Sulfur emissions has always been cited as a danger for humans. However, sulfur in the stratosphere is beneficial for the survival of most life forms, as it helps make clouds that have a strong albedo effect, which keeps the temperatures more consistent. Volcanoes are a major source of sulfuric emissions, even with only weak eruptions and degassing. If volcanoes are emitting lots of sulfur, they should be beneficial to the climate. Using data search websites, find the monthly temperature averages in the US and data values of the gases emitted during weak volcanic eruptions and degassing for the past ten years. Compare the two sets of data by taking notice of any patterns in the data. Record them. Trends could be in any value or multiple values.

Compare the patterns to connect any causation between weak eruptions/degassing and monthly temperature. Sulfur emissions from weak eruptions and degassing have been rising over the past years, and therefore could be decreasing the rate of temperature increase in the surrounding area. This is could help prove that volcanic emissions are helpful to the climate around it by keeping the temperature more constant than negatively affecting the temperature and climate

Joel Barlow High School
Teacher: Paul Testa

Sundararajan, Pranav Project #163

Completed Project, Science, Environmental

Relationship between weather patterns and ozone pollution in Connecticut

The fact that Connecticut has the worst ozone pollution in New England and recent extreme weather patterns such as the EF-1 tornado in New Canaan motivated this project. The objective is to find if there is a relationship between weather patterns and ozone levels in Connecticut. Data from the EPA, NOAA, DEEP, and NARR will be utilized. Ozone levels in Hartford, Bridgeport, New Haven, Stafford, Greenwich, Groton, and Danbury will be downloaded and organized using simple tools. It will then be compared to wind and weather events to find a correlation. It is expected that a relationship will be found between weather patterns and elevated levels of ozone. Certain factors may play a more important role, with wind direction expected to play a large role as well as extreme weather phenomena such as tornadoes. The main implication is better predictive software for ozone levels in Connecticut, which can look at specific factors to help further. It also may aid in future policies for ozone pollution.

Amity Regional High School
Teacher: Catherine Piscitelli

Tajmajer, Jack Project #164

Completed Project, Science, Environmental

Inter-Specific Competition Between Two Invasive Mosquito Species: *Aedes aegypti* and *Aedes albopictus*, over Multiple Generations

Zika, malaria, West Nile virus, dengue fever, yellow fever, and Chikungunya find their root at the various species of mosquito. *Aedes aegypti* and *Aedes albopictus* are two mosquito species native to Africa and Asia respectively, and have migrated into the United States. This project aims to measure the changes in the frequency of *Ae. aegypti* and *Ae. albopictus* in response to their competition over various generations in the laboratory. Each generation and the number of *Ae. aegypti* and *Ae. albopictus* will be recorded. Generation F0 will start with equal frequencies of males and females. Every generation, adults will be blood fed and provided with an egg laying substrate. Mosquitos will be allowed to lay eggs for a week. Adult frequencies and sex will be recorded at this point, and the subsequent generation will be started from the collected eggs. Adults will be stored in the freezer so the wing lengths can be measured as a proxy for lifetime fertility. Currently, the experiment has successfully moderated two generations and has overseen the rapid extinction of *Ae. albopictus* in response to the competition. The populations of two cages rapidly dropped and the ratio of one species to another was immensely unbalanced in favor of *Ae. aegypti*, pointing towards a competitive advantage. The experiment may provide data that supports the existence of mating, physical, or behavioral adaptations. This project is expected to increase the understanding of mosquito competition between two heavily impactful species, and will help future research on mosquito population control.

Amity Regional High School
Teacher: Deborah Day

**Talgo, Ellarie
Butler, Emma
Veber, Julia**

Project #165

Completed Project, Science, Health and Medical

**Using DNA Barcoding to Detect
Mislabeling in the Meat Industry**

Mislabeling in a variety of food industries is currently a large concern for consumers. Testing has been conducted in the fish and herbal supplement market but not much has been done in the exotic meat jerky market. It is hypothesized that various jerky companies may be mislabeling some of their exotic meat products so that they can charge higher prices while not having to pay for expensive exotic animals. In order to test what kinds of meats are actually in certain products, a wide variety of exotic meats and brands were obtained. DNA barcoding was used, which extracts DNA using the silica method, amplifies the DNA using PCR, and sequences the DNA for identification. The species of animal meat present in the highest quantity was detected and identified through sequencing and through the use of an online database. Thus far, several products have been found to be mislabeled, such as one manufacturer's alligator jerky, which was found to be *Bos taurus*, also known as cattle. Several jerky products were determined to be authentic such as wild boar and venison. Additional testing is underway with jerky and sausage sticks, such as caribou, kangaroo, and bison, from a variety of brands. This study is significant because potential mislabeling could impact consumers. If jerky companies are providing mislabeled products to consumers, this holds serious health, ethical, and legal implications. If further mislabeling is detected, an even wider sampling will occur to determine the full scope of the issue.

**Sacred Heart Greenwich
Teacher: Mary Musolino**

Tenerowicz, Keri

Project #166

Completed Project, Engineering, Health and Medical

**Using Artificial Neural Network Machine Learning
Algorithms to Detect Melanoma Skin Lesions**

Melanoma is characterized as the most aggressive type of skin cancer, though early diagnosis and subsequent treatment has a 99% survival rate. However, there has been little research into the discrete ways these trademark skin lesions can be recognized. As they are often confused with benign moles, it would be greatly beneficial to identify whether or not each one is malignant. Thus, a supervised machine learning artificial neural networking system was coded using Python to categorize a lesion as accurately as is feasible. This program analyzed smaller components of each image in the context of the whole to determine if the lesion was malignant. The student coded the program using the data from previous skin lesion scans. This was accomplished by a form of backpropagation: the delta rule. The error of the weighted outputs gradually approached a global minimum on the error space graph's surface, guided by the student's inputs. The program was then analyzed by comparing the accuracy to other programs with established degrees of accuracy. Because the program correctly classified a group of lesions to a certain accuracy level, the program was deemed successful. There were no known risks in this project. Results were useful in helping determine the characteristics of lesions parameters that are indicative of a malignant lesion. Future developments may look into tracking the advancement of the lesion over time and providing tracing the perimeters of lesions. Research on this engineering project was guided and supervised by Dr. James Duncan from Yale University.

**Amity Regional High School
Teacher: Catherine Piscitelli**

Tischer, Aiden**Project #167**

Completed Project, Science, Physical Science

Effect of Damaging Plants on the Growth of Solanum Lycopersicum

Mycorrhizal networks were first discovered in 1885 but their relationship with plants were not understood until recently. Now researchers have studied mycorrhizal networks and found out that the mycorrhizal fungi have a symbiosis with plants; the plants give the fungi glucose and the fungi give the plants the ability to communicate to each other and trade resources. The purpose of this experiment is to study the effect cutting twenty percent of the leaves off a tomato plant has on the growth of the plant next to it. In this experiment twelve roma tomato plants will be used and grown from seed. There will be two plants per container and all of the plants will be grown on a south facing window with a grow light. After all the seeds germinate and the seedlings can be seen, mycorrhizal powder will be added to encourage mycorrhizal growth in the soil. After three weeks, twenty percent of the leaves will be cut off from one of the two plants in the container. This will be repeated for all the experimental plants. The plant next to the one that was damaged will be measure to see if there is a difference in growth or largest leaf size. After the experiment is finished the pots will be sanitized with a paper towel doused with rubbing alcohol and the dirt baked in a two hundred degree oven for ten minutes to sterilize. It is anticipated that the plant next to the damaged plant will grow shorter and have a smaller largest leaf size. This is because the damaged plant sent a signal through the mycorrhizal network for the non-damaged plant to slow growth and conserve energy.

Amity Regional High School
Teacher: Deborah Day

Tomaj, Marie Ann Project #168

Research Proposal, Science, Health and Medical

The effect of bilateral deep brain stimulation of the internal pallidus on dystonia

The basal ganglia is a structure found deep within the cerebral hemispheres which monitors speed of movements and unwanted movements. This project focuses on the effect of bilateral deep brain stimulation of the internal pallidus, a structure a part of the basal ganglia, in patients suffering from primary dystonia that is refractory to drug therapy. For the procedure to be successful, the patient must have favourable symptoms; primary dystonia, DYT1, tardive dystonia, normal. Before surgery, the patients will be asked permission and all patient records will be kept confidential. will then get a CT scan of their brain to have a comparison for after. After surgery, patients will, once again, get a CT scan of their brain 3 months and 6 months in order to see progress. To gain access for these scans, I would work with my mentor, who would take these scans and help me analyze and interpret them. The surgery should reduce the symptoms by slightly more than 50%, but experience will vary based on the patient as some get very little benefit. However, it is likely that patients with the DYT1 gene will experience the best average results. This project promotes awareness of a rare neurological disease and the effects that it has on the brain. It further investigates the effect of bilateral DBS on the internal pallidus which promises significant improvement mainly in disabling generalized and segmental dystonic symptoms.

Newtown High School
Teacher: Timothy DeJulio

Voellmicke, Isabel**Project #169**

Research Proposal, Science, Health and Medical

The Effects of Environmental Factors on Epigenetics and Autism

Autism is a common, complex disease that causes social and mental impairments. Given autism's complex etiology, causes are mostly unknown. Epigenetics, which primarily uses methyl markers to alter DNA without actually changing the genetic sequence, links environmental factors to genes. Environmental factor studies can be examined to find connections to certain epigenetic sites. Epigenetics has a reversible nature, so if certain autism-linked methylated sites are found, treatments can be created. For this study, a meta-analysis will be performed. Data from different studies examining valproate or folic acid intake during pregnancy will be compiled and investigated to see different effects these factors have on autistic patients. The data will also be searched for links between the changes these environmental factors induce and how these different factors create the autistic phenotype. The results will show the significant impact valproate and folic acid have on the epigenetics of the cells, as well as the autistic phenotype. These studies will show specific epigenetic sites that cause autism to occur based on these factors. Characteristics of autism can also be linked to those factors, helping to understand autism further. This research will help develop new, patient specific epigenetic treatment plans formulated around specific epigenetic factors. These could majorly reduce symptoms and raise autistic patients' quality of life. This would be an important step in helping treat the millions of autistic individuals worldwide, lessening the extent or possibly curing this severe condition. This could also lead to prevention, reducing the number of individuals diagnosed with autism.

Ridgefield High School
Teacher: Patrick Hughes

Vollmer, Ursula**Project #170**

Research Proposal, Science, Health and Medical

From Farm to Fork: Comparing the Level of Nutrients in Locally Grown versus Imported Produce

Each and every day, the food we choose to eat affects our overall well-being. The purpose of this study is to look at the science behind the produce we eat to determine if the location in which it grows affects nutrient levels. Currently, the majority of our produce is imported from Latin American countries. Though we can purchase anything from squash to raspberries all year long, do we really know what is happening when the food leaves the country of origin? This experiment will investigate if buying produce both locally and in season affects the nutrient levels in the produce, showcasing the importance of choosing locally grown food over internationally shipped food. Locally and internationally grown produce will be purchased. Liquid samples will be extracted from the produce and a refractometer will be used to determine the refractive index of the liquid. A Brix number that relates to the nutrient quality will be visible and compared to nutrient levels available in a standard refractive index of crop juices chart. It is expected that after testing, produce such as blueberries and green beans, will have higher Brix numbers when grown locally. This will be stronger than the lower numbers of produce grown internationally. This study will demonstrate the importance of choosing produce that is local to your area rather than from outside the United States. It will also be important to test other types of food, beyond produce. For example, meats, dairy, and fish would also be interesting to research. If the hypothesis of this project is supported, looking into these categories of food groups would be next, as well as determining how the levels of antioxidants are affected.

Sacred Heart Greenwich
Teacher: Mary Musolino

Wagner, Samantha**Project #171**

Research Proposal, Science, Health and Medical

Verbal and Memory Skills in Children with Spinal Muscular Atrophy

Spinal muscular atrophy (SMA) is caused from a loss of nerve cells in the spinal cord called motor neurons, and is one of the leading causes of childhood mortality, affecting between 1:6,000 and 1:10,000 births. There are 4 types of this disease, ranging from onset during the neonatal days to adulthood, and symptoms vary from muscle weakness to the deterioration of a child's ability to walk, eat, or breathe. This proposed research focuses on testing the cognitive ability of 25 children aged 6-14 years of age with Kugelberg-Welander disease (type 3 SMA). These children must have a healthy sibling within 5 years of age for comparison. The cognitive ability of these children will be assessed by evaluating language and verbal memory skills. To test language skills, seven subtests will be administered from the Clinical Evaluation of Language Fundamentals, 3rd edition (CELF-3). For verbal memory testing, the children will be administered the California Verbal Learning Test - Children's Version (CVLT-C). The CVLT-C will test the child's ability to learn and recall everyday verbal material. Additionally, short-term and long-term recall, recognition, learning strategies, and serial position effects will be measured. It is predicted that the SMA-affected children will have a display a slightly lower level of cognitive ability when compared to their sibling. This study is important because the results will help draw attention to the importance of developing cognitive skills in adolescents can help compensate for the many physical restrictions of SMA.

Darien High School
Teacher: Guy Pratt

Wang, Sophia**Project #172**

Completed Project, Engineering, Environmental

Real-Time Sinkhole Detection using Civil Engineering Techniques, the Internet of Things (IoT), and Artificial Intelligence

In the United States, 20% of land is susceptible to sinkholes. These cavities are capable of "swallowing" cars, infrastructures, and unsuspecting individuals. Designs derived from civil engineering (structural health monitoring system (SHMS), wireless sensor network (WSN), and the finite element method (FEM)) and computer science (the Internet of Things (IoT) and Artificial Intelligence/Machine Learning (ML)) are used to more accurately and efficiently detect sinkholes compared to current methods, which are inapplicable to the most dangerous sinkhole type (cover-collapse sinkhole) and are not practiced in real-time. SHMS and WSN were used to create a sensor network composed of accelerometers that can diagnose underground structural state in real time. IoT created a user-friendly interface for data access. ML algorithms were developed to analyze data in real-time. ML provided for system automation and eliminated false positive detections. The establishment of FEM allowed for a computer simulation of cover-collapse sinkholes. The FEM formation stages identified can be transferred to ML. To test the detection system, a cover-collapse sinkhole was physically modeled using karst geology. The sensors were placed in set locations prior to simulation, which were recorded on camera. The sensor data was recorded during simulation and was analyzed through ML (KNN, neural networks, etc.) This was compared to corresponding visual evidence of formation. A significant sinkhole detection period was secured in real time. Through advancement, these designs have the potential to not only reduce property damage, but more importantly, reduce the massive public health threat that sinkholes pose.

Amity Regional High School
Teacher: Deborah Day

Wang, Sienna

Project #173

Completed Project, Engineering, Physical Science

Synthesizing Water Using the Chemical Reaction of Aluminum and Sodium Hydroxide, Decomposition of Hydrogen Peroxide, and Wastewater Treatment with Membrane Bioreactors (MBR)

Water supplies are frequently strained by climate-based problems. A novel system is needed to synthesize water that is efficient and limits the cost to the environment. To synthesize water, the reaction of aluminum and sodium hydroxide can create hydrogen and sodium aluminate in the chemical reaction: $2\text{Al}_{(s)} + 6\text{NaOH}_{(aq)} \rightarrow 3\text{H}_{2(g)} + 2\text{Na}_3\text{AlO}_{3(aq)}$. The hydrogen created can be combusted with oxygen created in the decomposition of hydrogen peroxide ($2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2$) to synthesize water. This synthesized water can be used as potable water. The chemical reaction to create hydrogen creates the byproduct of sodium aluminate, which can be used for the removal of phosphorus in industrial wastewater plants. The wastewater can be again treated using a membrane bioreactor (MBR), which can be used for irrigation and reintroduces water to the environment. Testing was done using a multi-chambered model. The first chamber contained aluminum and sodium aluminate. The second chamber contained hydrogen peroxide. The third chamber contained produced hydrogen and oxygen. The chambers were connected through rubber hoses. This chamber contained a solar-powered heating system to start the reaction. The fourth chamber contained sodium aluminate, wastewater, and a MBR to clean the wastewater. This is a water synthesizing and filter system. The student designed and did all the aforementioned steps, including constructing the physical model, with help from mentor when attaining and dealing with chemicals. Being as this is a small scale model system, this project is a proof of concept.

Amity Regional High School
Teacher: Catherine Piscitelli

Wei, William

Project #174

Completed Project, Science, Physical Science

Effect of Airfoil Material on the Speed of Quadcopters

The airfoil is one of the most important part of a drone. It can impact the flight of drones. Many companies making and selling drones to companies or to individuals may not be using the optimal material for the speed of the drones. This experiment will compare three materials' impact on the speed of a ZeroTech Dobby Drone. The three materials will be ABS plastic, carbon fiber, and polycarbonate. The results of the experiment will help hobbyists, businesses and other groups of people to decide what material to use for their experiment. The experiment will be conducted by marking out a distance of 100 meters. Then a Canon EOS 5D Mark III will be set up perpendicular to the 100 meters, capturing both ends of the 100. Data will start to be recorded when the drone is flown through the camera frame. This will be done five times for each material. The time it takes for the drone to fly the distance will be calculated by counting the amount of frames it takes for the drone to fly from one point to the other. The speed will be calculated by dividing the distance (100 meters) over time. It is hypothesized that the polycarbonate propellers will be able to reach the highest speed. This is because polycarbonate is the hardest material of the three so it won't flex when flying meaning it will be able to produce the most speed.

Amity Regional High School
Teacher: Deborah Day

Wheeler, Angelique

Project #175

Research Proposal, Engineering, Physical Science

Using Transforming Materials and Kirigami to Develop Improved Shelters

There is a desperate need for stable, portable and personal shelters for displaced populations. In this study, shelters constructed from combinations of plastic transforming materials and kirigami will be tested to see how the shelters will perform under pressure. It is hypothesized that the shelter built with a kirigami roof and transforming materials body will withstand the most pressure before buckling. This experiment aims to test the effectiveness of four building methods regarding the pressure withstood by the shelter when applied to predetermined points. This experiment aims to provide a baseline of pressure measurements able to be withstood by the kirigami plastic and the transforming materials. The shelters would be built according to the design plan laid out in this proposal. A test of the pressure withstood before buckling would then be conducted. It is expected that the results will show that the shelter made solely from transforming materials will withstand the most pressure, thereby differing from the initial hypothesis. The transforming materials will likely withstand significantly more pressure than the kirigami shelter. This study will reveal which material is the best for building shelters in order to design the most stable and portable shelter. This research could be used to show the feasibility of manufacturing shelters using transforming materials and kirigami techniques. These shelters could provide stable and portable homes for use in disaster relief, refugee crises, and homelessness. This research could lead to further studies concerning the use of the shelters and the impact in potentially decreasing homelessness.

Sacred Heart Greenwich
Teacher: Mary Musolino

Wijesekera, Adithi

Project #176

Completed Project, Science, Health and Medical

The Effect the Temperature of an Allergen Has on Its pH Levels

Fifteen million Americans suffer from a food allergy that impairs their daily life. However, in China, allergies are not as common. Foreign countries tend to cook nuts with other substances and liquids in foreign foods alter the pH and, therefore, change the effect on a person. This experiment will determine if the temperature of an allergen can impact its pH. It is hypothesized that there will be a difference in the pH of the allergens after heating them. Three allergens: almonds, peanuts, and cashews will be used and stored at 70 . The chosen nut will be placed in a blender accompanied by water with a pH of 7. Then, the pH of the mixture will be calculated with a pH meter. Next, each allergen batch will be placed in the oven at three temperatures: 100 , 200 , and 300 . After baking, the batch will cool down. Next, the blending process will repeat. Then, the pH level of this substance will be calculated. This procedure will be repeated three times for every allergen. The expected outcome is that temperature will have an effect on the pH of the allergen. Once obtained, the results will be displayed on a bar graph to show correlation between the temperature change and the pH of the nut. The results gathered can help people suffering from nut allergies; doctors may now instruct patients to consume some nuts differently.

Amity Regional High School
Teacher: Deborah Day

Wilkenloh, Kelsi**Project #177**

Research Proposal, Science, Environmental

Proposed research on Scio Spectrometer recording amounts of nutrients connected to climate change

Soil holds more carbon than the atmosphere and plants combined. If soil isn't protected, then it will not obtain certain nutrients and it will continue to release carbon into the atmosphere, and climate change will continue to increase. By testing how many nutrients are in the soil, and how climate interacts with this, it is clear which soils are protected and which need to be better preserved. To set up what is called a climosequence, a set of soils that differ only by some climate properties, then test how less nutrients are in areas with greater climate change. Then, investigate how climate affects the distribution of certain soil nutrients, and evaluate that nutrient from the soil using a Scio spectrometer. The concentration of this nutrient would be compared against temperature, precipitation or some sort of weather condition. The results are expected to show that an increase in carbon dioxide levels in the atmosphere will increase plant growth and more organic matter could potentially be added to the soil. If the soil isn't healthy and does not contain nutrients, then it will release carbon into the air and increase climate change. The findings of this experiment could be used to support movements to increase public awareness, and encourage action to plant more plants and improve overall soil health. Although it is only a subset of a larger issue, it is important to keep soil healthy so climate change doesn't continue to worsen.

Ridgefield High School
Teacher: Ryan Gleason

Williams, Emma**Project #178**

Research Proposal, Science, Health and Medical

Prevalence, Age at Onset, and Risk Factors of Self-Reported Asthma Among American Adolescent Elite Skiers

Asthma is a chronic, pulmonary condition characterized by inflammation of the airways. Athletes have a high risk of developing asthma, due to triggers like cold air and exercise. This proposal investigates how the amount of activity affects the prevalence and age at onset of asthma. It is expected that the prevalence of asthma and age at onset of asthma will be higher in the skier population than the reference group. This experiment requires around 250 skiers and non skiers. Participants will receive a questionnaire based on European Community Respiratory Health Survey II, which includes ,“yes or no,“ questions on smoking, asthma, medication, symptoms, age of first attack, nasal allergy, family history, and exercise. After data is collected, binary logistic regression will be performed. The results are predicted to support the hypothesis and show the prevalence and the age at onset of asthma to be higher in skiers than in non-skiers. Additionally, the results are hypothesized to show that nasal allergy, female sex, and family history are all independently associated with asthma. This research is crucial for determining risk factors for the development of asthma in athletes. Additionally, this research may provide a solution for the large number of false diagnoses of asthma in athletes. These findings will help to identify risk factors for asthma not only in athletes, but also in non-athletes, helping the 300 million people who suffer from this disease.

Darien High School
Teacher: Christine Leventhal

Wirth, Martin**Project #179**

Research Proposal, Science, Environmental

Eliminating Greenhouse Gasses Through Ecosystem Management

An excess of carbon dioxide has been released into the atmosphere from man made sources. Recently ecosystem management has been offered as a method of carbon sequestration. Ecosystems have the ability to increase their carbon sequestration rates when new species, with more efficient carbon absorption rates, are introduced by man. These species typically come in the form of marine organisms. The experiment would be performed by creating a closed system around a certain plant. CO₂ would then be added. The gas levels and proportion would be checked regularly to find the species that best absorbs CO₂, and has been found to best promote biodiversity. It is expected that marine, marsh, and swamp plants will be proven to be the most effective organisms for increased carbon sequestration within an ecosystem. Sea grasses and Mangroves will be the most effective at absorbing large amounts of CO₂ and storing them. If these results are correct, marine organisms could be introduced into new ecosystems or increased in their current ecosystems in order to allow for a decrease in the carbon dioxide in the atmosphere, and as a result, the effects of climate change on the earth.

Ridgefield High School

Teacher: Patrick Hughes

Wolters, Quin**Project #180**

Research Proposal, Science, Health and Medical

A Study of the Effect of Cognitive Reserve on Success of the SAGE Test

A relatively new concept, Cognitive Reserve (CR), tests the mind's resilience to pathological damage to the brain. The method by which Cognitive Reserve can be properly assessed is vague, with studies focused on factors related to lifestyle such as occupation, years of education, and amount of consistent stimulation to the brain throughout one's life. The amount of gray matter versus white matter density in one's brain is thought to also contribute to the level of CR. Studies show that people who have a high Cognitive Reserve will develop symptoms of neurodegeneration much later than those with a low Cognitive Reserve. In this study, the CR of 300 people, aged 65 years or older will be determined along with their level of cognitive impairment. Their level of cognitive impairment will be assessed by the SAGE Test. The Self-Administered Gerocognitive Exam (SAGE) was developed by researchers at Ohio State University and is designed to detect early signs of cognitive, memory, or thinking impairments. The Cognitive Reserve of each subject will be determined by a composite score relating to their type of occupation and the number of years of education that person has completed. It is expected that subjects who score higher on the SAGE test will also have a higher cognitive reserve than those with a lower score. Positive results can influence neurodegeneration research towards explaining the wide heterogeneity of these diseases and how it can manifest itself in each individual.

Darien High School

Teacher: David Lewis

Yin, Verna

Project #181

Completed Project, Science, Environmental

Filtration of Heavy Metal and Nitrate Pollutants from Drinking Water with Used Coffee Grounds Embedded in Discarded Polyurethane Sponges

Contamination of water, particularly by nitrates and heavy metals, highlights the need for an easy-to-fabricate, low-cost, and rapid filtration device. Simultaneously, the new PUF-C sponge was examined for nitrate contaminant removal in water. Groundwater and drinking water with nitrates often contain 10-30ppm nitrates. In this research, a new polyurethane-coffee sponge (PUF-C) ,“filter,“ was engineered via the combination of a used polyurethane sponge, 2g spent coffee grinds, and 4g of phenol stabilizer. To increase particle contact, the bottom of the syringe holder was lined with a layer of qualitative filter paper and analyzed for nitrate removal. Produced only with physical mixing and low temperature heating easily produced in field, the filter can rapidly (in minutes) remediate at least 1 Liter of 1000 ppb Pb-contaminated water to ~14 ppb (below the Pb EPA water action level), creating colorless, potable water, that is free of coffee, phenol, or sponge contamination. This corresponds to a removal efficiency of 33µg-Pb/gram of PUF-C filter, or 1.4mg-Pb/gram of incorporated coffee grinds removed. Re-filtration reduced the Pb content to near negligible amounts (2.0 ppb), with three additional passes through the filter. In all cases tested, results show that the PUF-C filter can produce potable drinking water (>10ppm EPA MCL) in one pass through the filter with 80% nitrate removal with each pass. In the final proposed design, a 3cm³ PUF-C sponge filter can be created by the consumer in only 1 hour, without sophisticated laboratory equipment, at a cost of ~25¢ per device.

Greenwich High School
Teacher: Andrew Bramante

Yoo, Olivia

Project #182

Completed Project, Science, Health and Medical

Angiotensin-II Hypertension Enhances Morphological Alterations of Tight Junctions

The blood-brain barrier is a key structure that protects the brain from pathogens and toxins. The brain is a major target of hypertension, which affects 75 million adults in the United States. Previous studies indicate that elevated blood pressure induces structural alterations of blood vessels, which compromise the blood flow to the brain and increase the risk of stroke and dementia. Further research is necessary to better understand the mechanisms by which hypertension induces these severe effects, so therapy and treatment can be developed. In an effort to discover how hypertension affects the blood-brain barrier, this study investigates the effects of angiotensin-II hypertension on the morphology of cerebral blood vessels and the tight junctions between endothelial cells which compromise the blood-brain barrier. It was hypothesized that hypertension would not affect blood vessel size and area, but decrease tight junction length and tortuosity, reducing the efficacy of the blood-brain barrier. This study examined eight C57BL6/J mice, four with slow-pressor angiotensin-II hypertension. Blood pressure was monitored in all mice for fourteen days, then brain tissue was processed and examined using transmission electron microscopy. Blood vessel size, area, and tight junction length and tortuosity were measured. Blood vessel measurements in hypertensive mice was not significantly different from normotensive mice. Tortuosity of the tight junctions was significantly decreased in hypertensive mice, suggesting that the functioning of the blood-brain barrier in hypertension is impaired because simple tight junctions are prone to leakage. Thus, hypertension is likely involved in the decline in blood-brain barrier function.

Darien High School
Teacher: David Lewis

You, Victor

Project #183

Completed Project, Science, Environmental

The Effect of Surface Oxygen Concentration of Multi-Walled Carbon Nanotubes on their Aggregation Behavior

Carbon nanotubes (CNT), cylinders of layers of graphene, are increasingly important in emerging technologies. CNTs have a wide range of uses, including in battery and water treatment technology, due to its unique properties, such as its conductivity, small size, and strength. However, the aggregation behavior of these nanotubes when in the natural environment is unknown. Studies have shown that aggregate size impacts toxicity, making studying CNT aggregation behavior very important. Multi-walled carbon nanotubes (MWCNTs) of similar length, but variable surface oxidation, were synthesized prior to this project. Solutions of natural organic matter (NOM) with varying salt concentrations and deionized water with varying salt concentrations were made to induce aggregation. Dynamic Light Scattering was used to measure the MWCNT aggregate size. The data was used to determine aggregate growth rates, which was then used to estimate critical coagulation concentration (CCC) values.

The results of this experiment confirm that an increase in salt concentration increases CNT aggregation until the CCC is reached. It also confirms that NOM reduces the amount of salt needed to reach the CCC, or maximum aggregation rate. In addition, this experiment demonstrates how a lower surface oxygen concentration leads to a decrease in CCC, due to a lower initial surface charge. These results show how different factors affect MWCNT aggregation behavior. This experiment can help manufacturers and material scientists better understand the environmental impacts of MWCNT and aid scientists and engineers in material selection, allowing them to choose materials that, when released to the environment, cause less harm.

Amity Regional High School
Teacher: Laura Roessler

Zafar, Baasim

Lee, Sean

Project #184

Completed Project, Science, Health and Medical

Cancer Targeting and Biologically Compatible NMR Molecular Imaging Probes

Nuclear magnetic resonance (NMR) is a method to obtain information about the structure and dynamics of molecules. Since these molecules have important cellular functions, probing them can provide insights about the cell's status. NMR methods keep being reinvented to probe nature for biomedical advancements. Four parts to the NMR experiments being conducted are essential, the spin system of the sample, polarizing the sample by exposing it to a high magnetic field, excite the system with exposure to radiation, and then detect what is being emitted. Our project will involve working with a high magnetic field that will be used to process and interpret NMR data. Specifically, the project will involve development and characterization of NMR probes using a method called Biosensor Imaging of Redundant Deviation in Shifts (BIRDS). Both of our studies will be conducted by placing samples into an NMR spectrometer. Fourier transform (Ft) models will be provided by ,“Topspin,“ , computer software linked to the machine. These areas will require interpretation of non-NMR results that characterize the shape of the nano-structure of the NMR probe. To collect data, the chemical shifts of the samples being tested will be used to design an optimal NMR probe. The chemical shift data will be collected through multiple analyses of the Ft models provided by the numerous experiments being conducted. The information obtained from these focuses will contribute to broader research regarding novel NMR probes and their effect on the physiology and chemistry of biological tissue.

Amity Regional High School
Teacher: Deborah Day

Zhang, Mason

Project #185

Completed Project, Science, Environmental

The Effect of Roads on Reproductive Success of Wood Frog Populations through the Swimming Velocity of Spermatozoa

Roads cover more than 64 million kilometers of the Earth's surface, and with these expansive systems come great environmental ramifications. Many ecosystems are being negatively impacted by roads which let out a plethora of harmful contaminants. In the United States, populations of amphibians are declining at a yearly rate of 3.7 percent, according to the U.S. Geological Survey. Meanwhile, sperm competition, as measured through velocity, is a crucial part in reproduction. The focus of this experiment is to investigate how roads impact wood frog fertility, determined through swimming velocity of spermatozoa. The independent variable is the location of the pond, which is either roadside or woodland. The dependent variable is the kinetics of sperm defined by average path (VCL), average motion (VSL), and average trajectory (VAP). It is hypothesized that roadside wood frogs have less potency, thus slower swimming velocity, compared to woodland ones. All samples were obtained from adult male frogs in 10 ponds, 5 near roads and 5 in relatively secluded woodlands, in the northeastern Connecticut Yale-Myers Forest. Overall, 47 samples were collected following IACUC protocol. Data will be analyzed with the programming language R. Preliminary results show that the data of roadside and woodland frogs are in similar ranges, but that there are subtle differences. This project aims to provide insights on how reproductive ability of wood frogs are affected by roads, and how that might be a factor in amphibian population growth and decline.

Amity Regional High School
Teacher: Deborah Day

Zhang, Ethan

Project #186

Research Proposal, Science, Health and Medical

The Association between Epidermal Growth Factor Receptor (EGFR) Gene Polymorphisms and Lung Cancer Risk

Each year, 1.3 million people worldwide die as a result of lung cancer. When fully developed, the disease spreads to surrounding organs, eventually filling the body with dormant tumors. By using genetic markers, such as EGFR (Epidermal Growth Factor Receptor), doctors can identify lung cancer earlier and with more certainty, leading to earlier and more effective treatment. However, in order to accurately predict one's risk of lung cancer, a definite relationship must be established between certain polymorphisms, different forms of a certain gene, of EGFR and prognosis of lung cancer. In this experiment, 4mL of blood from mice will be genotyped for the presence of rs712829, rs712830, rs2072454, and rs11543848. A sample of 400 mice of each polymorphism will be selected, and examined for tumors in the lung. All of these polymorphisms will be strongly correlated with lung cancer, because of the key role it plays in cell differentiation and proliferation. When polymorphisms that cause defects to this important receptor are present, the cell's ability to differentiate and proliferate will be impaired, thus leading to a high risk of cancer. By using mice instead of humans, more accurate data can be produced because more of them can be used. As stated, a definite relationship between genetic markers and the presence of lung cancer will open new doors in the vast realm of biomedical research, another step towards the ultimate goal of defeating cancer.

Darien High School
Teacher: Christine Leventhal

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

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

Darien High School
Teacher: David Lewis

The Effect of Various Nutritional Sources on Trout

I chose to start this problem because I love fish, trout especially. Trout are a species that have a very large involvement sustainability and are a largely farmed fish. While conducting this experiment I hope to learn more about how we can use trout for sustainability, as well as how the nutritional sources affect how the trout developed. To start this experiment I would like to raise Rainbow Trout, Brown Trout, and Brook trout from eggs to adults. Through their life cycle I would like to see the effects of different food sources on how they react behaviorally and how the different food sources effect coloration. These food sources would include typical trout feed pellets, as well as flies, snails, and other freshwater crustaceans. I have yet collect any data. However when I do get to that stage in my project I would hope to find I clear difference in the various nutritional sources. For example I hope to find that there is a clear correlation between between the food source and how it affects physical attributes and behavior. Conducting this experiment can help give a better understanding of how proteins effect coloration based on various nutritional sources. This experiment also gives a insight into sustainability and how farming trout can be a sustainable food source.

Newtown High School
Teacher: Tim DeJulio