



MAY 3, 2019



70TH ANNUAL MASSACHUSETTS HIGH SCHOOL DIVISION
SCIENCE & ENGINEERING FAIR

OFFICIAL PROGRAM AND ABSTRACT BOOK



Mark, Atopic Dermatitis, Denmark

FOCUSED ON DEVELOPING SPECIALTY TREATMENTS

for debilitating diseases that are often difficult to diagnose and treat, providing hope to patients and their families.

Conratulations to all of this year's MSSEF participants!

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SANOFI GENZYME

**2019
MASSACHUSETTS
SCIENCE & ENGINEERING
FAIR**

Official Program & Abstract Book

May 2 - 4, 2019

CELEBRATING MSEF'S 70TH ANNIVERSARY!

YOU INSPIRE US

2019 Massachusetts Science &
Engineering Fair

Fish is proud to
support STEM
learning and the
Massachusetts
Science and
Engineering Fair.



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10**

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**TOP
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Best Colleges for Women
in STEM fields
Best Colleges Online

**TOP
50**

Most Innovative
Schools
U.S. News & World Report



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Massachusetts Science & Engineering Fair

SCHEDULE OF EVENTS

May 2 – 4, 2019

While most of the events are for science fair students, please note special programs () for Science Educators, Judges and Parents, plus individual events, where everyone is welcome.*

Thursday, May 2, 2019

Advance Student Registration & Set-up 4:00 – 7:00 pm
Johnson Athletics Center

Friday, May 3, 2019

Student Registration, Project Set-Up, 7:30 – 8:30 am
Safety Inspections/Final Approval, Exhibitor Photos
Johnson Athletics Center

MSEF Educator Day 8:30 – 1:30 pm
Open to all STEM Educators
Stratton Student Center/Twenty Chimneys Room

Judge Orientation Program & Project Assignments 10:30 am
Kresge Auditorium
Judge Access to Student Exhibits begins after 11:30 am

Student Lunch in Exhibit Hall 11:00 – 11:15am
Lunch provided for students

Science Fair Kick-Off & Welcoming Remarks 11:15 – 11:30am

Judging of Exhibits
For Judges Only: *(Lunch 12:45-2:30 pm)* **JUDGES ONLY** 11:30 – 4:00pm
For Students Only **STUDENTS ONLY** 11:30 -- 6:00pm

MasterMind Challenge, Student Networking & Social Event 4:00 - 6:00 pm
Led by Symantec engineers & MSEF Volunteers!
Stratton Student Center/Lobdell Dining Area
STUDENTS MUST REMAIN UNTIL 6 PM when all judge score sheets have been received

Saturday, May 4, 2019

Tours of the MIT Campus* 8:30– 10:15 am

Career Opportunities Program* 10:15 – 12 noon
Stratton Student Center – Mezzanine Lounge
Students must return to Johnson Athletic Center no later than 12:30 pm

Public Showcase of Exhibits & STEM Expo* 12:30 – 3:00 pm
Johnson Athletics Center
Parking may be difficult due to special MIT campus activities.

Award Recognition Ceremony* 3:30 – 5:30 pm
Kresge Auditorium

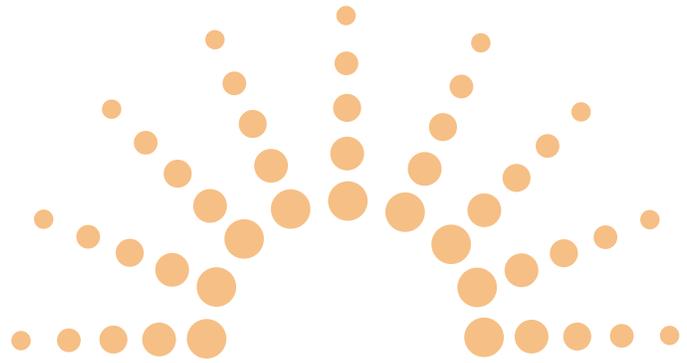
Closing 5:30 – 6:30 pm

2019 SCIENCE FAIR STEM EXPO

Featuring Major MSEF Sponsors & Partners

Sat, May 4 12:30 – 3 pm

Johnson Athletics Center



One of the nation's first STEM education providers and now a national model, MSEF celebrates 70 years of success. Through the years, your support has allowed MSEF to:

- Advance **science literacy** for close to a million young students
- Issue over **67 patent awards** for high school students with pro-bono guidance and services
- Engage **36,000 volunteer STEM professionals** as role models, judges and advisors
- Award **\$20 million in scholarships, internships and prizes**
- Support hundreds of **disadvantaged youth and high-needs communities** through special initiatives
 - Inspire and mentor seven **generations of science & engineering leaders**



MSEF and science fairs had a profound impact on my life. Exploration, discovery, curiosity, presenting complex ideas, and an appreciation for questioning and redefining boundaries. These formative experiences laid the foundation for pursuits and opportunities in neuroscience, healthcare, technology, and finance that once seemed impossible to a kid from a small town.”

— MSEF Alumnus



2019 Massachusetts Science & Engineering Fair!

CELEBRATING 70 YEARS OF STUDENT RESEARCH & INNOVATION

Special Message to Students, Teachers, Parents, Mentors, Alumni & Sponsors

Today's science fair program is about tomorrow's innovators. Each year, MSEF partners with over 200 Massachusetts schools so they can give their students the rare opportunity to be investigators and problem-solvers on a real-world topic of their own choosing.

Why MSEF programs matter so much to all of our futures!

Through MSEF, students "learn through doing and discovery," a process that enables them to think like scientists, using real-world practices with hands-on projects. Motivated by the potential of solving today's big challenges and learning something new, students use the practices of scientists and engineers to explore a topic in depth, raise new questions and apply innovative approaches. In MSEF, young students are helping to cure diseases, clean up the planet and fix common "everyday problems."

Now in our 70th year, MSEF programs reach over 70,000 students each year, providing extra support for schools in high-needs districts. Through the Curious Minds Initiative (CMI), MSEF is realizing its goal to bring its program of authentic student research & innovation to every high school and middle school in the state: 57% of "CMI Schools" are in high-needs districts, 93% are public schools.

To all of our donors, sponsors and volunteers (judges, educators & mentors) today and throughout the last seven decades, thank you! Together, we will continue to build a world-class innovation workforce and a brighter future for Massachusetts and our nation. Our success is a credit to your generosity. We are proud to offer MSEF programs at no cost to children or schools.

To all, we extend a warm welcome to the 2019 Massachusetts Science & Engineering Fair, and special congratulations to all of the high school students who are this year's participants!

Sincerely,

Rishi Shukla
Chair of the Board

Cora Beth Abel
President & CEO

William F. Rigney
Chair, High School Committee

THE MSEF VISION

Imagine a future where every child is inspired and guided to realize their dream to help make the world a better place. MSEF programs help teachers to unleash each child's potential -- to develop the skills and confidence needed to thrive in a future not yet understood or even imagined.



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CHARLES D. BAKER
GOVERNOR

KARYN E. POLITO
LIEUTENANT GOVERNOR

May 2019

Dear 2019 Science Fair Students,

On behalf of the Commonwealth of Massachusetts, Lieutenant Governor Karyn Polito and I would like to congratulate each and every high school student who has earned a place in the 2019 Massachusetts Science & Engineering Fair (MSEF). We commend you for your innovative ideas, your diligence and your passion for science and technology.

Now in its 70th year as a national academic leader, MSEF programs attract the “best and the brightest” to pursue careers in Science, Technology, Engineering, and Math (STEM), opening pathways and providing scholarships to the nation’s best colleges, many of which are right here in Massachusetts. Advocating and supporting high quality STEM Education is an important priority for Massachusetts, and MSEF will be a critical partner in helping us reach this goal.

We extend our congratulations to MSEF and the sponsors and partners who support it, including the many Massachusetts companies that are leaders in the science and technology sectors and our institutions of higher education, including the University of Massachusetts network. Lieutenant Governor Polito and I are grateful for the 70 years of service and contributions MSEF has made to the Commonwealth and are proud of this great milestone.

Thank you for all that you do and best of luck to all of the 2019 Science Fair participants! By investing in STEM education we are not only investing in our children, but in our future as a Commonwealth. It is important that we all continue to work together to encourage more students to pursue careers in STEM fields and to provide them with the tools and resources they need to become the successful leaders of tomorrow.

Sincerely,

Handwritten signature of Charles D. Baker in blue ink.

CHARLES D. BAKER
GOVERNOR

Handwritten signature of Karyn E. Polito in blue ink.

KARYN E. POLITO
LIEUTENANT GOVERNOR



The Patent Award Winners – 2002-2018

Fish & Richardson, a Boston-based leading global law firm practicing in intellectual property, litigation, and corporate law internationally, introduced their Patent Award in 2002. Presented each year to the two science projects deemed “most patentable”, these awards are given without regard to placement results, and all MSEF entrants are eligible for consideration. These awards consist of the legal services to prepare and file an application to request a patent, prosecuting the application or responding to any questions that the patent office may have as it reviews the application.

2002 Marian Chaffe

Mass. Academy of Math & Science

2003 Sarah Rich

Mass. Academy of Math & Science

Jose Flores, James Giadone & Jason Robichaud

Leominster High School

Shahriar Khan

North Attleboro High School

2004 Meghan Gibson

Bishop Feehan High School

Herbert Hedberg

North Attleboro High School

2005 George Byram, Brad

Garvey & Carolyn Purington

Mass. Academy of Math & Science

2006 Alexander Isakov &

Nicholas Hunter-Jones

Lincoln-Sudbury Reg. H. S.

2006 Laura Castrale, Becky

Smith & Todd Volkman

Pittsfield High School

2007 Mark Buckler

Hamilton-Wenham Regional H. S.

2007 Jamie Dickhaus, Molly Sullivan & Caitlin White

Pittsfield High School

2008 Shawn Onessimo &

William Overstreet

Lowell Catholic High School

Mary Lucia Hedberg

North Attleboro High School

2009 Benjamin Davidson

Mass. Academy of Math & Science

Jackie Boino & Kalee Carmel

Pittsfield High School

2010 John Hinkel III

Hopkinton High School

Kenneth Cottrell

The Engineering School, Boston

2011 Ricky Housley

Boston University Academy

Erica Budina

Medford High School

2012 Anish Athalye

Mass. Academy of Math & Science

Dhroova Aiyam

Mass. Academy of Math & Science

2013 Kevin Song

Lexington High School

Paul Troy

Worcester Technical High School

2014 Allison Coomber

Mass. Academy of Math & Science

Amol Punjabi

Advanced Math & Science Academy

2015 Tyler Ethier

Berkshire Arts & Technology Charter

School

Christopher Aring

Martha's Vineyard Regional H. S.

2016 James Magnasco

East Boston High School

Daniel Gaines & David Webster

Martha's Vineyard Regional H. S.

2017 Indumathi Prakash

Sharon High School

John Ta

Mass. Academy of Math & Science

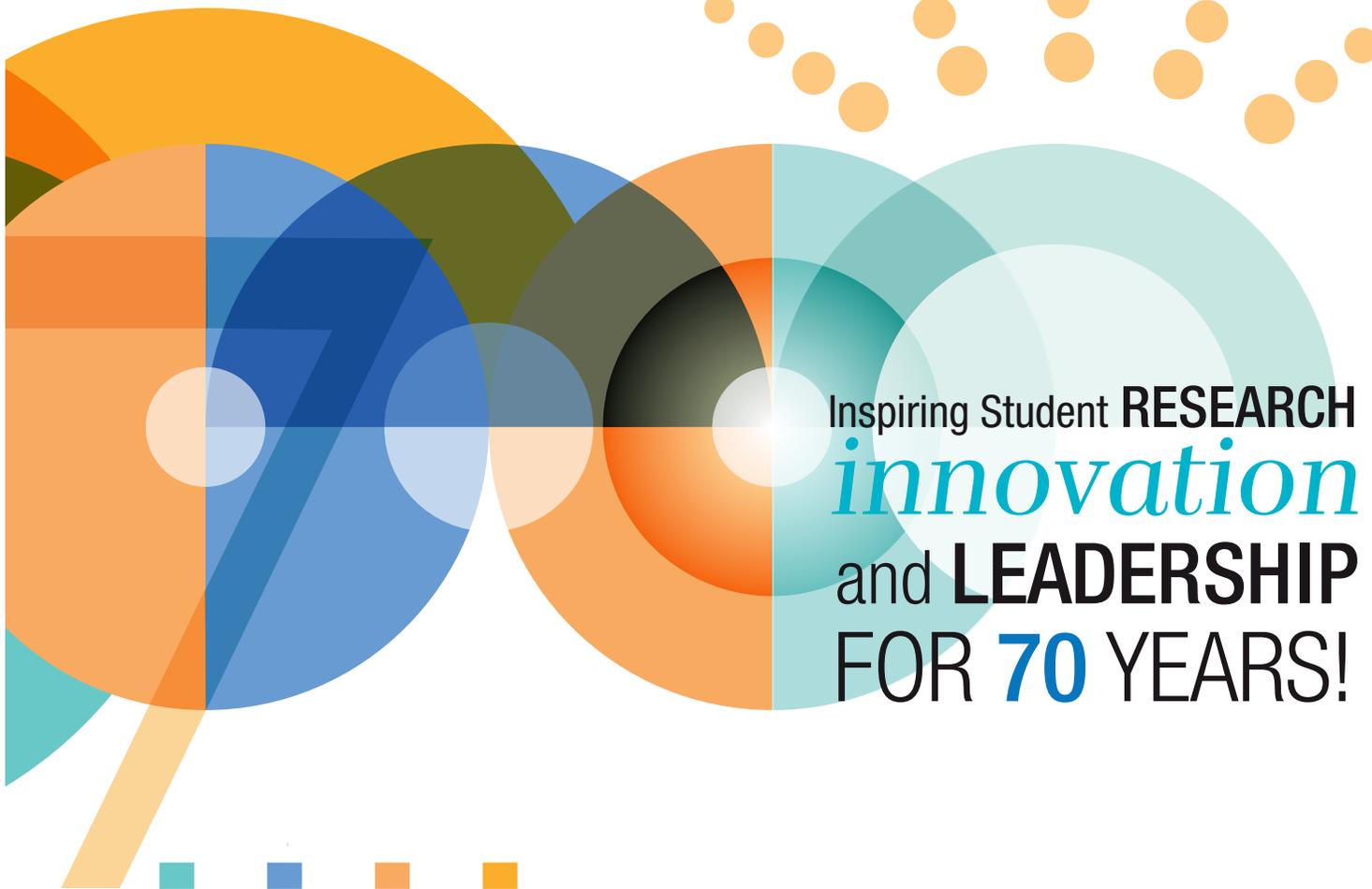
2018 Charlie Fenske

Falmouth Academy

Jack Adiletta

Worcester Academy





70TH ANNUAL MASSACHUSETTS HIGH SCHOOL DIVISION
SCIENCE & ENGINEERING FAIR

SALUTING OUR 2019

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As a leading specialty chemicals and performance materials company, we strive to be the most innovative, respected and responsible leader in our markets – delivering performance that makes a difference. Our commitment to sustainability extends beyond our manufacturing facilities as we look to make a positive and lasting difference in our communities. Our philanthropic emphasis on science, technology, engineering and mathematics (STEM) education programs is a vital part of this commitment. We are passionate about providing opportunities to today's young people who will join us in solving the challenges of tomorrow.



Sanofi Genzyme has developed a strategic giving program to support science education, access to healthcare, and other unmet needs in communities where Sanofi Genzyme has a significant business presence. From promoting basic science to raising awareness of the biotechnology industry, Sanofi Genzyme strongly supports programs that help build excitement and enthusiasm about science education. We are also committed to promoting better understanding of health issues and to increasing the accessibility of health programs.



Founded in 1878, Fish & Richardson is a leading global intellectual property law firm unlike any other in the world. Fish is one of the largest practicing patent prosecution, IP strategy and counseling, and IP litigation firms, trusted by the world's most innovative brands and influential technology leaders. As a law firm that has helped great innovators and entrepreneurs protect their intellectual property, we have a keen interest in promoting science education, and look forward to working with the next century of great innovators.



For more than a decade, STEM Synergy has worked in global locations to inspire and engage school-aged children with an education in Science, Technology, Engineering, and Math. Early exposure to STEM subjects empowers learners to choose careers in innovation and technology, paving the way to a sustainably brighter future.
www.StemSynergy.org

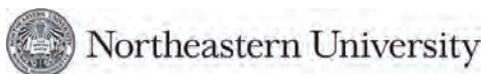
LINDE FAMILY FOUNDATION



UMASS Boston is pleased to award the **Chancellor's Scholarship in STEM** to an outstanding high school researcher in the 2018 MA Science & Engineering Fair. This science fair winner will have the opportunity to study science or engineering in the University of Massachusetts Boston College of Science and Mathematics, School for the Environment, or College of Nursing and Health Sciences. 2018 is a special year – the scholarship winner can live, learn and study in the residence complex coming in fall 2018! Plus there is the opportunity to join the Honors College for access to many interdisciplinary courses. The UMASS Boston campus is located on a beautiful waterfront, just minutes from downtown Boston, which gives students prime access to research, internships, clinicals and employment opportunities. We wish success to all the science fair students, and look forward to welcoming the prize winner of the UMass Boston Chancellor's Scholarship! www.umb.edu



Founded in 1947 in North Andover, MA, Merrimack College is a private Augustinian Catholic college home to over 3,400 undergraduate and 650 graduate students. Merrimack is the second largest Catholic college in Massachusetts and offers over 100 academic programs in science and engineering, liberal arts, business, and education and social policy. Merrimack has a close-knit community dedicated to the success of each student through an innovative learning environment complete with highly engaging hands-on learning and career preparation opportunities.



Founded in 1865 in Worcester, Mass., WPI is one of the nation's first engineering and technology universities. Its 14 academic departments offer more than 50 undergraduate and graduate degree programs in science, engineering, technology, business, the social sciences, and the humanities and arts, leading to bachelor's, master's and doctoral degrees. WPI's talented faculty work with students on interdisciplinary research that seeks solutions to important and socially relevant problems in fields as diverse as the life sciences and bioengineering, energy, information security, materials processing, and robotics. Students also have the opportunity to make a difference to communities and organizations around the world through the university's innovative Global Perspective Program. There are more than 40 WPI project centers throughout the Americas, Africa, Asia-Pacific, and Europe.

Founded in 1898, Northeastern University is a private research university located in the heart of Boston. Northeastern is a leader in worldwide experiential learning, urban engagement, and interdisciplinary research that meets global and societal needs. Our broad mix of experience-based education programs—our signature cooperative education program, as well as student research, service learning, and global learning—build the connections that enable students to transform their lives. The University offers a comprehensive range of undergraduate and graduate programs leading to degrees through the doctorate in six undergraduate colleges, eight graduate schools, and two part-time divisions.

• S U S T A I N I N G •



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• IN APPRECIATION •

We are grateful to our supporters – companies, universities, foundations, individuals and professional organizations, for their help over the past 70 years in advancing inquiry-based learning and science fair programs throughout Massachusetts.

Generous contributions from our sponsors enable us to invest in our schools, communities and children. Working together, we will continue to inspire future generations of science and engineering leaders, build science literacy for all students, and open pathways to college and new careers for students in high-needs communities.

Massachusetts Science & Engineering Fair, Inc. (MSEF) is incorporated in the Commonwealth of Massachusetts as a not-for-profit corporation and is a Federal tax-exempt organization under Federal law 501c(3). Federal Tax Exempt Number: 04-2707499



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Massachusetts Science & Engineering Fair

INTERNATIONAL SCIENCE & ENGINEERING FAIR

Hats off to the 2019 Massachusetts Delegates!

The 2019 Massachusetts delegates to the Intel International Science and Engineering Fair (ISEF) will be introduced at the Award Recognition Ceremony on May 4. The 2019 International Fair will be held in Phoenix from May 12-17.

The MSEF delegation is comprised of the top winners from each of the six regional fairs held in March. A total of 20 students and 4 chaperones will be travelling to ISEF this year.

The International Science and Engineering Fair, the world's largest international pre-college science competition, annually provides a forum for more than 1,800 high school students from over 75 countries to showcase their independent research. Today, millions of students (grades 9-12) worldwide compete in local and school-sponsored science fairs; the winners of these events go on to participate in Intel ISEF-affiliated regional and state fairs from which the best win the opportunity to attend the Intel ISEF. Intel ISEF unites these top young scientific minds, showcasing their talent on an international stage, enabling them to submit their work to judging by doctoral level scientists—and providing the opportunity to compete for nearly \$4 million in prizes and scholarships.

We wish to thank the INTEL Foundation and our other generous sponsors for their support of our Massachusetts/ISEF Delegation. We salute our full delegation, including the chaperones, and extend our best wishes to all for much success and pleasure at the 2019 "International".



INSPIRING THE NEXT GENERATION OF INNOVATORS

Intel is proud to be a sponsor of the 2019 Massachusetts State Science and Engineering Fair.

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Congratulations and Best Wishes to the Massachusetts Delegates at the 2019 INTEL International Science and Engineering Fair

Good Luck in Phoenix!





TEACHERS SCHOOLS DISTRICT PARTNERSHIPS

The “Curious Minds” Initiative (CMI)

Support for every school to offer MSEF’s Young Researchers & Innovators program with a focus on children in high-needs districts.

We created CMI to help schools and STEM teachers that aren’t ready to participate in MSEF programs because of lack of skills and/or funding. Our \$3M Curious Minds Initiative is a national-model program with an important goal: to enable every Massachusetts school to engage students in independent research and inventions. CMI focuses on underserved communities and impacts 46,000 students each year. CMI components are designed to work synergistically:

TEACHERS: STEM Professional Development to help teachers change the way they teach, so they can inspire and prepare our youth for the future – for jobs not yet created or even imagined. Teachers gain tools, expertise and resources necessary to integrate inquiry and project-based activities into their existing curricula, and to run fun competitions (science fair events) that showcase student STEM achievements. For our recently released, “10-Year Impact Report” about CMI professional development, send a request to: cmi@scifair.com

SCHOOLS: Mini Grants awarded to schools to expand opportunities for student research and invention, especially in high-needs districts.

DISTRICT PARTNERSHIPS: Personalized After-School Mentoring connects to in-school STEM learning for students in high-needs communities. MSEF provides an on-site STEM facilitator to recruit and train mentors from industry and academia, and to drive the program forward, providing support to STEM teachers, students and mentors.



Through CMI, students learn through science/engineering practices & guided, independent research

Interested in CMI at your School?

Contact us today!

cmi@scifair.com

<http://scifair.com/curious-minds/>



Curious Minds Initiative

Teach “Real World” Science & Engineering Practices – Register Today for **2019 STEM Professional Development Courses!**

1

TSIP: “Teaching Science through the Inquiry Process”

6 days • 3 credits

Practical strategies to infuse more science practices into your existing curricula – no need to purchase new curricula!

June 24 – 28 & November 16
Framingham State University

2

PCS: “Project-based Classroom Science”

5 days • 2 credits

Develop project-based units for science and engineering concepts

August 19 – 22 & November 16
Location: TBD

3

GRIPS: “Guiding Research & Innovation Projects by Students”

NEW! 5 ONLINE Sessions* • 1 credit

Tools to guide student research and manage your “Science Fair Program”

For details: cmi@scifair.com
***ZOOM Platform – Easy to participate!**

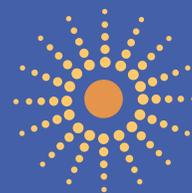


- Scholarships Available
- Open to STEM Teachers Grades 6-12
- Complete all three CMI Courses for graduate credit and earn the **STEM Certificate in Science & Engineering Practices** from Framingham State University!

Be Our Guest!

2020 MSEF Educator Day
May 1st @ MIT...

“Behind the Scenes” at the high school Science Fair



Guide your students to explore **“Real-World” Science Practices.**

For more Information: cmi@scifair.com

CMI Courses – a program of Massachusetts Science & Engineering Fair, Inc. (MSEF)
Developed in collaboration with the Education Development Center (EDC)

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This Could Be YOUR School!

MSEF
and
Curious Minds!

Building life skills and STEM competencies: Massachusetts Science & Engineering Fair (MSEF) and Curious Minds programs.

MSEF Mini-Grants enable schools & teachers to inspire children through direct engagement in research and invention projects, and the excitement of science fair competition.

Your Mini-Grant includes a stipend for the lead science fair teacher and tuition scholarships to Curious Minds courses for STEM teachers. Learn ways to bring the professional science and engineering practices right into your classrooms and to align with the new MA STE standards.



APPLY NOW! *Rolling Applications — No Deadline*

Eligible Schools: All schools with grades 6-12 in Massachusetts that currently do not offer OR aim to expand their annual Science & Engineering Fair program.

Goal: Schools develop a sustainable Science Fair program, and teachers bring science & engineering practices into their classrooms to align with NGSS & revised MA STE standards

Benefits:

- Grants up to \$1,500 for the first year, and renewable up to \$3,500 for a multi-year program
- Tuition Scholarships of \$3,500 for up to 6 STEM teachers to enroll in CMI courses scifair.com/curious-minds/

- Science Fair consultant to visit your school upon request

- Invitations for Teachers & School Leaders to:

—Join meetings of MSEF's High School Committee that helps to shape policy and organize the statewide science fair programs.

—Attend **MSEF Educator Day** (free) at MIT – a look behind-the-scenes at the statewide Science & Engineering Fair for high school students held annually in May.

For more information: scifair.com | cmi@scifair.com



2019 MSEF EDUCATOR DAY

Friday May 3, 2019 ☐ **8:30am – 1:30pm**

Held during the 2019 MA State Science & Engineering Fair for High School Students

Open to All STEM Educators & Special Guests

Location: *Stratton Student Center, MIT Building W20 -- Twenty Chimneys Room*
On the MIT map: <https://whereis.mit.edu/?go=W20>

AGENDA

- 8:30 AM** **Welcome and Review Agenda** (*Continental Breakfast & Coffee*)
- 8:45** **Student Panel - “My Independent Research Experience” - Q&A**
Hear from several students who will be part of the 2018 MA Delegation to the International Science & Engineering Fair (ISEF).
- 9:45** **Visit the Showcase of Student Research & Innovation Projects –**
Tour the Exhibition Hall to view student projects in the Johnson Athletics Center (hockey rink). MIT Building W34. Visit three student projects and note items of interest and/or questions.
- 10:30** **Attend the Judge Orientation Session –**
With hundreds of MSEF Judges in Kresge Auditorium. MIT Building W16.
- 11:30** **Lunch & Review**
Participants discuss the Judge Orientation session and the student projects they viewed, and explore concepts & ideas to help guide their students working on independent research & innovative design projects.
- 1:15 PM** **Ed Day Evaluation – Help Us Improve!**
Online Questionnaire –<https://form.jotform.com/80966345883168>
- 1:30** **Adjourn**

2019 Educator Day is hosted by MSEF’s Curious Minds Initiative (CMI)

Many thanks for the generosity of our major CMI donors who make this day possible:

Linde Family Foundation & STEM Synergy
Alexion, DCU for Kids & MathWorks



The COP PROGRAM Career Opportunities Presentations

Many students wonder how their projects relate to science and technology in today's world. The Career Opportunities Presentations address this issue. This is a forum for young scientists and engineers to meet individuals from Massachusetts' business, educational and professional sectors to hear how your current science fair involvement can impact your future educational and career choices in exciting STEM fields -- Science, Technology, Engineering and Math.

2019 COP Panel

Moderator

**Barnas G. Monteith, MSEF Vice Chair and Former Participant
Massachusetts Science & Engineering Fair, Inc.**

**Indranil Sarkar, Esq.
Associate
Fish & Richardson
Boston**

**Daniel Leibholz
Vice President
Analog Devices, Inc.
Wilmington**

Held on Saturday morning, May 4 @ 10:15 am, the COP Program is open to all Science Fair students, parents and families, science educators, friends and special guests. Student should return to Johnson Athletics Center by 12:30 pm for the start of the Public Showcase of Exhibits.



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Note: HS/High School; MS/Middle School

Region I: Western Massachusetts

Western Massachusetts Region I Science Fair

Massachusetts College of Liberal Arts

HS & MS Co-Chairs: Shannon Zayac & Jennifer LaForest

Region II: Central Massachusetts

Worcester Regional Science & Engineering Fair

Worcester Polytechnic Institute, Worcester

HS Chair: Nicholas Guerin;

MS Chairs: Lisa Greenwald and Karin Lebeau

Region III: Southwestern Massachusetts

Rensselaer - BCC Region III Science & Engineering Fair

Bristol Community College, Fall River

Chair: Dr. James Pelletier

Region IV: Northeastern Massachusetts

Massachusetts Region IV Science Fair

Somerville High School, Somerville

HS Chair: Mr. Chris Angelli

MS Chair: Dr. Carol Barry

Fair Host: UMASS Lowell

Region V: Southeastern Massachusetts

Massachusetts Region V Science & Engineering Fair

Bridgewater State College

HS Chair: Mary-Louise Coates

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Fair Host: Regis College, Weston

Region VI: City of Boston

Boston Public Schools Regional Science Fair

Northeastern University, Boston

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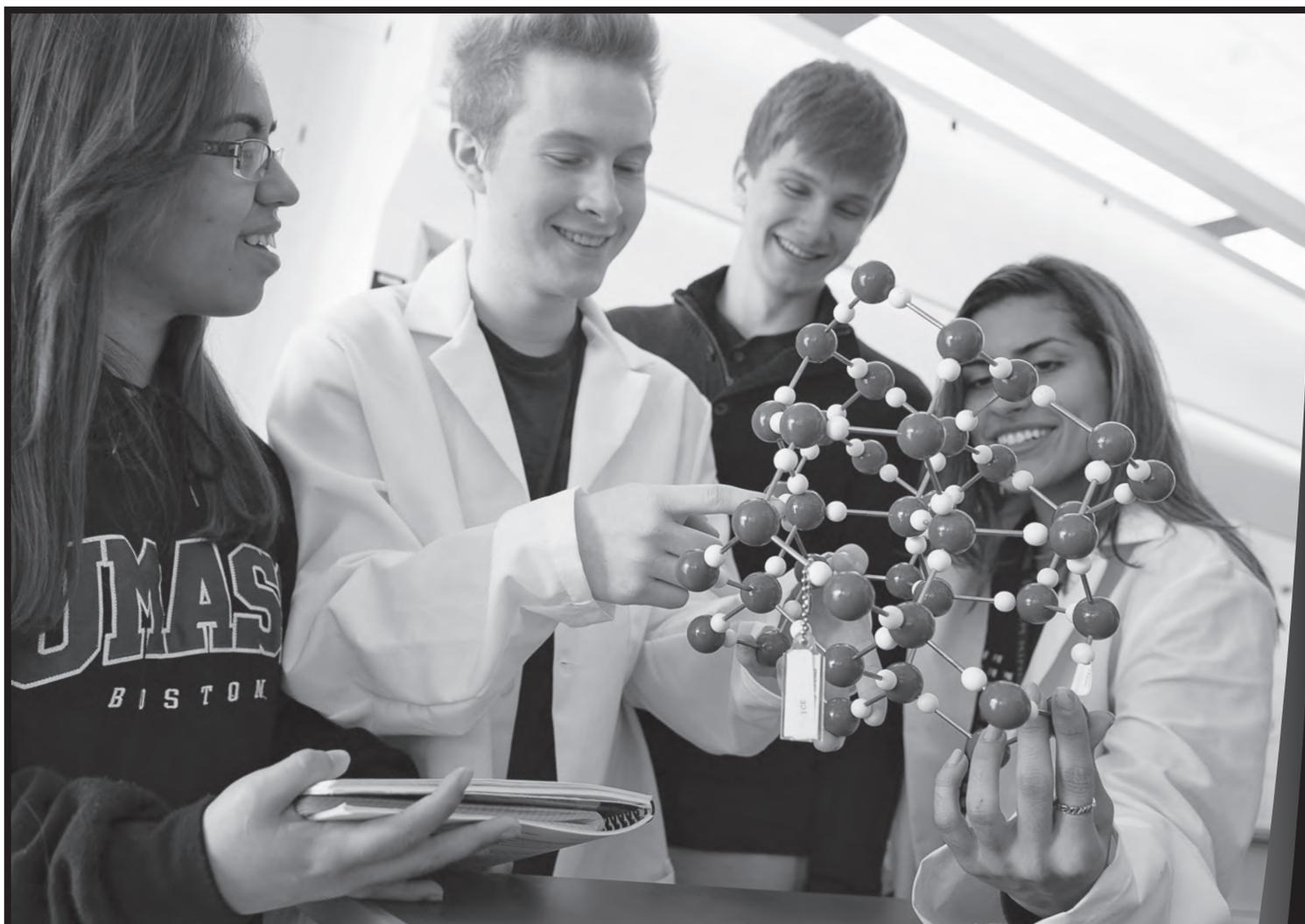
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Ajlouni, Burouj	Thermo Fisher Scientific
Alamoudi, Deema	Northeastern University
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Awrach, James	SeaFire Micros, Inc.
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Pizzimenti, Patrick	Schneider Electric
Poitras, Michael	Dana Farber Cancer Institute
Pokharel, Hem	MA Dept. of Energy & Environmental Affairs
Pond, Jennifer	Moderna Therapeutics
Poteete, Anthony	UMASS Medical School
Potier, Yohann	Novartis
Poza, Ricardo	UMASS Medical School
Prapas, Jason	Massachusetts Institute of Technology
Prejean, Chelse	Cabot Corporation
Prentice, Holly	HPrentice Consulting, LLC
Prevost, Tina	Analog Devices, Inc.
Prohaska, John	Overnia, LLC
Psencik, Jeffrey	MIT Lincoln Laboratory
Rabideau, Amy	Moderna Therapeutics
Raff, Laura	StemCell Technologies Inc.
Ranjan, Sukrit	Massachusetts Institute of Technology
Ravel, Deepali	Harvard Medical School
Rayess, Rachid	INTEL Corp.
Reinhold, Arnold	A G Reinhold
Rice, Lisa	Moderna Therapeutics

Ricles, Robert E	Robert E. Ricles, Esq.
Roaquin, Debora	Moderna Therapeutics
Romero, Romulo	AstraZeneca
Rosen, David	Massachusetts Institute of Technology
Roy, Jefferson	Massachusetts Institute of Technology
Rudnick, Elizabeth	Imaginic, Inc.
Saeboe, Alexander	Boston University
Saha, Kamalika	Sanofi
Salazar Gomez, Andres Felipe	Boston University
Salomon, William	Intellia Therapeutics
Santos, Jason	MA Dept. of Conservation & Recreation
Sanyal, Sulagna	Merck Research Laboratories
Satyam, Abhigyan	Harvard Medical School
Savageau, Judy	UMASS Medical School
Schmitz, Judith	MA Dept. of Environmental Protection
Schroeder, Joseph	Smith & Nephew
Schwaid, Adam	Merck Research Laboratories
Sekar, Narendran	GreenLight Biosciences Inc.
Servi, Les	The MITRE Corporation
Shanahan, James	SynDevRx, Inc.
Sharma, D	Wentworth Institute of Technology
Sikder, Mishel	Design Consultants, Inc.
Sinha, Neeharika	Dana Farber Cancer Institute
Siriwardana, Nirodhini	Merck Research Laboratories
Song, Hyun-Ho (Greco)	Massachusetts Institute of Technology
Sopka, John R	High Performance Systems Software
Speciner, Mike	The Singing Torah
Spencer, Kerrie	Merck Research Laboratories
Stefani, Eda	Worcester Polytechnic Institute
Stephan, Mark	Dell EMC
Stephen, Ralph	WHOI
Stephen, Emily	Massachusetts Institute of Technology
Strattman, Wayne	Consultant
Strizhak, Elliott	UTC Aerospace Systems
Stroman, Michael	MA Dept. of Environmental Protection
Stroman, Grace	Merck Research Laboratories
Strott, Douglas	Sensata Technologies, Inc.
Subramanian, Gokul	Systems & Technology Research
Sullivan, Susan	Iksuda Therapeutics
Sunkari, Madhavi	Tester Work
Sze, Marc	Merck Research Laboratories
Szewczak, Lara	Cell Press/Elsevier
Talcott, Sarah	X-Chem Pharmaceuticals

Tam, James	Moderna Therapeutics
Tarselli, Mike	SLAS
Tartaglia, Lawrence	Beth Israel Deaconess Medical Center
Thai, Nikki	Merck Research Laboratories
Thessen, Anne	Oregon State University
Thrasher, Daniel	IPSEN Bioscience, Inc.
Toudjarska, Iva	Evotec A.G.
Tzameli, Effie	Pfizer Global Research & Development
Uppiliappan, Badhri	Analog Devices, Inc.
Vaidyanathan, Bharat	EMD Serono
Valcourt, James	Harvard University
Vanchinathan, Lakshmanan	INTEL Corp.
Varsamis, Zacharenia	Ribon Therapeutics
Wadhwa, Navish	Harvard University
Wagner, Jeff	Harvard School of Public Health
Wallingford, Mary	Tufts Medical Center
Walton, Thomas	Aeroplas Corp. Intl.
Watson, Mike	Moderna Therapeutics
Webster, Christopher	BioApprovals
Wei, Linna	Sanofi Genzyme
Weintraub, Daniel	Cabot Corporation
Whalen, Michael	EMD Millipore
White, Andre	XTAL Biostructures
Whiteneck, Julia	MA Dept. of Transportation DOT
Wijnja, Hotze	Commonwealth of Massachusetts
Wilgo, Matthew	New England Cord Blood Bank
Wilson, Amanda	Alexion Pharmaceuticals
Wittels, Norman	Dexter Southfield School
Wohlrab, Hartmut	Harvard Medical School
Wolshin, Ernest	Retired
Wong, Jimson	Amgen, Inc.
Xiong, Jincheng	Cabot Corporation
Yamamoto, Kumiko	Amgen, Inc.
Yawe, Joseph	StemCell Technologies Inc.
Zacharek, Sima	Moderna Therapeutics
Zervantonakis, Ioannis	Harvard Medical School
Zhang, Fu	MathWorks, Inc.
Zhao, Wei	Amgen, Inc.

Section 2 - Page 8 of 8



MASSACHUSETTS
MSEIF
Science & 
Engineering Fair

2019 Exhibitors

Apr 12, 2019

Section 1 - Last Name of Student

Section 2 - City/Town, School, Last Name of Student

Section 3 - Team Project Listing

Exhibitors Listing by Last Name

Exhibitor	ID	School
Abrams-Greenberg, Aaren	A24	Somerville High School
Addanki, Anvitha	P15	Canton High School
Adeyemo, Victoria	F24	Jeremiah E. Burke High School
Adiletta, Jack	A10	Worcester Academy
Adiletta, Andrew	A28	Worcester Academy
Ahmed, Rayhan	J5	Lexington High School
Aitnouri, Amina	H2	Boston Latin Academy
Alicea, Aracely	H11	Taunton High School
Amador, Isabella	P8	Edward M. Kennedy Academy for Health Careers
Amazan, Isadorah	N10	Brockton High School
Anantha, Sidharth	B7	Lexington High School
Anger, Abigail	H23	Taunton High School
Anisetti, Shravya	C17	Shrewsbury High School
Anyosa-Galvez, Gonzalo	G19	Cambridge Rindge & Latin High School
Arace, Gianna	K5	Taconic High School
Arias, Anyeli	F28	Edward M. Kennedy Academy for Health Careers

August, Colby	N23	St. John Paul II High School
Ayanna, Henry	D10	Somerville High School
Baek, Jung Won	F20	Northfield-Mt.Hermon School
Bah, Ibrahim	P7	Edward M. Kennedy Academy for Health Careers
Baker, Mairead	J3	Boston Latin Academy
Balaji, Shreya	C18	Mass. Academy of Math & Science
Bao, Yuxuan	C27	Northfield-Mt.Hermon School
Beatrice, Kyle	D21	Silver Lake Regional High School
Becka, Helga	K22	Quincy High School
Berberi, Fiona	J10	North Quincy High School
Bereus, Sophia	F22	Jeremiah E. Burke High School
Berger, Ella	B9	Home School
Berry, Kayla	F5	Berkshire Arts & Technology Charter Public School
Bhalla, Neel	D6	Lexington High School
Bharadwaj, Pratik	A22	Acton-Boxborough Regional High School
Bhattacharjee, Neelasha	C12	Shrewsbury High School
Bhuiyan, Mymoon	C11	Burncoat Senior High School
Billo, Tess	N24	Stoughton High School
Bone, Emily	K20	Westfield High School
Boonpongmanee, Trisha	N6	Deerfield Academy
Booth, Justin	K19	Somerville High School
Bourzgui, Driss	F15	Berkshire Arts & Technology Charter Public School
Boutarf, Chimaa	J16	Pioneer Charter School of Science II
Bozo, Rim	P5	Pioneer Charter School of Science
Bravo, Hailey	G12	Excel High School
Brulport, Michaela	N15	Edward M. Kennedy Academy for Health Careers
Campbell, Orlando	K21	Jeremiah E. Burke High School
Campos, Maria-Isabela	J18	Pioneer Charter School of Science II
Casey, Connor	N2	Leominster High School
Casey, Conroy	C15	Berkshire Arts & Technology Charter Public School
Castaneda, Fernanda	F21	Edward M. Kennedy Academy for Health Careers
Castillo, Sharina	G8	Edward M. Kennedy Academy for Health Careers
Cetinbas, Ece	P18	Excel High School
Chakravarti, Sachiv	J5	Lexington High School
Chen, Kai	D27	Bourne High School
Chen, Benjamin	D26	Weston High School
Chen, Angie	J17	Hopedale Junior Senior High School
Chen, Stanley	C14	Boston Latin Academy
Chen, Song Yu	J25	North Quincy High School
Chintalapati, Arun	A20	Mass. Academy of Math & Science
Chisholm, Aiden	D15	Westfield High School
Choi, Booyeon	A12	Middlesex School
Choi, Jiwon	A18	St. Mark's School
Christy, Megan	A5	St. Mark's School

Chumakova, Yana	C10	Westfield High School
Clardy, Lily	H16	Hudson High School
Clark, Silas	H14	Falmouth Academy
Coholan, Sofia	G24	Bishop Stang High School
Cole, Faith	G15	Boston Latin Academy
Cole, Matthew	P3	Newton South High School
Collins, Samantha	K15	Mary Lyon Pilot High School
Coté, Luc	A25	St. Mark's School
Cuevas, Marina	K21	Jeremiah E. Burke High School
Cui, Daniel	B12	Deerfield Academy
Cullen, Aedan	C24	Hopkins Academy
Dai, Jessica	K18	Boston Latin Academy
Daniar, Adiva	C9	Pioneer Charter School of Science
Danila, Andrea	D25	Sharon High School
Davis, Teyah	F22	Jeremiah E. Burke High School
De Luis, Maya	N8	Newton Country Day School
DeGowin, Emily	K10	Bourne High School
DeMasi, Thomas	C14	Boston Latin Academy
Desir, Thajhea	H8	Foxborough Regional Charter School
Dhaurali, Shubhecchha	B3	Medford High School
Dillon, Steve	F22	Jeremiah E. Burke High School
DiMare, Francesca	K26	Brockton High School
Ding, Elizabeth	J4	Lexington High School
Dion, Jillian	G6	Marlborough High School
Dion, Haley	H4	St. Mark's School
Dion, Margaret	H21	Bishop Feehan High School
Doddipalli, Niya	F14	North Attleboro High School
Dubuisson, Michael	C14	Boston Latin Academy
Duncan, Nicholas	C28	Westfield High School
Dwyer, Benjamin	B28	Wachusett Regional High School
Elfman, Andrew	D8	Southeastern Regional Vocational Technical High School
Elkerton, Molly	H27	Bishop Feehan High School
Elkondakly, Sarah	J1	Medford High School
Emani, Sreenvitha	C1	Shrewsbury High School
Erives, Ezra	J6	Lexington High School
Exilhomme, Christina	P19	Boston Latin Academy
Fan, Yutian	P17	Milton Academy
Farah, Albert	A11	Medford High School
Fardin, Fariha	J19	Hopkinton High School
Ferdinand, Kerry	P8	Edward M. Kennedy Academy for Health Careers
Ferreira, Maicoll	F28	Edward M. Kennedy Academy for Health Careers
Fields, Jonathan	B14	Grafton Memorial Senior High School
Flores, Alberto	D11	Southeastern Regional Vocational Technical High School
Flores Munoz, Pablo	J11	North Quincy High School

Frisella, Megan	F6	Mass. Academy of Math & Science
Fulghum, Mariel	N1	Swampscott High School
Furtado, Kiana	K8	Brockton High School
Gaetani, Ruby	J27	Falmouth Academy
Gaffney, Tyler	B16	Somerville High School
Gardner, Marissa	A17	Mass. Academy of Math & Science
Gattuso, Grant	A3	St. Mark's School
Gaus, Evan	B13	Mass. Academy of Math & Science
Gendron, Camille	N27	Bishop Stang High School
Genova, Abby	H16	Hudson High School
Giwa, Hadiya	H17	Wachusett Regional High School
Glasgow, Noah	H7	Falmouth Academy
Godfrey, Alexandra	K28	Plymouth South High School
Goel, Lavanya	B19	Prospect Hill Academy Charter School
Goldbach, James	P20	Falmouth Academy
Goldstein-Gelb, Brayden	D10	Somerville High School
Goncalves, Zelinda	K14	Southeastern Regional Vocational Technical High School
Gong, Renny	K25	Belmont Hill School
Goretskiy, Stefan	F18	Westfield High School
Gow, James	H13	Concord Academy
Goyette, Abby	D17	Westfield High School
Gravel-Blaney, Zachariah	G26	Westfield High School
Guerrier, Davidson	P18	Excel High School
Gupta, Mahika	H24	North Attleboro High School
Gupta, Yashvi	H19	Grafton Memorial Senior High School
Harley, Brianna	G7	Edward M. Kennedy Academy for Health Careers
Harpin, Rachelle	H6	Assabet Valley Vocational High School
Harrington, Luke	H26	Mary Lyon Pilot High School
Hartman, Emma	J21	Newton Country Day Sch/Sacred Heart
Haxhimali, Era	J28	Somerville High School
He, Anna	B24	Mass. Academy of Math & Science
Heggadahalli, Bharath	J15	Mass. Academy of Math & Science
Hinck, Stephen	C28	Westfield High School
Hollyer, Joshua	A23	Shrewsbury High School
Honor, Sam	F8	Bishop Feehan High School
Hossaini, Chaimaa	A15	Pioneer Charter School of Science
Huezo-Santiago, Tashaina	H15	Urban Science Academy
Huffman, Annabelle	C5	Bancroft School
Husain, Abida	H9	Foxborough Regional Charter School
James, C'Lannye	H5	John D. O'Bryant School of Mathematics and Science
Jarmale, Shashank	C23	Billerica Memorial High School
Jennings, Faith	N16	St. Mark's School
Joseph, Rachel	G13	Taunton High School
Jude, Sadie	G3	Burncoat Senior High School

Julmiste, Ashley	P9	West Roxbury High School
Jury, Ellen	F1	Westfield High School
Karki, Supriti	K11	Quincy High School
Karpe, Gaurang	N18	Chelmsford High School
Kaur, Simran	C6	Hopkinton High School
Kayzakian, Imma	C7	Westfield High School
Keeler, Emma	N14	Falmouth Academy
Kelly, Emma	H19	Grafton Memorial Senior High School
Kelsey, Hannah	K23	Foxborough Regional Charter School
Khan, Shazain	F19	Hopkinton High School
Kim, Dongyup	A6	Deerfield Academy
Kleindinst, Charlie	F12	Upper Cape Cod Vocational Technical High School
Kozak, John	C19	Berkshire Arts & Technology Charter Public School
Krishna, Sanjana	C16	Acton-Boxborough Regional High School
Krstanovic, Katerina	F3	Matignon High School
Krzanik, Grace	C20	Berkshire Arts & Technology Charter Public School
Kumar, Akash	B22	Shrewsbury High School
Kumar, Nidhi	N22	Upper Cape Cod Vocational Technical High School
Lamm, Maya	B20	Lexington High School
Lanzendorf, Lucas	B10	Mass. Academy of Math & Science
Lawrence, Claire	F16	Lexington High School
Legkoduikh, Evelynna	D16	Westfield High School
LeMaire, Tatum	H10	Taunton High School
Leopold, Grace	K27	Calvary Chapel Academy
Leshner, Elizabeth	N17	Newton Country Day School
Lin, John	H18	Boston Latin School
Lin, Xiandong	A2	Stoneleigh-Burnham School
Liu, Sarah	B23	Lexington High School
Liu, Julie	F27	Boston Latin Academy
Malur, Neil	D26	Weston High School
Manic, Mila	D23	Plymouth South High School
Martinez, Pamela	G12	Excel High School
Martinez, Brianna	D1	Berkshire Arts & Technology Charter Public School
Martinez, Stephanie	N20	East Boston High School
Massoni-Nesman, Rianna	B11	Wachusett Regional High School
Mattingly, Ella	N4	Lexington High School
McConaga, Isaiah	K8	Brockton High School
McElhinney, Olivia	B1	Matignon High School
McGauley, Katelyn	J26	Newton Country Day Sch/Sacred Heart
Mclaren, Nilay	F4	Mass. Academy of Math & Science
McSweeney, Emma	G9	Stoughton High School
Mendes, Ethan	K16	Westford Academy
Menzel, Abigail	N5	Westfield High School
Miller, Jenna	G4	Shepherd Hill Regional High School

Miller, Alannah	B17	Hopkinton High School
Millette, Justin	A24	Somerville High School
Minier, Ian	D18	Marlborough High School
Minocha, Rohan	A9	Hopkinton High School
Mirisola, Joseph	N21	Silver Lake Regional High School
Mishra, Arnav	A14	Shrewsbury High School
Mizerak, Elise	G20	Wachusett Regional High School
Mohamud, Maryan	F23	Jeremiah E. Burke High School
Mohsin, Saad	K4	St. John's High School
Molloy, Katherine	N10	Brockton High School
Moore, Timothy	H6	Assabet Valley Vocational High School
Morales, Myah	G14	East Boston High School
Morris, Siobhan	D24	Falmouth High School
Morrissey, Catherine	D7	Westfield High School
Morrissey, Brendan	D15	Westfield High School
Morse, Julianne	H12	Plymouth South High School
Moskal, Lindsey	N7	Bishop Feehan High School
Motto, Darian	K21	Jeremiah E. Burke High School
Mufti, Saad	C21	St. John's High School
Muller, Brianna	G28	Taunton High School
Muratore, California	H22	Taunton High School
Nafreere, Deeandria	J9	Foxborough Regional Charter School
Naittalb, Sarrah	P5	Pioneer Charter School of Science
Najah, Aiman	A7	Pioneer Charter School of Science II
Nasankar, Shakaani	B4	Pioneer Charter School of Science II
Nasankar, Sharani	N19	Pioneer Charter School of Science II
Nathan, Krish	B18	Mass. Academy of Math & Science
Nemalikanti, Archita	B8	Hopkinton High School
Nene, Advait	B27	Hopkinton High School
Ng, Esther	A1	Mass. Academy of Math & Science
Ngo, Andrea	K7	North Quincy High School
Ngokila, Maryam	K24	Pioneer Charter School of Science II
Nguyen, Liem	F9	North Quincy High School
Nyman, Yasmin	D27	Bourne High School
Ogbebor, Martha	F24	Jeremiah E. Burke High School
Olofsson, Michelle	F16	Lexington High School
Omorodion, Merit	F24	Jeremiah E. Burke High School
Onffroy, Maxwell	B5	Bancroft School
Ortiz, Nayeli	G25	Edward M. Kennedy Academy for Health Careers
Padela, Umar	J22	Braintree High School
Paiva, Izabel	G23	Bishop Stang High School
Pal, Antara	A8	Acton-Boxborough Regional High School
Pan, Edward	D4	Northfield-Mt.Hermon School
Parlapiano, Cloey	C3	Taconic High School

Patel, Hirni	J13	North Attleboro High School
Pathak, Devesh	D5	Lexington High School
Patta, Anoop	B18	Westborough High School
Paul, Carter	D18	Marlborough High School
Paul, Harrison	D18	Marlborough High School
Pease, Emilie	H3	Westfield High School
Peerzade, Sayedazhar	C26	Advanced Math and Science Academy
Pereira, Alexander	G27	Taunton High School
Perumal, Neha	G5	Mass. Academy of Math & Science
Petzold, Emma	N5	Westfield High School
Phan, Sally	H5	John D. O'Bryant School of Mathematics and Science
Pike, Emily	K12	Bourne High School
Pinkhassik, Timothy	D28	Boston University Academy
Pinto, Katia	F23	Jeremiah E. Burke High School
Piratla, Srivishnu	B21	Advanced Math and Science Academy
Prabakar, Ajan	A23	Shrewsbury High School
Prabhakar, Garima	C22	Shrewsbury High School
Prendergast-Tombeno, Rachel	D3	Acton-Boxborough Regional High School
Prenosil, Nina	F1	Westfield High School
Przechocki, Charles	B2	Westfield High School
Puhov, Hannah	A13	Mass. Academy of Math & Science
Pulya, Ritvik	A26	Acton-Boxborough Regional High School
Puri, Ashish	A19	Lexington High School
Puttaraju, Thrusha	C2	Hopkinton High School
Pyrdol, Mary	N13	Brockton High School
Quetant, Claweens	N26	West Roxbury High School
Racela, Sandy	G1	Berkshire Arts & Technology Charter Public School
Rae, Mackenzie	H3	Westfield High School
Rainville, Olivia	N3	Marlborough High School
Rajagopal, Saniya	J23	Falmouth Academy
Rajgor, Tanisha	B8	Hopkinton High School
Ramirez, Cindy	G8	Edward M. Kennedy Academy for Health Careers
Ramos Chavez, Brian	C13	East Boston High School
Raun, Morgan	N3	Marlborough High School
Ravikumar, Akshaya	N12	Sharon High School
Ray, Roshni	D20	Lexington High School
Regnier, Elizabeth	D7	Westfield High School
Reid, Jaden	D22	Southeastern Regional Vocational Technical High School
Rico, Taina	K13	Brockton High School
Rivas, Jasmani	G25	Edward M. Kennedy Academy for Health Careers
Roman, Melanie	F21	Edward M. Kennedy Academy for Health Careers
Rosen, Elan	F19	Hopkinton High School
Rossi, Ramon	J28	Somerville High School
Rotondo, Joseph	P4	Upper Cape Cod Vocational Technical High School

Rush, Juliana	G9	Stoughton High School
Sacchetti, Courtney	N10	Brockton High School
Sadagopan, Ananthan	A16	Westborough High School
Saligrama, Aditya	F11	Weston High School
Sanchez, Omar	F27	Boston Latin Academy
Sane, Eshan	B18	Westborough High School
Sankar, Sanjana	N4	Lexington High School
Sathiamurthy, Srinivasan	J6	Lexington High School
Savant, Gaurav	A27	Worcester Academy
Schastny, Alyssa	A15	Pioneer Charter School of Science
Schiffer, Ben	N23	St. John Paul II High School
Schifman, Arianna	G10	Bishop Feehan High School
Schmalz, Katherine	G18	Wachusett Regional High School
Scholl, Abigail	D1	Berkshire Arts & Technology Charter Public School
Schremp, Michele	J8	Bishop Feehan High School
Schumacher, Samuel	D12	Taunton High School
Seaver, Rachel	K14	Southeastern Regional Vocational Technical High School
Seetharaman, Amruth	B14	Grafton Memorial Senior High School
Seifu, Feven	G2	Boston Latin School
Servetnik, Nicole	H20	Westfield High School
Sgueglia, Stephanie	D19	Westfield High School
Shapally, Himasri	H19	Grafton Memorial Senior High School
Shenoy, Rohan	B6	Amherst Regional High School
Shin, Jiho	J20	Miss Hall's School
Shvyryd, Tetyana	F17	Westfield High School
Silva, Nelly	K13	Brockton High School
Simco, Morgan	J1	Medford High School
Smith, Gordon	D21	Silver Lake Regional High School
Sonti, Advika	K1	Tahanto Regional High School
Spooner, Nicholas	D22	Southeastern Regional Vocational Technical High School
St. Aubin, Owen	J14	Plymouth South High School
St.Louis-Severe, Christine	G22	Edward M. Kennedy Academy for Health Careers
Stathatos, Nicholas	D19	Westfield High School
Stolyar, Alisa	B17	Hopkinton High School
Stucenski, Trent	F2	Westfield High School
Suhocki, Anthony	J2	Westfield High School
Sukthankar, Ashwin	D9	St. John's High School
Sullivan, Ellie	G23	Bishop Stang High School
Sun, Emily	P16	Boston Latin School
Sundararajan, Suvin	B25	Westfield High School
Sunkari, Aakash	D13	North Attleboro High School
Suraparaju, Krish	B14	Grafton Memorial Senior High School
Sweeney, Ellia	F26	Bishop Feehan High School
Syed, Muneeb	C21	St. John's High School

Takang, Susan	K13	Brockton High School
Tan, Janet	F27	Boston Latin Academy
Tang, Lawrence	F13	Falmouth High School
Tavares, Nolan	K9	Taunton High School
Taylor, Kylie	F15	Berkshire Arts & Technology Charter Public School
Taylor, Jillian	F10	Upper Cape Cod Vocational Technical High School
Tejeda, Joandy	H28	Edward M. Kennedy Academy for Health Careers
Thieler, Sarah	H25	Falmouth Academy
Thirumalai, Amrita	C25	Worcester Academy
Thomas Cruz, Ana	C4	Assabet Valley Vocational High School
Tierney, Ryan	D14	Silver Lake Regional High School
Todd-Weinstein, Natalie	N9	Falmouth Academy
Togneri, Charles	K3	Hudson High School
Toncelli, Silvia	F25	Bishop Feehan High School
Tran, Vivian	P1	North Quincy High School
Tribendis, Allison	K17	Swampscott High School
Tribendis, Madeline	K17	Swampscott High School
Trumble, Sam	N28	John D. O'Bryant School of Mathematics and Science
Ural, Barut	F7	Southeastern Regional Vocational Technical High School
Valcin, Marc	K8	Brockton High School
Vardar, Nazif	B26	St. Peter-Marian Jr. Sr. CCHS
Velavan, Raceja	J24	Ursuline Academy
Verbeek, Kerrie	G16	St. Mark's School
Volfson, Alexa	H1	Wachusett Regional High School
Wadekar, Adway	A4	St. John's High School
Walsh, Lauren	N11	St. John Paul II High School
Wang, Daisy	K2	Boston Latin School
Wang, Anzhuo	C8	Westborough High School
Wang, Allen	B15	Acton-Boxborough Regional High School
Wang, Yuchen	N25	St. Mark's School
Weber, Olivia	G11	Taunton High School
Webster, Abigail	D2	Berkshire Arts & Technology Charter Public School
Whidden, Cole	D14	Silver Lake Regional High School
Whitbeck, Hunter	D3	Acton-Boxborough Regional High School
Wiggins-Howard, Missoura	J12	Dearborn STEM Academy
Woods, Mary	G21	Bishop Feehan High School
Xu, Eileen	G17	Wachusett Regional High School
Ye, Tiffany	P2	Boston Latin Academy
Yee, Gianfranco	P6	Urban Science Academy
Yee, Stefania	H15	Urban Science Academy
Youssef, Andrew	A21	Mass. Academy of Math & Science
Youssfzai, Illum	K6	Mary Lyon Pilot High School
Yuman Revolorio, Irma	K6	Mary Lyon Pilot High School
Zarola, Georgia	D3	Acton-Boxborough Regional High School

Zhang, Patrick
Zhang, Andrew

K16 Lexington High School
J7 Roxbury Latin School

Section 3 - Page 10 of 10

Exhibitors by School City/Town, School, Student

Acton	Acton-Boxborough Regional High School	Region: 4
Bharadwaj, Pratik	Discipline : Computers	Exhibit: A22
	Using Deep Learning for Noise Reduction and Artifact Suppression in CT	
Acton	Acton-Boxborough Regional High School	Region: 4
Prendergast-Tombeno, Rachel	Discipline : Biology	TEAM Exhibit: D3
	Stride Length and Running Economy in Athletes	
Acton	Acton-Boxborough Regional High School	Region: 4
Pulya, Ritvik	Discipline : Biology	Exhibit: A26
	The Effects of Various Substances on β -amyloid Toxicity in <i>C. elegans</i>	
Acton	Acton-Boxborough Regional High School	Region: 4
Whitbeck, Hunter	Discipline : Biology	TEAM Exhibit: D3
	Stride Length and Running Economy in Athletes	
Acton	Acton-Boxborough Regional High School	Region: 4
Wang, Allen	Discipline : Mathematics	Exhibit: B15
	The Mullineux Involution and Generalized Regularization	
Acton	Acton-Boxborough Regional High School	Region: 4
Krishna, Sanjana	Discipline : Chemistry	Exhibit: C16
	Effect of pH and Concentration on Antioxidants in Berries and Dementia	
Acton	Acton-Boxborough Regional High School	Region: 4
Zarola, Georgia	Discipline : Biology	TEAM Exhibit: D3
	Stride Length and Running Economy in Athletes	
Acton	Acton-Boxborough Regional High School	Region: 4
Pal, Antara	Discipline : Biology	Exhibit: A8
	The Role of Extracellular Matrix Arrangement in Cancer Cell Migration	
Adams	Berkshire Arts & Technology Charter Public School	Region: 1
Krzanik, Grace	Discipline : Physics & Electronics	Exhibit: C20
	Archery Techniques: Determining the Best Arrow to Penetrate a Target	
Adams	Berkshire Arts & Technology Charter Public School	Region: 1
Scholl, Abigail	Discipline : Biology	TEAM Exhibit: D1
	Do Your Plants Like Music?	
Adams	Berkshire Arts & Technology Charter Public School	Region: 1
Webster, Abigail	Discipline : Biology	Exhibit: D2
	A Real Slip-Up	
Adams	Berkshire Arts & Technology Charter Public School	Region: 1
Berry, Kayla	Discipline : Physics & Electronics	Exhibit: F5
	Blood Spatter Analysis	

Adams	Berkshire Arts & Technology Charter Public School	Region: 1
Martinez, Brianna	Discipline : Biology	TEAM Exhibit: D1
	Do Your Plants Like Music?	
Adams	Berkshire Arts & Technology Charter Public School	Region: 1
Bourzgui , Driss	Discipline : Environmental Science	TEAM Exhibit: F15
	Reduction of Atmospheric CO2 Using the Algae Scenedesmus and Ulothrix	
Adams	Berkshire Arts & Technology Charter Public School	Region: 1
Racela, Sandy	Discipline : Environmental Science	Exhibit: G1
	Let 'Em Worm!	
Adams	Berkshire Arts & Technology Charter Public School	Region: 1
Taylor, Kylie	Discipline : Environmental Science	TEAM Exhibit: F15
	Reduction of Atmospheric CO2 Using the Algae Scenedesmus and Ulothrix	
Adams	Berkshire Arts & Technology Charter Public School	Region: 1
Kozak, John	Discipline : Engineering	Exhibit: C19
	Building a Better Tabinet (Table-Cabinet)	
Amherst	Amherst Regional High School	Region: 1
Shenoy, Rohan	Discipline : Engineering	Exhibit: B6
	Creating a Human Powered Flashlight	
Attleboro	Bishop Feehan High School	Region: 3
Sweeney, Ellia	Discipline : Biology	Exhibit: F26
	Going Green to Prevent Breast Cancer	
Attleboro	Bishop Feehan High School	Region: 3
Honor, Sam	Discipline : Computers	Exhibit: F8
	How Does Tree Depth Effect the Performance and Efficiency of Chess AI	
Attleboro	Bishop Feehan High School	Region: 3
Moskal, Lindsey	Discipline : Environmental Science	Exhibit: N7
	Effect of Microwave Radiation on Different Organisms	
Attleboro	Bishop Feehan High School	Region: 3
Woods, Mary	Discipline : Physics & Electronics	Exhibit: G21
	Designing the Most Effective Pulley System	
Attleboro	Bishop Feehan High School	Region: 3
Dion, Margaret	Discipline : Biology	Exhibit: H21
	The Effect of Sanitation Methods on Dirty Sponges.	
Attleboro	Bishop Feehan High School	Region: 3
Elkerton , Molly	Discipline : Chemistry	Exhibit: H27
	Alternatives For Chemical Ice Melt	

Attleboro	Bishop Feehan High School	Region: 3
Schifman, Arianna	Discipline : Environmental Science	Exhibit: G10
	Using Microorganisms to Reduce Nitrogen Pollution in Water Ecosystems	
Attleboro	Bishop Feehan High School	Region: 3
Schremp, Michele	Discipline : Environmental Science	Exhibit: J8
	Testing the Durability and Long Term Reliability of Solar Cells	
Attleboro	Bishop Feehan High School	Region: 3
Toncelli, Silvia	Discipline : Biochemistry	Exhibit: F25
	Testing Methods of Lipid Extraction from Microalgae	
Belmont	Belmont Hill School	Region: 4
Gong, Renny	Discipline : Behavioral Science	Exhibit: K25
	The Effects of Mindfulness on Amygdala Volume and Perceived Stress	
Billerica	Billerica Memorial High School	Region: 4
Jarmale, Shashank	Discipline : Biology	Exhibit: C23
	Designing a Machine Learning Solution to Atrial Fibrillation	
Billerica	Matignon High School	Region: 4
McElhinney, Olivia	Discipline : Earth & Space Science	Exhibit: B1
	Wood Ash in Fire Prevention	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Bah, Ibrahim	Discipline : Biology	Exhibit: P7
	Chemotaxis and Response to Stimuli in <i>C. elegans</i> : Vanilla vs. Bleach	
Boston	Boston Latin Academy	Region: 6
Aitnouri, Amina	Discipline : Biology	Exhibit: H2
	The Effect of pH on Enzyme Acitivity	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Ferdinand, Kerry	Discipline : Chemistry	TEAM Exhibit: P8
	Fiji vs. Poland Springs	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Ferreira, Maicoll	Discipline : Chemistry	TEAM Exhibit: F28
	Hidden Sugar	
Boston	Jeremiah E. Burke High School	Region: 6
Omorodion, Merit	Discipline : Environmental Science	TEAM Exhibit: F24
	Food Waste At The Burke	
Boston	Boston Latin Academy	Region: 6
Sanchez, Omar	Discipline : Biology	TEAM Exhibit: F27
	Effect of Apple Cider Vinegar Solutions on Bacterial Growth	

Boston	Boston Latin School	Region: 6
Wang, Daisy	Discipline : Biochemistry	Exhibit: K2
	RNA-based Early Detection Method for Prostate Cancer Using Nanotech	
Boston	Boston Latin School	Region: 6
Lin, John	Discipline : Biology	Exhibit: H18
	Development of a qPCR Assay for Quantification of Saccharibacteria	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Roman, Melanie	Discipline : Chemistry	TEAM Exhibit: F21
	Don't Use Carmex, Use FeMe	
Boston	Boston Latin Academy	Region: 6
Dubuisson, Michael	Discipline : Engineering	TEAM Exhibit: C14
	How Does the Sweep Angle of a Wing Affect Its Lift Force?	
Boston	Boston Latin Academy	Region: 6
Cole, Faith	Discipline : Biology	Exhibit: G15
	The Effect of Temperature on The Rate of Fermentation of Yeast	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Castaneda, Fernanda	Discipline : Chemistry	TEAM Exhibit: F21
	Don't Use Carmex, Use FeMe	
Boston	Boston Latin Academy	Region: 6
DeMasi, Thomas	Discipline : Engineering	TEAM Exhibit: C14
	How Does the Sweep Angle of a Wing Affect Its Lift Force?	
Boston	Boston Latin Academy	Region: 6
Tan, Janet	Discipline : Biology	TEAM Exhibit: F27
	Effect of Apple Cider Vinegar Solutions on Bacterial Growth	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Arias, Anyeli	Discipline : Chemistry	TEAM Exhibit: F28
	Hidden Sugar	
Boston	Boston Latin Academy	Region: 6
Chen, Stanley	Discipline : Engineering	TEAM Exhibit: C14
	How Does the Sweep Angle of a Wing Affect Its Lift Force?	
Boston	Boston University Academy	Region: 5
Pinkhassik, Timothy	Discipline : Chemistry	Exhibit: D28
	Using a Watch for Chemical Analysis: A Wearable Diagnostic Platform	
Boston	Boston Latin Academy	Region: 6
Baker, Mairead	Discipline : Biochemistry	Exhibit: J3
	Vitamins and Their Effectiveness as Antioxidants	

Boston Harley, Brianna	Edward M. Kennedy Academy for Health Careers Discipline : Behavioral Science The Law of Attraction	Region: 6 Exhibit: G7
Boston Yee, Gianfranco	Urban Science Academy Discipline : Chemistry How Does pH Level Impact Enzyme Activity in Lactaid Pills	Region: 6 Exhibit: P6
Boston Ramirez, Cindy	Edward M. Kennedy Academy for Health Careers Discipline : Biology Which Type of Sugar Elicits the Strongest Response?	Region: 6 TEAM Exhibit: G8
Boston Ye, Tiffany	Boston Latin Academy Discipline : Biology Antibiotic Cocktail	Region: 6 Exhibit: P2
Boston Quetant, Claweens	West Roxbury High School Discipline : Chemistry The Hidden Secret of Science	Region: 6 Exhibit: N26
Boston Brulport, Michaela	Edward M. Kennedy Academy for Health Careers Discipline : Chemistry Water vs. Electrolytes	Region: 6 Exhibit: N15
Boston Harrington, Luke	Mary Lyon Pilot High School Discipline : Biology Microbial Fuel Cell	Region: 6 Exhibit: H26
Boston St.Louis-Severe, Christine	Edward M. Kennedy Academy for Health Careers Discipline : Behavioral Science Where We Live	Region: 6 Exhibit: G22
Boston Cuevas, Marina	Jeremiah E. Burke High School Discipline : Biology Devel of Bdelloid Rotifers As Experimental Model For Cell Rejuvenation	Region: 6 TEAM Exhibit: K21
Boston Dai, Jessica	Boston Latin Academy Discipline : Environmental Science Salinity Versus the Growth of Mung Beans	Region: 6 Exhibit: K18
Boston Castillo, Sharina	Edward M. Kennedy Academy for Health Careers Discipline : Biology Which Type of Sugar Elicits the Strongest Response?	Region: 6 TEAM Exhibit: G8
Boston Sun, Emily	Boston Latin School Discipline : Biology Does the Constant Region of the cMet Antibody Affect Its Function?	Region: 6 Exhibit: P16

Boston	Jeremiah E. Burke High School	Region: 6
Motto, Darian	Discipline : Biology	TEAM Exhibit: K21
	Devel of Bdelloid Rotifers As Experimental Model For Cell Rejuvenation	
Boston	Boston Latin Academy	Region: 6
Liu, Julie	Discipline : Biology	TEAM Exhibit: F27
	Effect of Apple Cider Vinegar Solutions on Bacterial Growth	
Boston	Urban Science Academy	Region: 6
Yee, Stefania	Discipline : Biology	TEAM Exhibit: H15
	The Effect of Nitrate Levels in Polluted Water on Daphnia	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Tejeda, Joandy	Discipline : Chemistry	Exhibit: H28
	Electrolyte Challenge: Tropicana Orange Juice vs. Gatorade	
Boston	Boston Latin School	Region: 6
Seifu, Feven	Discipline : Behavioral Science	Exhibit: G2
	Comparing the Diets of German Cockroaches (Blattella germanica)	
Boston	John D. O'Bryant School of Mathematics and Science	Region: 6
James, C'Lannye	Discipline : Environmental Science	TEAM Exhibit: H5
	Ocean Acidification	
Boston	Jeremiah E. Burke High School	Region: 6
Campbell , Orando	Discipline : Biology	TEAM Exhibit: K21
	Devel of Bdelloid Rotifers As Experimental Model For Cell Rejuvenation	
Boston	Dearborn STEM Academy	Region: 6
Wiggins-Howard, Missoura	Discipline : Engineering	Exhibit: J12
	Autonomous Cars	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Ortiz, Nayeli	Discipline : Chemistry	TEAM Exhibit: G25
	How To Get Away With Murder	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Rivas, Jasmani	Discipline : Chemistry	TEAM Exhibit: G25
	How To Get Away With Murder	
Boston	Jeremiah E. Burke High School	Region: 6
Dillon, Steve	Discipline : Behavioral Science	TEAM Exhibit: F22
	The Impact of Induced Social Anxiety on Health and Well Being	
Boston	East Boston High School	Region: 6
Martinez, Stephanie	Discipline : Environmental Science	Exhibit: N20
	Comparing Stream Characteristics between Winchester,MA and Puerto Rico	

Boston Exilhomme , Christina	Boston Latin Academy Discipline : Biology IL-6 in B-Cells	Region: 6 Exhibit: P19
Boston Trumble, Sam	John D. O'Bryant School of Mathematics and Science Discipline : Physics & Electronics Cell Phone Microscope	Region: 6 Exhibit: N28
Bourne Taylor, Jillian	Upper Cape Cod Vocational Technical High School Discipline : Biochemistry Spectroanalyzing Commonly Used Bottled Water	Region: 5 Exhibit: F10
Bourne Nyman, Yasmin	Bourne High School Discipline : Engineering Building an Automatic Fish Feeder	Region: 5 TEAM Exhibit: D27
Bourne Chen, Kai	Bourne High School Discipline : Engineering Building an Automatic Fish Feeder	Region: 5 TEAM Exhibit: D27
Bourne DeGowin, Emily	Bourne High School Discipline : Biology How Sound Frequencies Affect the Growth of Plants	Region: 5 Exhibit: K10
Bourne Kumar, Nidhi	Upper Cape Cod Vocational Technical High School Discipline : Biochemistry Which is the Most Effective Sunscreen?	Region: 5 Exhibit: N22
Bourne Pike, Emily	Bourne High School Discipline : Biochemistry Harvesting Energy from Photosynthesis-Related Bacteria	Region: 5 Exhibit: K12
Bourne Kleindinst, Charlie	Upper Cape Cod Vocational Technical High School Discipline : Engineering Testing Lasering Under Pressure	Region: 5 Exhibit: F12
Boylston Sonti, Advika	Tahanto Regional High School Discipline : Chemistry Determining the Specific Heat Capacity of Different Substances	Region: 2 Exhibit: K1
Braintree Padela, Umar	Braintree High School Discipline : Biology The Impact of Benzo-Lipoxin A4 on Mesenchymal Stem Cells	Region: 5 Exhibit: J22
Brighton Youssfzai, Illum	Mary Lyon Pilot High School Discipline : Biology Identifying DNA	Region: 6 TEAM Exhibit: K6

Brighton	Mary Lyon Pilot High School	Region: 6
Yuman Revolorio, Irma	Discipline : Biology	TEAM Exhibit: K6
	Identifying DNA	
Brighton	Mary Lyon Pilot High School	Region: 6
Collins, Samantha	Discipline : Biology	Exhibit: K15
	Bioluminescent Algae	
Brockton	Brockton High School	Region: 5
Takang, Susan	Discipline : Physics & Electronics	TEAM Exhibit: K13
	Phony Radiation: The Effect of EMFs on Plants	
Brockton	Brockton High School	Region: 5
Rico, Taina	Discipline : Physics & Electronics	TEAM Exhibit: K13
	Phony Radiation: The Effect of EMFs on Plants	
Brockton	Brockton High School	Region: 5
Pyrdol, Mary	Discipline : Environmental Science	Exhibit: N13
	Using Minerals to Combat Ocean Acidification	
Brockton	Brockton High School	Region: 5
McConaga, Isaiah	Discipline : Biology	TEAM Exhibit: K8
	Composting Critters	
Brockton	Brockton High School	Region: 5
DiMare, Francesca	Discipline : Environmental Science	Exhibit: K26
	A DNA Barcode Approach to Ascertain the Foraging Habits of Native Bees	
Brockton	Brockton High School	Region: 5
Sacchetti , Courtney	Discipline : Engineering	TEAM Exhibit: N10
	Permeable Concrete for Flood Sustainability	
Brockton	Brockton High School	Region: 5
Furtado, Kiana	Discipline : Biology	TEAM Exhibit: K8
	Composting Critters	
Brockton	Brockton High School	Region: 5
Valcin, Marc	Discipline : Biology	TEAM Exhibit: K8
	Composting Critters	
Brockton	Brockton High School	Region: 5
Molloy, Katherine	Discipline : Engineering	TEAM Exhibit: N10
	Permeable Concrete for Flood Sustainability	
Brockton	Brockton High School	Region: 5
Silva, Nelly	Discipline : Physics & Electronics	TEAM Exhibit: K13
	Phony Radiation: The Effect of EMFs on Plants	

Brockton	Brockton High School	Region: 5
Amazan, Isadorah	Discipline : Engineering	TEAM Exhibit: N10
	Permeable Concrete for Flood Sustainability	
Cambridge	Matignon High School	Region: 4
Krstanovic, Katerina	Discipline : Biochemistry	Exhibit: F3
	Engineering a Hybridized Pentameric HIV-1 Antibody	
Cambridge	Prospect Hill Academy Charter School	Region: 4
Goel, Lavanya	Discipline : Behavioral Science	Exhibit: B19
	Episodic vs. Semantic Memory	
Cambridge	Cambridge Rindge & Latin High School	Region: 4
Anyosa-Galvez, Gonzalo	Discipline : Biology	Exhibit: G19
	The Use of Essential Oils to Fight Fire Blight in Fruit Trees	
Canton	Canton High School	Region: 5
Addanki, Anvitha	Discipline : Biology	Exhibit: P15
	A Novel Noninvasive Biomarker for Diagnosing Major Depressive Disorder	
Chelmsford	Chelmsford High School	Region: 4
Karpe, Gaurang	Discipline : Engineering	Exhibit: N18
	Hot Car Deaths	
Concord	Concord Academy	Region: 4
Gow, James	Discipline : Engineering	Exhibit: H13
	Optimizing Efficiency of Pelton Turbine Based On Euler's Equation	
Concord	Middlesex School	Region: 4
Choi, Booyeon	Discipline : Mathematics	Exhibit: A12
	The Hausdorff Dimensions of Higher Dimensional Random Walks	
Dartmouth	Bishop Stang High School	Region: 3
Paiva, Izabel	Discipline : Biochemistry	TEAM Exhibit: G23
	Bioplastic from Banana Peels	
Dartmouth	Bishop Stang High School	Region: 3
Coholan, Sofia	Discipline : Environmental Science	Exhibit: G24
	How Climate Change Affects Water Quality	
Dartmouth	Bishop Stang High School	Region: 3
Sullivan, Ellie	Discipline : Biochemistry	TEAM Exhibit: G23
	Bioplastic from Banana Peels	
Dedham	Ursuline Academy	Region: 5
Velavan, Raceja	Discipline : Biology	Exhibit: J24
	Extracting DNA from Spinach	

Deerfield	Deerfield Academy	Region: 1
Cui, Daniel	Discipline : Physics & Electronics	Exhibit: B12
	Computer Vision-Based Characterization of Nanoscale Lamina	
Deerfield	Deerfield Academy	Region: 1
Boonpongmanee, Trisha	Discipline : Biology	Exhibit: N6
	Using Fourier Analysis to Distinguish Pancreatic Cysts	
Deerfield	Deerfield Academy	Region: 1
Kim, Dongyup	Discipline : Earth & Space Science	Exhibit: A6
	A Theory for Ring Formation Around Asteroid Chariklo	
Dorchester	Jeremiah E. Burke High School	Region: 6
Pinto, Katia	Discipline : Biology	TEAM Exhibit: F23
	Phenotypic Diversity	
Dorchester	Jeremiah E. Burke High School	Region: 6
Ogbebor, Martha	Discipline : Environmental Science	TEAM Exhibit: F24
	Food Waste At The Burke	
Dorchester	Jeremiah E. Burke High School	Region: 6
Davis, Teyah	Discipline : Behavioral Science	TEAM Exhibit: F22
	The Impact of Induced Social Anxiety on Health and Well Being	
Dorchester	Jeremiah E. Burke High School	Region: 6
Bereus, Sophia	Discipline : Behavioral Science	TEAM Exhibit: F22
	The Impact of Induced Social Anxiety on Health and Well Being	
Dorchester	Jeremiah E. Burke High School	Region: 6
Mohamud, Maryan	Discipline : Biology	TEAM Exhibit: F23
	Phenotypic Diversity	
Dorchester	Jeremiah E. Burke High School	Region: 6
Adeyemo, Victoria	Discipline : Environmental Science	TEAM Exhibit: F24
	Food Waste At The Burke	
Dudley	Shepherd Hill Regional High School	Region: 2
Miller, Jenna	Discipline : Biochemistry	Exhibit: G4
	Antimicrobial Affect of Silver	
East Boston	East Boston High School	Region: 6
Morales, Myah	Discipline : Biology	Exhibit: G14
	Testing GMO and DNA Extraction	
East Boston	East Boston High School	Region: 6
Ramos Chavez, Brian	Discipline : Behavioral Science	Exhibit: C13
	Listening to Music with Your Bones	

Easton	Southeastern Regional Vocational Technical High School	Region: 5
Elfman, Andrew	Discipline : Engineering	Exhibit: D8
	Designing a New Wing Shape	
Everett	Pioneer Charter School of Science	Region: 4
Hossaini, Chaimaa	Discipline : Biology	TEAM Exhibit: A15
	The Effect of Garlic Extract on the Lysozyme Activity of the B. Mori	
Everett	Pioneer Charter School of Science	Region: 4
Schastny, Alyssa	Discipline : Biology	TEAM Exhibit: A15
	The Effect of Garlic Extract on the Lysozyme Activity of the B. Mori	
Everett	Pioneer Charter School of Science	Region: 4
Bozo, Rim	Discipline : Biology	TEAM Exhibit: P5
	The Inhibition of E.coli Growth	
Everett	Pioneer Charter School of Science	Region: 4
Daniar, Adiva	Discipline : Computers	Exhibit: C9
	An Application of Machine Learning for Insulin Injections	
Everett	Pioneer Charter School of Science	Region: 4
Naittalb, Sarrah	Discipline : Biology	TEAM Exhibit: P5
	The Inhibition of E.coli Growth	
Falmouth	Falmouth Academy	Region: 5
Goldbach, James	Discipline : Biology	Exhibit: P20
	Testing the Potential of Marine Fungi to Bioremediate Crude Oil Spills	
Falmouth	Falmouth Academy	Region: 5
Glasgow, Noah	Discipline : Biology	Exhibit: H7
	The Acidifying Ocean's Effect on Protease Activity in Alteromonas	
Falmouth	Falmouth Academy	Region: 5
Rajagopal, Saniya	Discipline : Biology	Exhibit: J23
	Behavioral Response of Coral to Anthropogenic Noise	
Falmouth	Falmouth Academy	Region: 5
Clark, Silas	Discipline : Biology	Exhibit: H14
	The Impact of Temperature Changes on the Coral Microbiome	
Falmouth	Falmouth Academy	Region: 5
Thieler, Sarah	Discipline : Environmental Science	Exhibit: H25
	Exploring the Presence of Microplastics in Great Pond	
Falmouth	Falmouth Academy	Region: 5
Keeler, Emma	Discipline : Biology	Exhibit: N14
	The Classification of Fungal Derivatives with Clinical Potential	

Falmouth	Falmouth Academy	Region: 5
Gaetani, Ruby	Discipline : Environmental Science	Exhibit: J27
	Soybean Futures in a Changing Climate	
Falmouth	Falmouth Academy	Region: 5
Todd-Weinstein, Natalie	Discipline : Biology	Exhibit: N9
	The Effect of Sleep Deprivation on Cockroach Behavior	
Falmouth	Falmouth High School	Region: 5
Morris, Siobhan	Discipline : Physics & Electronics	Exhibit: D24
	A Correlation between Telescope Lens Diameter and Image Resolution	
Falmouth	Falmouth High School	Region: 5
Tang, Lawrence	Discipline : Computers	Exhibit: F13
	Using Machine Learning Techniques to Categorize the Seafloor	
Foxboro	Foxborough Regional Charter School	Region: 3
Husain, Abida	Discipline : Biochemistry	Exhibit: H9
	A Pill's Pathway	
Foxboro	Foxborough Regional Charter School	Region: 3
Kelsey, Hannah	Discipline : Environmental Science	Exhibit: K23
	The Effect of Hydrogen Peroxide on Grass Growth	
Foxborough	Foxborough Regional Charter School	Region: 3
Nafreere, Deeandria	Discipline : Biology	Exhibit: J9
	Effects of Alcohol and Aspartame on the Heart Rate of Daphnia magna	
Foxborough	Foxborough Regional Charter School	Region: 3
Desir, Thajhea	Discipline : Chemistry	Exhibit: H8
	Anatomy of A Kidney	
Grafton	Grafton Memorial Senior High School	Region: 2
Suraparaju, Krish	Discipline : Biology	TEAM Exhibit: B14
	Saving Plants Using Automation	
Grafton	Grafton Memorial Senior High School	Region: 2
Kelly, Emma	Discipline : Chemistry	TEAM Exhibit: H19
	DMS Produced by Phytoplankton as a Solution to Ocean Acidification	
Grafton	Grafton Memorial Senior High School	Region: 2
Seetharaman, Amruth	Discipline : Biology	TEAM Exhibit: B14
	Saving Plants Using Automation	
Grafton	Grafton Memorial Senior High School	Region: 2
Gupta, Yashvi	Discipline : Chemistry	TEAM Exhibit: H19
	DMS Produced by Phytoplankton as a Solution to Ocean Acidification	

Grafton	Grafton Memorial Senior High School	Region: 2
Fields, Jonathan	Discipline : Biology	TEAM Exhibit: B14
	Saving Plants Using Automation	
Greenfield	Stoneleigh-Burnham School	Region: 1
Lin, Xiandong	Discipline : Engineering	Exhibit: A2
	A Novel Wall-Climbing Hexapod Robot	
Hadley	Hopkins Academy	Region: 1
Cullen, Aedan	Discipline : Computers	Exhibit: C24
	A Problem-Agnostic Black Box Metaoptimization Strategy	
Holden	Wachusett Regional High School	Region: 2
Massoni-Nesman, Rianna	Discipline : Biology	Exhibit: B11
	The Effects of Cell Phone Electromagnetic Radiation on C. elegans	
Holden	Wachusett Regional High School	Region: 2
Xu, Eileen	Discipline : Biology	Exhibit: G17
	Testing the Inhibitory Effects of Straw on Algae	
Holden	Wachusett Regional High School	Region: 2
Schmalz, Katherine	Discipline : Biology	Exhibit: G18
	The Effect of Preadult Malnutrition on Offspring Learning and Memory	
Holden	Wachusett Regional High School	Region: 2
Mizerak, Elise	Discipline : Biology	Exhibit: G20
	The Effect of Lithium on Learning and Memory in D. Melanogaster	
Holden	Wachusett Regional High School	Region: 2
Dwyer, Benjamin	Discipline : Biology	Exhibit: B28
	The Effects of Carbon vs. Phosphates on Algal Growth +Lipid Production	
Holden	Wachusett Regional High School	Region: 2
Giwa, Hadiya	Discipline : Biology	Exhibit: H17
	Evaluating the Safety of Baby Powder	
Holden	Wachusett Regional High School	Region: 2
Volfson, Alexa	Discipline : Biology	Exhibit: H1
	The Effect of Propolis on E. coli	
Hopedale	Hopedale Junior Senior High School	Region: 2
Chen, Angie	Discipline : Environmental Science	Exhibit: J17
	Do You See What I Sea?	
Hopkinton	Hopkinton High School	Region: 2
Miller, Alannah	Discipline : Biochemistry	TEAM Exhibit: B17
	Let's Yeet This Wheat: Removing Gluten from Fryer Oil	

Hopkinton	Hopkinton High School	Region: 2
Puttaraju, Thrusha	Discipline : Behavioral Science	Exhibit: C2
	Activation of R26E01 Neurons/dsx Enhance Aggression in Drosophila	
Hopkinton	Hopkinton High School	Region: 2
Nemalikanti, Archita	Discipline : Computers	TEAM Exhibit: B8
	Calling 911 When Detecting an Irregular Heart Rate Using Arduino	
Hopkinton	Hopkinton High School	Region: 2
Stolyar, Alisa	Discipline : Biochemistry	TEAM Exhibit: B17
	Let's Yeet This Wheat: Removing Gluten from Fryer Oil	
Hopkinton	Hopkinton High School	Region: 2
Rosen, Elan	Discipline : Biology	TEAM Exhibit: F19
	Engineering of Congenic Huntington Fibroblast Cell Lines, Using CRISPR	
Hopkinton	Hopkinton High School	Region: 2
Kaur, Simran	Discipline : Physics & Electronics	Exhibit: C6
	The Mystery Behind Aerial Warfare	
Hopkinton	Hopkinton High School	Region: 2
Nene, Advait	Discipline : Engineering	Exhibit: B27
	Patient Specific Proton Beam Radiation Delivery	
Hopkinton	Hopkinton High School	Region: 2
Khan, Shazain	Discipline : Biology	TEAM Exhibit: F19
	Engineering of Congenic Huntington Fibroblast Cell Lines, Using CRISPR	
Hopkinton	Hopkinton High School	Region: 2
Fardin, Fariha	Discipline : Biology	Exhibit: J19
	Spill The Tea, Sis: Can Green Tea Prevent & Cure Cancer	
Hopkinton	Hopkinton High School	Region: 2
Rajgor , Tanisha	Discipline : Computers	TEAM Exhibit: B8
	Calling 911 When Detecting an Irregular Heart Rate Using Arduino	
Hopkinton	Hopkinton High School	Region: 2
Minocha, Rohan	Discipline : Engineering	Exhibit: A9
	Systems & Methods for Automated Programmable Dispensing of Medication	
Hudson	Hudson High School	Region: 2
Clardy , Lily	Discipline : Environmental Science	TEAM Exhibit: H16
	Mealworms Biodegrading Styrofoam	
Hudson	Hudson High School	Region: 2
Togneri, Charles	Discipline : Engineering	Exhibit: K3
	Making Astronomical Observations Using the Electromagnetic Spectrum	

Hudson	Hudson High School	Region: 2
Genova, Abby	Discipline : Environmental Science	TEAM Exhibit: H16
	Mealworms Biodegrading Styrofoam	
Hyannis	St. John Paul II High School	Region: 5
Walsh , Lauren	Discipline : Biology	Exhibit: N11
	The Effect of Common Chemicals on Daphnia Heart Rate	
Hyannis	St. John Paul II High School	Region: 5
August, Colby	Discipline : Engineering	TEAM Exhibit: N23
	Active Aerodynamics for Automobiles	
Hyannis	St. John Paul II High School	Region: 4
Schiffer, Ben	Discipline : Engineering	TEAM Exhibit: N23
	Active Aerodynamics for Automobiles	
Kingston	Silver Lake Regional High School	Region: 5
Whidden, Cole	Discipline : Engineering	TEAM Exhibit: D14
	Dynamically Controlled First Person Viewing System For Drones	
Kingston	Silver Lake Regional High School	Region: 5
Tierney, Ryan	Discipline : Engineering	TEAM Exhibit: D14
	Dynamically Controlled First Person Viewing System For Drones	
Kingston	Silver Lake Regional High School	Region: 5
Beatrice, Kyle	Discipline : Engineering	TEAM Exhibit: D21
	Bioelectrically-Controlled Robotic Hand	
Kingston	Silver Lake Regional High School	Region: 5
Smith, Gordon	Discipline : Engineering	TEAM Exhibit: D21
	Bioelectrically-Controlled Robotic Hand	
Kingston	Silver Lake Regional High School	Region: 5
Mirisola, Joseph	Discipline : Environmental Science	Exhibit: N21
	Aquaponics	
Leominster	Leominster High School	Region: 2
Casey, Connor	Discipline : Biology	Exhibit: N2
	Modeling and Treating Cardiac Arrthmias using Caenorhbditis elegans	
Lexington	Lexington High School	Region: 4
Zhang, Patrick	Discipline : Computers	TEAM Exhibit: K16
	Direct Anonymous Attestation with Subverted Platforms	
Lexington	Lexington High School	Region: 4
Mattingly, Ella	Discipline : Environmental Science	TEAM Exhibit: N4
	The Arlington Reservoir: An Analysis of Climate Change Preparedness	

Lexington	Lexington High School	Region: 4
Chakravarti, Sachiv	Discipline : Biology	TEAM Exhibit: J5
	Phylogenetics of an Evolving Viral Population	
Lexington	Lexington High School	Region: 4
Sankar, Sanjana	Discipline : Environmental Science	TEAM Exhibit: N4
	The Arlington Reservoir: An Analysis of Climate Change Preparedness	
Lexington	Lexington High School	Region: 4
Anantha, Sidharth	Discipline : Engineering	Exhibit: B7
	Seeing For The Blind	
Lexington	Lexington High School	Region: 4
Puri, Ashish	Discipline : Engineering	Exhibit: A19
	Self-Healing Circuit Networks in Resilient Power Distribution Systems	
Lexington	Lexington High School	Region: 4
Lawrence, Claire	Discipline : Biology	TEAM Exhibit: F16
	The Effects of Temperature on C3 vs. C4 Plants	
Lexington	Lexington High School	Region: 4
Pathak, Devesh	Discipline : Biology	Exhibit: D5
	The Role of Intracellular Trafficking in Immune Response to Lyme	
Lexington	Lexington High School	Region: 4
Liu, Sarah	Discipline : Chemistry	Exhibit: B23
	Finding an Efficient Method to Remove Phosphate from Water	
Lexington	Lexington High School	Region: 4
Ray, Roshni	Discipline : Biology	Exhibit: D20
	A Bioinformatics Analysis of Circadian Rhythms	
Lexington	Lexington High School	Region: 4
Ding, Elizabeth	Discipline : Biology	Exhibit: J4
	Ultrasensitive Detection of Early Cancer by ctDNA Sequencing with UMIs	
Lexington	Lexington High School	Region: 4
Olofsson, Michelle	Discipline : Biology	TEAM Exhibit: F16
	The Effects of Temperature on C3 vs. C4 Plants	
Lexington	Lexington High School	Region: 4
Ahmed, Rayhan	Discipline : Biology	TEAM Exhibit: J5
	Phylogenetics of an Evolving Viral Population	
Lexington	Lexington High School	Region: 4
Bhalla, Neel	Discipline : Computers	Exhibit: D6
	Defenses Against Adversarial Examples Using Signal Processing Tech.	

Lexington Lamm, Maya	Lexington High School Discipline : Biology The Possible Effect of Nitrogen on Venus Fly Trap Action Potential	Region: 4 Exhibit: B20
Lexington Erives, Ezra	Lexington High School Discipline : Mathematics Asymptotics of k-Dimensional Visibility	Region: 4 TEAM Exhibit: J6
Lexington Sathiamurthy, Srinivasan	Lexington High School Discipline : Mathematics Asymptotics of k-Dimensional Visibility	Region: 4 TEAM Exhibit: J6
Malden Amador, Isabella	Edward M. Kennedy Academy for Health Careers Discipline : Chemistry Fiji vs. Poland Springs	Region: 6 TEAM Exhibit: P8
Marlborough Raun, Morgan	Marlborough High School Discipline : Biology Organic Sulforaphane: A Novel Treatment to Reduce Malarial Progression	Region: 2 TEAM Exhibit: N3
Marlborough Dion, Jillian	Marlborough High School Discipline : Biology Myelin Sheath Regeneration in the Neurons of Zebrafish	Region: 2 Exhibit: G6
Marlborough Paul, Carter	Marlborough High School Discipline : Biology Effects of Wax Worm Digestive Bacteria on Polyethylene Biodegradation	Region: 2 TEAM Exhibit: D18
Marlborough Thomas Cruz, Ana	Assabet Valley Vocational High School Discipline : Biology The Effect of Naturopathic Substances to Regenerate Planaria	Region: 2 Exhibit: C4
Marlborough Harpin, Rachelle	Assabet Valley Vocational High School Discipline : Environmental Science Effectiveness of Specialized Microbes on Synthetic and Organic Greases	Region: 2 TEAM Exhibit: H6
Marlborough Moore, Timothy	Assabet Valley Vocational High School Discipline : Environmental Science Effectiveness of Specialized Microbes on Synthetic and Organic Greases	Region: 2 TEAM Exhibit: H6
Marlborough Piratla, Srivishnu	Advanced Math and Science Academy Discipline : Computers R-View	Region: 2 Exhibit: B21
Marlborough Paul, Harrison	Marlborough High School Discipline : Biology Effects of Wax Worm Digestive Bacteria on Polyethylene Biodegradation	Region: 2 TEAM Exhibit: D18

Marlborough	Marlborough High School	Region: 2
Minier, Ian	Discipline : Biology	TEAM Exhibit: D18
	Effects of Wax Worm Digestive Bacteria on Polyethylene Biodegradation	
Marlborough	Home School	Region: 2
Berger, Ella	Discipline : Physics & Electronics	Exhibit: B9
	Relativity: The Secrets of the Octonions	
Marlborough	Marlborough High School	Region: 2
Rainville, Olivia	Discipline : Biology	TEAM Exhibit: N3
	Organic Sulforaphane: A Novel Treatment to Reduce Malarial Progression	
Marlborough	Advanced Math and Science Academy	Region: 2
Peerzade, Sayedazhar	Discipline : Engineering	Exhibit: C26
	Smart White Cane	
Medford	Medford High School	Region: 4
Farah, Albert	Discipline : Engineering	Exhibit: A11
	Modeling Mass Flow Distribution in a Multistage Rocket Concept Design	
Medford	Medford High School	Region: 4
Elkondakly, Sarah	Discipline : Biology	TEAM Exhibit: J1
	The Motion of Blood Flow through Different Aortic Heart Valve Models	
Medford	Medford High School	Region: 4
Simco, Morgan	Discipline : Biology	TEAM Exhibit: J1
	The Motion of Blood Flow through Different Aortic Heart Valve Models	
Medford	Medford High School	Region: 4
Dhaurali, Shubhecchha	Discipline : Biology	Exhibit: B3
	Comparing Muscle Hemodynamics in Human Calves w/ & w/out a Thigh Cuff	
Milton	Milton Academy	Region: 5
Fan, Yutian	Discipline : Computers	Exhibit: P17
	Rehabilitation System for Limb Movement Evaluation	
Mount Hermon	Northfield-Mt.Hermon School	Region: 1
Bao, Yuxuan	Discipline : Computers	Exhibit: C27
	Effects of Different Training Sets on Image Classification	
Mount Hermon	Northfield-Mt.Hermon School	Region: 1
Baek, Jung Won	Discipline : Mathematics	Exhibit: F20
	A New Space Filling Technique Using a Domain Transformation Method	
Newton	Newton Country Day School	Region: 5
Leshner, Elizabeth	Discipline : Biology	Exhibit: N17
	Which Factors Increase the Risk of Contracting the Common Cold?	

Newton Hartman, Emma	Newton Country Day Sch/Sacred Heart Discipline : Engineering Identifying EEG Correlates to Intentional Motor Movement	Region: 5 Exhibit: J21
Newton McGauley, Katelyn	Newton Country Day Sch/Sacred Heart Discipline : Environmental Science The Parallel between Rising Shark and Seal Populations Off Cape Cod	Region: 5 Exhibit: J26
Newton De Luis, Maya	Newton Country Day School Discipline : Biology Isolating and Identifying Fungal Endophytes in Seaweed	Region: 5 Exhibit: N8
Newton Centre Cole, Matthew	Newton South High School Discipline : Behavioral Science Effect of Music Exposures on High School Student Cognitive Performance	Region: 5 Exhibit: P3
North Adams Casey, Conroy	Berkshire Arts & Technology Charter Public School Discipline : Chemistry Table Salt. Surprisingly Complex	Region: 1 Exhibit: C15
North Attleboro Doddipalli, Niya	North Attleboro High School Discipline : Engineering Predicting College Admissions Using AI	Region: 3 Exhibit: F14
North Attleboro Sunkari, Aakash	North Attleboro High School Discipline : Physics & Electronics Quantum Catalyzation of a Portable, High Energy Nuclear "ARC" Reactor	Region: 3 Exhibit: D13
North Attleboro Gupta, Mahika	North Attleboro High School Discipline : Environmental Science Purification of Waste Water	Region: 3 Exhibit: H24
North Attleborough Patel, Hirni	North Attleboro High School Discipline : Behavioral Science Memory In A Tech Savvy World	Region: 3 Exhibit: J13
North Dartmouth Gendron, Camille	Bishop Stang High School Discipline : Biology Decellularization of Spinach and Its Application to Medicine	Region: 3 Exhibit: N27
Northfield Pan, Edward	Northfield-Mt.Hermon School Discipline : Behavioral Science Evaluation and Resolution of Reading Literacy in Rural China	Region: 1 Exhibit: D4
Pittsfield Parlapiano, Cloey	Taconic High School Discipline : Biochemistry Reef Safe SPF 30 Sunscreens	Region: 1 Exhibit: C3

Pittsfield Arace, Gianna	Taconic High School Discipline : Biochemistry Saving the Environment One Utensil at a Time	Region: 1 Exhibit: K5
Pittsfield Shin, Jiho	Miss Hall's School Discipline : Engineering Programmable Water Bottle Heater from Arduino and 3D Printing	Region: 1 Exhibit: J20
Plymouth St. Aubin, Owen	Plymouth South High School Discipline : Biology Jack and the Glow in the Dark Bean Stalk	Region: 5 Exhibit: J14
Plymouth Morse, Julianne	Plymouth South High School Discipline : Biology Ajoene: The Silencer	Region: 5 Exhibit: H12
Plymouth Godfrey, Alexandra	Plymouth South High School Discipline : Environmental Science Is Organic GMO-free?	Region: 5 Exhibit: K28
Plymouth Manic, Mila	Plymouth South High School Discipline : Biology The Effects of Juul Juice on <i>Saccharomyces cerevisiae</i>	Region: 5 Exhibit: D23
Quincy Nguyen, Liem	North Quincy High School Discipline : Biology The Effect of Duration of Light Exposure on the Color of <i>Artemia</i>	Region: 5 Exhibit: F9
Quincy Ngo, Andrea	North Quincy High School Discipline : Environmental Science Sweet Pea Plant Growth Using Tea	Region: 5 Exhibit: K7
Quincy Tran, Vivian	North Quincy High School Discipline : Biology Is the Efficacy of Soap Constant?	Region: 5 Exhibit: P1
Quincy Chen, Song Yu	North Quincy High School Discipline : Chemistry Impact of Additives on Surface Tension	Region: 5 Exhibit: J25
Quincy Berberi, Fiona	North Quincy High School Discipline : Environmental Science Methods That Speed Up Germination	Region: 5 Exhibit: J10
Quincy Flores Munoz, Pablo	North Quincy High School Discipline : Environmental Science Specific Leaf Area and Decomposition Rate, Are They Related?	Region: 5 Exhibit: J11

Quincy Karki, Supriti	Quincy High School Discipline : Physics & Electronics Exploring the Diffractive Bending of Light Through Apertures	Region: 5 Exhibit: K11
Quincy Becka, Helga	Quincy High School Discipline : Environmental Science Bio-digester Solving Energy Problems in Developing Countries	Region: 5 Exhibit: K22
Rockland Leopold, Grace	Calvary Chapel Academy Discipline : Environmental Science How Does Sodium Chloride Affect a Microbial Fuel Cell's Power Output?	Region: 5 Exhibit: K27
Roxbury Phan, Sally	John D. O'Bryant School of Mathematics and Science Discipline : Environmental Science Ocean Acidification	Region: 6 TEAM Exhibit: H5
Sandwich Rotondo, Joseph	Upper Cape Cod Vocational Technical High School Discipline : Environmental Science Redesigning a Soil Moisture Radar for Drone Application	Region: 5 Exhibit: P4
Saugus Ngokila, Maryam	Pioneer Charter School of Science II Discipline : Engineering Water Purification Through Solar Disillation	Region: 4 Exhibit: K24
Saugus Nasankar, Shakaani	Pioneer Charter School of Science II Discipline : Biochemistry Artificial Pancreas: Making Lives Easier	Region: 4 Exhibit: B4
Saugus Boutarf, Chimaa	Pioneer Charter School of Science II Discipline : Environmental Science Neurotoxicological Effect of Perfluorohexane Sulfonate on Dugesia t.	Region: 4 Exhibit: J16
Saugus Campos, Maria-Isabela	Pioneer Charter School of Science II Discipline : Biology Turmeric vs. Bacteria	Region: 4 Exhibit: J18
Saugus Nasankar, Sharani	Pioneer Charter School of Science II Discipline : Biology Effects of Magnetism on Dugesia Tigrina Regeneration and Growth	Region: 4 Exhibit: N19
Saugus Najah, Aiman	Pioneer Charter School of Science II Discipline : Environmental Science Carbon Dioxide Capture Using Polyethylenimine Infused Silica Gel	Region: 4 Exhibit: A7
Sharon Ravikumar, Akshaya	Sharon High School Discipline : Biology Investigation of the Genetics of Smoking Behavior in the UK Biobank	Region: 5 Exhibit: N12

Sharon	Sharon High School	Region: 5
Danila, Andrea	Discipline : Computers	Exhibit: D25
	Toxic or Not: Using Machine Learning to Predict Toxicity	
Shewsbury	St. John's High School	Region: 2
Mohsin, Saad	Discipline : Biology	Exhibit: K4
	Synthetic Biology for Treating Neurodegenerative Diseases	
Shewsbury	Shewsbury High School	Region: 2
Bhattacharjee, Neelasha	Discipline : Engineering	Exhibit: C12
	Are You Seeing What I'm Seeing? Analyzing Glaucoma Patient Data	
Shewsbury	Shewsbury High School	Region: 2
Hollyer, Joshua	Discipline : Engineering	TEAM Exhibit: A23
	Pharm: A Pill Dispenser Designed to Control Opioid Abuse	
Shewsbury	St. John's High School	Region: 2
Syed, Muneeb	Discipline : Engineering	TEAM Exhibit: C21
	Gun Control without the Politics	
Shewsbury	Shewsbury High School	Region: 2
Prabakar, Ajan	Discipline : Engineering	TEAM Exhibit: A23
	Pharm: A Pill Dispenser Designed to Control Opioid Abuse	
Shewsbury	St. John's High School	Region: 2
Sukthankar, Ashwin	Discipline : Computers	Exhibit: D9
	Teletherapy Platform with Integrated Eye Tracking Technology	
Shewsbury	Shewsbury High School	Region: 2
Mishra, Arnav	Discipline : Engineering	Exhibit: A14
	Helping the Blind: One Step at a Time	
Shewsbury	Shewsbury High School	Region: 2
Prabhakar, Garima	Discipline : Earth & Space Science	Exhibit: C22
	An Algorithm to Uncover Exoplanets Using Stellar Spectral Properties	
Shewsbury	Shewsbury High School	Region: 2
Anisetti , Shravya	Discipline : Engineering	Exhibit: C17
	Detecting and Gathering PET in Landfills	
Shewsbury	St. John's High School	Region: 2
Mufti, Saad	Discipline : Engineering	TEAM Exhibit: C21
	Gun Control without the Politics	
Shewsbury	Shewsbury High School	Region: 2
Emani, Sreeanvitha	Discipline : Biochemistry	Exhibit: C1
	HeLa and NIH/3T3 Activity on Plastic Tissue Culture and PDMS Substrate	

Shrewsbury Kumar, Akash	Shrewsbury High School Discipline : Computers Is It a Plane? Is It a Dragonfly? Ask the Machine	Region: 2 Exhibit: B22
Somerville Abrams-Greenberg, Aaren	Somerville High School Discipline : Physics & Electronics Concentrated Sound Waves and the Extinguishing of Flame	Region: 4 TEAM Exhibit: A24
Somerville Rossi, Ramon	Somerville High School Discipline : Chemistry What Effect Does Low pH Acid Rain Have on Different Coatings?	Region: 4 TEAM Exhibit: J28
Somerville Ayanna, Henry	Somerville High School Discipline : Computers The Evolution of Buses: Optimizing Bus Routes Using Genetic Algorithms	Region: 4 TEAM Exhibit: D10
Somerville Millette, Justin	Somerville High School Discipline : Physics & Electronics Concentrated Sound Waves and the Extinguishing of Flame	Region: 4 TEAM Exhibit: A24
Somerville Haxhimali, Era	Somerville High School Discipline : Chemistry What Effect Does Low pH Acid Rain Have on Different Coatings?	Region: 4 TEAM Exhibit: J28
Somerville Goldstein-Gelb, Brayden	Somerville High School Discipline : Computers The Evolution of Buses: Optimizing Bus Routes Using Genetic Algorithms	Region: 4 TEAM Exhibit: D10
Somerville Gaffney, Tyler	Somerville High School Discipline : Environmental Science Determining Effectiveness of Water Filtration Methods Using D. magna	Region: 4 Exhibit: B16
Somerville Booth, Justin	Somerville High School Discipline : Chemistry Effects of Food Additives on Maillard Reaction and Water Loss	Region: 4 Exhibit: K19
South Boston Bravo, Hailey	Excel High School Discipline : Environmental Science Treated Plants	Region: 6 TEAM Exhibit: G12
South Boston Cetinbas, Ece	Excel High School Discipline : Engineering Super Magnets	Region: 6 TEAM Exhibit: P18
South Boston Martinez, Pamela	Excel High School Discipline : Environmental Science Treated Plants	Region: 6 TEAM Exhibit: G12

South Boston	Excel High School	Region: 6
Guerrier, Davidson	Discipline : Engineering	TEAM Exhibit: P18
	Super Magnets	
South Easton	Southeastern Regional Vocational Technical High School	Region: 5
Spooner, Nicholas	Discipline : Engineering	TEAM Exhibit: D22
	Smart Glasses	
South Easton	Southeastern Regional Vocational Technical High School	Region: 5
Ural, Barut	Discipline : Physics & Electronics	Exhibit: F7
	A Simple Low-Cost Device To Measure Fluid Viscosity	
South Easton	Southeastern Regional Vocational Technical High School	Region: 5
Goncalves , Zelinda	Discipline : Engineering	TEAM Exhibit: K14
	DIY Stethoscope	
South Easton	Southeastern Regional Vocational Technical High School	Region: 5
Seaver, Rachel	Discipline : Engineering	TEAM Exhibit: K14
	DIY Stethoscope	
South Easton	Southeastern Regional Vocational Technical High School	Region: 5
Reid, Jaden	Discipline : Engineering	TEAM Exhibit: D22
	Smart Glasses	
South Easton	Southeastern Regional Vocational Technical High School	Region: 5
Flores, Alberto	Discipline : Computers	Exhibit: D11
	Quality Printing, A How To!	
South Grafton	Grafton Memorial Senior High School	Region: 2
Shapally , Himasri	Discipline : Chemistry	TEAM Exhibit: H19
	DMS Produced by Phytoplankton as a Solution to Ocean Acidification	
Southborough	St. Mark's School	Region: 2
Dion, Haley	Discipline : Biochemistry	Exhibit: H4
	Impact of ApoE on IGF-1 Signaling in Alzheimer's Disease	
Southborough	St. Mark's School	Region: 2
Wang, Yuchen	Discipline : Biology	Exhibit: N25
	Creating a Noninvasive Glucose Monitoring System for Diabetic Patients	
Southborough	St. Mark's School	Region: 2
Verbeek, Kerrie	Discipline : Biology	Exhibit: G16
	The Effects of Exercise on Aggression in a SIgA Model of Schizophrenia	
Southborough	St. Mark's School	Region: 2
Gattuso, Grant	Discipline : Biology	Exhibit: A3
	Ketogenic Diet in a Drosophila Model of Parkinson's Disease	

Southborough Choi, Jiwon	St. Mark's School Discipline : Engineering Bio-ink: Evaluation of Protein as Biomaterials for 3D Bioprinting	Region: 2 Exhibit: A18
Southborough Christy, Megan	St. Mark's School Discipline : Biochemistry Electrospun Polymer Materials for Endothelialization on Stent Grafts	Region: 2 Exhibit: A5
Southborough Coté, Luc	St. Mark's School Discipline : Computers Privacy Vulnerabilities within IoT Device Traffic	Region: 2 Exhibit: A25
Southborough Jennings, Faith	St. Mark's School Discipline : Biology The Effect of Stressors on Telomeres Using C. elegans as a Model	Region: 2 Exhibit: N16
Stoughton McSweeney, Emma	Stoughton High School Discipline : Biochemistry Shining a Light on Phototherapy: Using Blue Light to Stop Infection	Region: 5 TEAM Exhibit: G9
Stoughton Billo, Tess	Stoughton High School Discipline : Biochemistry Can You Go "All Natural" With Antibiotics?	Region: 5 Exhibit: N24
Stoughton Rush, Juliana	Stoughton High School Discipline : Biochemistry Shining a Light on Phototherapy: Using Blue Light to Stop Infection	Region: 5 TEAM Exhibit: G9
Swampscott Fulghum, Mariel	Swampscott High School Discipline : Chemistry How Do CO2 Levels in Sea Water Affect Algae Growth?	Region: 4 Exhibit: N1
Swampscott Tribendis, Allison	Swampscott High School Discipline : Chemistry Impact of Increasing Liquids on Diluting Digestion	Region: 4 TEAM Exhibit: K17
Swampscott Tribendis, Madeline	Swampscott High School Discipline : Chemistry Impact of Increasing Liquids on Diluting Digestion	Region: 4 TEAM Exhibit: K17
Taunton Pereira, Alexander	Taunton High School Discipline : Biology Effects of Alcohol on Flatworm Regeneration	Region: 3 Exhibit: G27
Taunton Alicea, Aracely	Taunton High School Discipline : Biology Does Caffeine or Sugar Have a Greater Effect on Heart Rate?	Region: 3 Exhibit: H11

Taunton Muller, Brianna	Taunton High School Discipline : Physics & Electronics Magnetic Force Variations with Temperature	Region: 3 Exhibit: G28
Taunton Joseph, Rachel	Taunton High School Discipline : Behavioral Science Multitasking: Gain or Drain?	Region: 3 Exhibit: G13
Taunton Tavares, Nolan	Taunton High School Discipline : Chemistry Which Dilutions of Gatorade Are Safe to Drink?	Region: 3 Exhibit: K9
Taunton Schumacher, Samuel	Taunton High School Discipline : Computers Which Sorting Algorithm is the Fastest on Average for Sorting Lists?	Region: 3 Exhibit: D12
Taunton Muratore, California	Taunton High School Discipline : Biochemistry The Effects of Silver Nanoparticles on Drug Resistant Bacteria	Region: 3 Exhibit: H22
Taunton LeMaire, Tatum	Taunton High School Discipline : Environmental Science The Dangerous Effects of Sunscreen on Freshwater Plants	Region: 3 Exhibit: H10
Taunton Anger, Abigail	Taunton High School Discipline : Biology Sex Determination in Brine Shrimp	Region: 3 Exhibit: H23
Taunton Weber, Olivia	Taunton High School Discipline : Biology Ultrasonic Enhancement of Antibiotics on Bacteria	Region: 3 Exhibit: G11
West Roxbury Julmiste, Ashley	West Roxbury High School Discipline : Chemistry Does the Temperature Affect the Growth of Crystals?	Region: 6 Exhibit: P9
West Roxbury Huezo-Santiago, Tashaina	Urban Science Academy Discipline : Biology The Effect of Nitrate Levels in Polluted Water on Daphnia	Region: 6 TEAM Exhibit: H15
West Roxbury Zhang, Andrew	Roxbury Latin School Discipline : Computers Antimicrobial Resistance Prediction Using Convolutional Neural Network	Region: 5 Exhibit: J7
Westborough Sadagopan, Ananthan	Westborough High School Discipline : Biochemistry IFN γ Susceptibility in Chordoma	Region: 2 Exhibit: A16

Westborough	Westborough High School	Region: 2
Patta, Anoop	Discipline : Biochemistry	TEAM Exhibit: B18
	Designing a Thyroid Hormone Detection System	
Westborough	St. John's High School	Region: 2
Wadekar, Adway	Discipline : Behavioral Science	Exhibit: A4
	Predicting Opioid Use Disorder (OUD) Using Machine Learning	
Westborough	Westborough High School	Region: 2
Wang, Anzhuo	Discipline : Engineering	Exhibit: C8
	Home Status Hub with Arduino	
Westborough	Westborough High School	Region: 2
Sane, Eshan	Discipline : Biochemistry	TEAM Exhibit: B18
	Designing a Thyroid Hormone Detection System	
Westfield	Westfield High School	Region: 1
Legkodukh, Evelynna	Discipline : Engineering	Exhibit: D16
	Testing Bridge Length Based on Bridge Span	
Westfield	Westfield High School	Region: 1
Goretskiy, Stefan	Discipline : Environmental Science	Exhibit: F18
	Injection of Oryzalin: Transformation of Daylilies into Tetraploids	
Westfield	Westfield High School	Region: 1
Goyette, Abby	Discipline : Chemistry	Exhibit: D17
	Concentration of Red Dye 40 in Sports Drinks	
Westfield	Westfield High School	Region: 1
Sundararajan, Suvin	Discipline : Chemistry	Exhibit: B25
	Analysis of Mfg. Process of D-Glucose-Based Thermoformed-Polymers	
Westfield	Westfield High School	Region: 1
Rae, Mackenzie	Discipline : Physics & Electronics	TEAM Exhibit: H3
	The Effects of Using App Functions on a Cellular Electromagnetic Field	
Westfield	Westfield High School	Region: 1
Jury, Ellen	Discipline : Biology	TEAM Exhibit: F1
	Using Daphnia Magna to Examine Water Acidity	
Westfield	Westfield High School	Region: 1
Hinck, Stephen	Discipline : Computers	TEAM Exhibit: C28
	Multi-Scale GPA Conversion Calculator	
Westfield	Westfield High School	Region: 1
Kayzakian, Imma	Discipline : Biology	Exhibit: C7
	The Effect of Wireless Fidelity on Planarian Regeneration	

Westfield	Westfield High School	Region: 1
Duncan , Nicholas	Discipline : Computers	TEAM Exhibit: C28
	Multi-Scale GPA Conversion Calculator	
Westfield	Westfield High School	Region: 1
Petzold, Emma	Discipline : Biology	TEAM Exhibit: N5
	The Effects of Homemade Water Filters	
Westfield	Westfield High School	Region: 1
Servetnik, Nicole	Discipline : Biology	Exhibit: H20
	The Efficacy of Subzero Storage Methods on Dietary Proteins	
Westfield	Westfield High School	Region: 1
Regnier, Elizabeth	Discipline : Chemistry	TEAM Exhibit: D7
	Quantifying Effect of a Rapid Temperature Increase on Coral Bleaching	
Westfield	Westfield High School	Region: 1
Stathatos, Nicholas	Discipline : Engineering	TEAM Exhibit: D19
	Concrete's Strength Lies in Aggregate	
Westfield	Westfield High School	Region: 1
Sgueglia, Stephanie	Discipline : Engineering	TEAM Exhibit: D19
	Concrete's Strength Lies in Aggregate	
Westfield	Westfield High School	Region: 1
Morrissey, Catherine	Discipline : Chemistry	TEAM Exhibit: D7
	Quantifying Effect of a Rapid Temperature Increase on Coral Bleaching	
Westfield	Westfield High School	Region: 1
Pease, Emilie	Discipline : Physics & Electronics	TEAM Exhibit: H3
	The Effects of Using App Functions on a Cellular Electromagnetic Field	
Westfield	Westfield High School	Region: 1
Morrissey, Brendan	Discipline : Biology	TEAM Exhibit: D15
	Statistical and Cost Effective Lens on Computers at WHS	
Westfield	Westfield High School	Region: 1
Suhocki, Anthony	Discipline : Biology	Exhibit: J2
	What Cleaning Solutions Are the Best for Disinfecting Wrestling Mats	
Westfield	Westfield High School	Region: 1
Prenosil, Nina	Discipline : Biology	TEAM Exhibit: F1
	Using Daphnia Magna to Examine Water Acidity	
Westfield	Westfield High School	Region: 1
Przechocki, Charles	Discipline : Engineering	Exhibit: B2
	Scientific Study Comparing Adhesives as Threadlocker Alternative	

Westfield	Westfield High School	Region: 1
Menzel, Abigail	Discipline : Biology	TEAM Exhibit: N5
	The Effects of Homemade Water Filters	
Westfield	Westfield High School	Region: 1
Chisholm, Aiden	Discipline : Biology	TEAM Exhibit: D15
	Statistical and Cost Effective Lens on Computers at WHS	
Westfield	Westfield High School	Region: 1
Gravel-Blaney, Zachariah	Discipline : Physics & Electronics	Exhibit: G26
	Wifi-Signal Strength, Obstructed and Measured	
Westfield	Westfield High School	Region: 1
Stucenski, Trent	Discipline : Biology	Exhibit: F2
	The Extension of Time before Growth of Mold on Food Via Silica Gel	
Westfield	Westfield High School	Region: 1
Bone, Emily	Discipline : Chemistry	Exhibit: K20
	Creating Bioplastic from Starch	
Westfield	Westfield High School	Region: 1
Chumakova, Yana	Discipline : Physics & Electronics	Exhibit: C10
	Piezoelectricity	
Westfield	Westfield High School	Region: 1
Shvyryd, Tetyana	Discipline : Biology	Exhibit: F17
	The Time it Takes Painkillers to Dissolve in the Stomach	
Westford	Westford Academy	Region: 4
Mendes, Ethan	Discipline : Computers	TEAM Exhibit: K16
	Direct Anonymous Attestation with Subverted Platforms	
Weston	Weston High School	Region: 5
Chen, Benjamin	Discipline : Computers	TEAM Exhibit: D26
	Using Machine Learning to Predict Flu Outbreaks	
Weston	Weston High School	Region: 5
Malur, Neil	Discipline : Computers	TEAM Exhibit: D26
	Using Machine Learning to Predict Flu Outbreaks	
Weston	Weston High School	Region: 5
Saligrama, Aditya	Discipline : Computers	Exhibit: F11
	KnowBias: A Novel AI Method to Detect Political Bias in Text	
Worcester	Mass. Academy of Math & Science	Region: 2
Heggadahalli, Bharath	Discipline : Engineering	Exhibit: J15
	ACL Tear Prevention: Engineering a More Efficient Knee Brace	

Worcester Bhuiyan, Mymoon	Burncoat Senior High School Discipline : Environmental Science Utilizing Algae Based PhotoBioreactors To Reduce Carbon Dioxide	Region: 2 Exhibit: C11
Worcester Perumal, Neha	Mass. Academy of Math & Science Discipline : Biochemistry The Efficacy of Gefitinib in Lung Cancer Causing EGFR Mutations	Region: 2 Exhibit: G5
Worcester Mclaren, Nilay	Mass. Academy of Math & Science Discipline : Engineering Economical Device for Detection of Pneumonia Causing Pathogens	Region: 2 Exhibit: F4
Worcester Nathan, Krish	Mass. Academy of Math & Science Discipline : Biochemistry Designing a Thyroid Hormone Detection System	Region: 2 TEAM Exhibit: B18
Worcester Ng, Esther	Mass. Academy of Math & Science Discipline : Biology The Effects of Metalloproteinase Inhibition on UV-Induced Danio rerio	Region: 2 Exhibit: A1
Worcester Vardar, Nazif	St. Peter-Marian Jr. Sr. CCHS Discipline : Computers A Sound-Based Mobile Application for People with Sleep Disorders	Region: 2 Exhibit: B26
Worcester Onffroy, Maxwell	Bancroft School Discipline : Chemistry Using Superhydrophobic Coatings to Prevent Corrosion	Region: 2 Exhibit: B5
Worcester Adiletta, Andrew	Worcester Academy Discipline : Computers A Study In The Traveling Salesman Problem	Region: 2 Exhibit: A28
Worcester Gardner, Marissa	Mass. Academy of Math & Science Discipline : Biology Effects of Methylene Blue on Drosophila Models of Huntington's Disease	Region: 2 Exhibit: A17
Worcester Huffman, Annabelle	Bancroft School Discipline : Behavioral Science Correlative Study between DiSC Personality Type and Conformity	Region: 2 Exhibit: C5
Worcester Frisella, Megan	Mass. Academy of Math & Science Discipline : Behavioral Science Investigating Economic Influence on Homeless Populations in Boston, MA	Region: 2 Exhibit: F6
Worcester Chintalapati, Arun	Mass. Academy of Math & Science Discipline : Biology Effects of Sensory Stimuli on Memory in Alzheimer's Drosophila Models	Region: 2 Exhibit: A20

Worcester Thirumalai, Amrita	Worcester Academy Discipline : Physics & Electronics Visualization of Sound Waves in 3D	Region: 2 Exhibit: C25
Worcester Puhov, Hannah	Mass. Academy of Math & Science Discipline : Engineering Under Pressure: Customized Insoles for Plantar Pressure Ulcers	Region: 2 Exhibit: A13
Worcester Savant, Gaurav	Worcester Academy Discipline : Engineering A Tool to Represent the Surroundings of a Blind Person	Region: 2 Exhibit: A27
Worcester Jude, Sadie	Burncoat Senior High School Discipline : Engineering Water Purification with UVc Light	Region: 2 Exhibit: G3
Worcester Lanzendorf, Lucas	Mass. Academy of Math & Science Discipline : Computers Mobile Application of A Deep Convolutional Neural Network for Produce	Region: 2 Exhibit: B10
Worcester Balaji, Shreya	Mass. Academy of Math & Science Discipline : Biology Effects of BDNF Inhibition on Hypoxia-Induced Danio rerio Development	Region: 2 Exhibit: C18
Worcester Youssef, Andrew	Mass. Academy of Math & Science Discipline : Physics & Electronics SafeSound: A Novel Method NIHL Prevention via Sound Attenuation	Region: 2 Exhibit: A21
Worcester He, Anna	Mass. Academy of Math & Science Discipline : Engineering Heating and Cooling Unit for Optimizing Short Sleep Periods	Region: 2 Exhibit: B24
Worcester Gaus, Evan	Mass. Academy of Math & Science Discipline : Engineering The Sound of Silence: Alternative Way for the Deaf to Experience Music	Region: 2 Exhibit: B13
Worcester Adiletta, Jack	Worcester Academy Discipline : Engineering A Biologically Inspired Modular Robotic Arm	Region: 2 Exhibit: A10

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Team Projects Listing

Acton Prendergast-Tombeno, Rachel	Acton-Boxborough Regional High School Discipline : Biology Stride Length and Running Economy in Athletes	Region: 4 Exhibit: D3
Acton Whitbeck, Hunter	Acton-Boxborough Regional High School Discipline : Biology Stride Length and Running Economy in Athletes	Region: 4 Exhibit: D3
Acton Zarola, Georgia	Acton-Boxborough Regional High School Discipline : Biology Stride Length and Running Economy in Athletes	Region: 4 Exhibit: D3
Adams Scholl, Abigail	Berkshire Arts & Technology Charter Public School Discipline : Biology Do Your Plants Like Music?	Region: 1 Exhibit: D1
Adams Bourzgui , Driss	Berkshire Arts & Technology Charter Public School Discipline : Environmental Science Reduction of Atmospheric CO2 Using the Algae Scenedesmus and Ulothrix	Region: 1 Exhibit: F15
Adams Martinez, Brianna	Berkshire Arts & Technology Charter Public School Discipline : Biology Do Your Plants Like Music?	Region: 1 Exhibit: D1
Adams Taylor, Kylie	Berkshire Arts & Technology Charter Public School Discipline : Environmental Science Reduction of Atmospheric CO2 Using the Algae Scenedesmus and Ulothrix	Region: 1 Exhibit: F15
Boston James, C'Lannye	John D. O'Bryant School of Mathematics and Science Discipline : Environmental Science Ocean Acidification	Region: 6 Exhibit: H5
Boston Dubuisson, Michael	Boston Latin Academy Discipline : Engineering How Does the Sweep Angle of a Wing Affect Its Lift Force?	Region: 6 Exhibit: C14
Boston Dillon, Steve	Jeremiah E. Burke High School Discipline : Behavioral Science The Impact of Induced Social Anxiety on Health and Well Being	Region: 6 Exhibit: F22
Boston Rivas, Jasmani	Edward M. Kennedy Academy for Health Careers Discipline : Chemistry How To Get Away With Murder	Region: 6 Exhibit: G25
Boston Chen, Stanley	Boston Latin Academy Discipline : Engineering How Does the Sweep Angle of a Wing Affect Its Lift Force?	Region: 6 Exhibit: C14

Boston Sanchez, Omar	Boston Latin Academy Discipline : Biology Effect of Apple Cider Vinegar Solutions on Bacterial Growth	Region: 6 Exhibit: F27
Boston Omorodion, Merit	Jeremiah E. Burke High School Discipline : Environmental Science Food Waste At The Burke	Region: 6 Exhibit: F24
Boston Ferreira, Maicoll	Edward M. Kennedy Academy for Health Careers Discipline : Chemistry Hidden Sugar	Region: 6 Exhibit: F28
Boston Arias, Anyeli	Edward M. Kennedy Academy for Health Careers Discipline : Chemistry Hidden Sugar	Region: 6 Exhibit: F28
Boston Roman, Melanie	Edward M. Kennedy Academy for Health Careers Discipline : Chemistry Don't Use Carmex, Use FeMe	Region: 6 Exhibit: F21
Boston DeMasi, Thomas	Boston Latin Academy Discipline : Engineering How Does the Sweep Angle of a Wing Affect Its Lift Force?	Region: 6 Exhibit: C14
Boston Ramirez, Cindy	Edward M. Kennedy Academy for Health Careers Discipline : Biology Which Type of Sugar Elicits the Strongest Response?	Region: 6 Exhibit: G8
Boston Tan, Janet	Boston Latin Academy Discipline : Biology Effect of Apple Cider Vinegar Solutions on Bacterial Growth	Region: 6 Exhibit: F27
Boston Castaneda, Fernanda	Edward M. Kennedy Academy for Health Careers Discipline : Chemistry Don't Use Carmex, Use FeMe	Region: 6 Exhibit: F21
Boston Castillo, Sharina	Edward M. Kennedy Academy for Health Careers Discipline : Biology Which Type of Sugar Elicits the Strongest Response?	Region: 6 Exhibit: G8
Boston Liu, Julie	Boston Latin Academy Discipline : Biology Effect of Apple Cider Vinegar Solutions on Bacterial Growth	Region: 6 Exhibit: F27
Boston Cuevas, Marina	Jeremiah E. Burke High School Discipline : Biology Devel of Bdelloid Rotifers As Experimental Model For Cell Rejuvenation	Region: 6 Exhibit: K21

Boston	Jeremiah E. Burke High School	Region: 6
Motto, Darian	Discipline : Biology	Exhibit: K21
	Devel of Bdelloid Rotifers As Experimental Model For Cell Rejuvenation	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Ortiz, Nayeli	Discipline : Chemistry	Exhibit: G25
	How To Get Away With Murder	
Boston	Urban Science Academy	Region: 6
Yee, Stefania	Discipline : Biology	Exhibit: H15
	The Effect of Nitrate Levels in Polluted Water on Daphnia	
Boston	Jeremiah E. Burke High School	Region: 6
Campbell , Orando	Discipline : Biology	Exhibit: K21
	Devel of Bdelloid Rotifers As Experimental Model For Cell Rejuvenation	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Ferdinand, Kerry	Discipline : Chemistry	Exhibit: P8
	Fiji vs. Poland Springs	
Bourne	Bourne High School	Region: 5
Nyman, Yasmin	Discipline : Engineering	Exhibit: D27
	Building an Automatic Fish Feeder	
Bourne	Bourne High School	Region: 5
Chen, Kai	Discipline : Engineering	Exhibit: D27
	Building an Automatic Fish Feeder	
Brighton	Mary Lyon Pilot High School	Region: 6
Youssfzai, Illum	Discipline : Biology	Exhibit: K6
	Identifying DNA	
Brighton	Mary Lyon Pilot High School	Region: 6
Yuman Revolorio, Irma	Discipline : Biology	Exhibit: K6
	Identifying DNA	
Brockton	Brockton High School	Region: 5
Furtado, Kiana	Discipline : Biology	Exhibit: K8
	Composting Critters	
Brockton	Brockton High School	Region: 5
Silva, Nelly	Discipline : Physics & Electronics	Exhibit: K13
	Phony Radiation: The Effect of EMFs on Plants	
Brockton	Brockton High School	Region: 5
Valcin, Marc	Discipline : Biology	Exhibit: K8
	Composting Critters	

Brockton Takang, Susan	Brockton High School Discipline : Physics & Electronics Phony Radiation: The Effect of EMFs on Plants	Region: 5 Exhibit: K13
Brockton Molloy, Katherine	Brockton High School Discipline : Engineering Permeable Concrete for Flood Sustainability	Region: 5 Exhibit: N10
Brockton Rico, Taina	Brockton High School Discipline : Physics & Electronics Phony Radiation: The Effect of EMFs on Plants	Region: 5 Exhibit: K13
Brockton Amazan, Isadorah	Brockton High School Discipline : Engineering Permeable Concrete for Flood Sustainability	Region: 5 Exhibit: N10
Brockton Sacchetti , Courtney	Brockton High School Discipline : Engineering Permeable Concrete for Flood Sustainability	Region: 5 Exhibit: N10
Brockton McConaga, Isaiah	Brockton High School Discipline : Biology Composting Critters	Region: 5 Exhibit: K8
Dartmouth Paiva, Izabel	Bishop Stang High School Discipline : Biochemistry Bioplastic from Banana Peels	Region: 3 Exhibit: G23
Dartmouth Sullivan, Ellie	Bishop Stang High School Discipline : Biochemistry Bioplastic from Banana Peels	Region: 3 Exhibit: G23
Dorchester Ogbebor, Martha	Jeremiah E. Burke High School Discipline : Environmental Science Food Waste At The Burke	Region: 6 Exhibit: F24
Dorchester Pinto, Katia	Jeremiah E. Burke High School Discipline : Biology Phenotypic Diversity	Region: 6 Exhibit: F23
Dorchester Davis, Teyah	Jeremiah E. Burke High School Discipline : Behavioral Science The Impact of Induced Social Anxiety on Health and Well Being	Region: 6 Exhibit: F22
Dorchester Bereus, Sophia	Jeremiah E. Burke High School Discipline : Behavioral Science The Impact of Induced Social Anxiety on Health and Well Being	Region: 6 Exhibit: F22

Dorchester Mohamud, Maryan	Jeremiah E. Burke High School Discipline : Biology Phenotypic Diversity	Region: 6 Exhibit: F23
Dorchester Adeyemo, Victoria	Jeremiah E. Burke High School Discipline : Environmental Science Food Waste At The Burke	Region: 6 Exhibit: F24
Everett Bozo, Rim	Pioneer Charter School of Science Discipline : Biology The Inhibition of E.coli Growth	Region: 4 Exhibit: P5
Everett Hossaini, Chaimaa	Pioneer Charter School of Science Discipline : Biology The Effect of Garlic Extract on the Lysozyme Activity of the B. Mori	Region: 4 Exhibit: A15
Everett Schastny, Alyssa	Pioneer Charter School of Science Discipline : Biology The Effect of Garlic Extract on the Lysozyme Activity of the B. Mori	Region: 4 Exhibit: A15
Everett Naittalb, Sarah	Pioneer Charter School of Science Discipline : Biology The Inhibition of E.coli Growth	Region: 4 Exhibit: P5
Grafton Gupta, Yashvi	Grafton Memorial Senior High School Discipline : Chemistry DMS Produced by Phytoplankton as a Solution to Ocean Acidification	Region: 2 Exhibit: H19
Grafton Fields, Jonathan	Grafton Memorial Senior High School Discipline : Biology Saving Plants Using Automation	Region: 2 Exhibit: B14
Grafton Suraparaju, Krish	Grafton Memorial Senior High School Discipline : Biology Saving Plants Using Automation	Region: 2 Exhibit: B14
Grafton Kelly, Emma	Grafton Memorial Senior High School Discipline : Chemistry DMS Produced by Phytoplankton as a Solution to Ocean Acidification	Region: 2 Exhibit: H19
Grafton Seetharaman, Amruth	Grafton Memorial Senior High School Discipline : Biology Saving Plants Using Automation	Region: 2 Exhibit: B14
Hopkinton Rosen, Elan	Hopkinton High School Discipline : Biology Engineering of Congenic Huntington Fibroblast Cell Lines, Using CRISPR	Region: 2 Exhibit: F19

Hopkinton Nemalikanti, Archita	Hopkinton High School Discipline : Computers Calling 911 When Detecting an Irregular Heart Rate Using Arduino	Region: 2 Exhibit: B8
Hopkinton Khan, Shazain	Hopkinton High School Discipline : Biology Engineering of Congenic Huntington Fibroblast Cell Lines, Using CRISPR	Region: 2 Exhibit: F19
Hopkinton Miller, Alannah	Hopkinton High School Discipline : Biochemistry Let's Yeet This Wheat: Removing Gluten from Fryer Oil	Region: 2 Exhibit: B17
Hopkinton Rajgor , Tanisha	Hopkinton High School Discipline : Computers Calling 911 When Detecting an Irregular Heart Rate Using Arduino	Region: 2 Exhibit: B8
Hopkinton Stolyar, Alisa	Hopkinton High School Discipline : Biochemistry Let's Yeet This Wheat: Removing Gluten from Fryer Oil	Region: 2 Exhibit: B17
Hudson Clardy , Lily	Hudson High School Discipline : Environmental Science Mealworms Biodegrading Styrofoam	Region: 2 Exhibit: H16
Hudson Genova, Abby	Hudson High School Discipline : Environmental Science Mealworms Biodegrading Styrofoam	Region: 2 Exhibit: H16
Hyannis August, Colby	St. John Paul II High School Discipline : Engineering Active Aerodynamics for Automobiles	Region: 5 Exhibit: N23
Hyannis Schiffer, Ben	St. John Paul II High School Discipline : Engineering Active Aerodynamics for Automobiles	Region: 4 Exhibit: N23
Kingston Beatrice, Kyle	Silver Lake Regional High School Discipline : Engineering Bioelectrically-Controlled Robotic Hand	Region: 5 Exhibit: D21
Kingston Smith, Gordon	Silver Lake Regional High School Discipline : Engineering Bioelectrically-Controlled Robotic Hand	Region: 5 Exhibit: D21
Kingston Whidden, Cole	Silver Lake Regional High School Discipline : Engineering Dynamically Controlled First Person Viewing System For Drones	Region: 5 Exhibit: D14

Kingston Tierney, Ryan	Silver Lake Regional High School Discipline : Engineering Dynamically Controlled First Person Viewing System For Drones	Region: 5 Exhibit: D14
Lexington Olofsson, Michelle	Lexington High School Discipline : Biology The Effects of Temperature on C3 vs. C4 Plants	Region: 4 Exhibit: F16
Lexington Zhang, Patrick	Lexington High School Discipline : Computers Direct Anonymous Attestation with Subverted Platforms	Region: 4 Exhibit: K16
Lexington Sankar, Sanjana	Lexington High School Discipline : Environmental Science The Arlington Reservoir: An Analysis of Climate Change Preparedness	Region: 4 Exhibit: N4
Lexington Mattingly, Ella	Lexington High School Discipline : Environmental Science The Arlington Reservoir: An Analysis of Climate Change Preparedness	Region: 4 Exhibit: N4
Lexington Chakravarti, Sachiv	Lexington High School Discipline : Biology Phylogenetics of an Evolving Viral Population	Region: 4 Exhibit: J5
Lexington Lawrence, Claire	Lexington High School Discipline : Biology The Effects of Temperature on C3 vs. C4 Plants	Region: 4 Exhibit: F16
Lexington Ahmed, Rayhan	Lexington High School Discipline : Biology Phylogenetics of an Evolving Viral Population	Region: 4 Exhibit: J5
Lexington Sathiamurthy, Srinivasan	Lexington High School Discipline : Mathematics Asymptotics of k-Dimensional Visibility	Region: 4 Exhibit: J6
Lexington Erives, Ezra	Lexington High School Discipline : Mathematics Asymptotics of k-Dimensional Visibility	Region: 4 Exhibit: J6
Malden Amador, Isabella	Edward M. Kennedy Academy for Health Careers Discipline : Chemistry Fiji vs. Poland Springs	Region: 6 Exhibit: P8
Marlborough Moore, Timothy	Assabet Valley Vocational High School Discipline : Environmental Science Effectiveness of Specialized Microbes on Synthetic and Organic Greases	Region: 2 Exhibit: H6

Marlborough Minier, Ian	Marlborough High School Discipline : Biology	Region: 2 Exhibit: D18
	Effects of Wax Worm Digestive Bacteria on Polyethylene Biodegradation	
Marlborough Rainville, Olivia	Marlborough High School Discipline : Biology	Region: 2 Exhibit: N3
	Organic Sulforaphane: A Novel Treatment to Reduce Malarial Progression	
Marlborough Raun, Morgan	Marlborough High School Discipline : Biology	Region: 2 Exhibit: N3
	Organic Sulforaphane: A Novel Treatment to Reduce Malarial Progression	
Marlborough Paul, Carter	Marlborough High School Discipline : Biology	Region: 2 Exhibit: D18
	Effects of Wax Worm Digestive Bacteria on Polyethylene Biodegradation	
Marlborough Harpin, Rachelle	Assabet Valley Vocational High School Discipline : Environmental Science	Region: 2 Exhibit: H6
	Effectiveness of Specialized Microbes on Synthetic and Organic Greases	
Marlborough Paul, Harrison	Marlborough High School Discipline : Biology	Region: 2 Exhibit: D18
	Effects of Wax Worm Digestive Bacteria on Polyethylene Biodegradation	
Medford Simco, Morgan	Medford High School Discipline : Biology	Region: 4 Exhibit: J1
	The Motion of Blood Flow through Different Aortic Heart Valve Models	
Medford Elkondakly, Sarah	Medford High School Discipline : Biology	Region: 4 Exhibit: J1
	The Motion of Blood Flow through Different Aortic Heart Valve Models	
Roxbury Phan, Sally	John D. O'Bryant School of Mathematics and Science Discipline : Environmental Science	Region: 6 Exhibit: H5
	Ocean Acidification	
Shrewsbury Mufti, Saad	St. John's High School Discipline : Engineering	Region: 2 Exhibit: C21
	Gun Control without the Politics	
Shrewsbury Prabakar, Ajan	Shrewsbury High School Discipline : Engineering	Region: 2 Exhibit: A23
	Pharm: A Pill Dispenser Designed to Control Opioid Abuse	
Shrewsbury Syed, Muneeb	St. John's High School Discipline : Engineering	Region: 2 Exhibit: C21
	Gun Control without the Politics	

Shrewsbury Hollyer, Joshua	Shrewsbury High School Discipline : Engineering Pharm: A Pill Dispenser Designed to Control Opioid Abuse	Region: 2 Exhibit: A23
Somerville Ayanna, Henry	Somerville High School Discipline : Computers The Evolution of Buses: Optimizing Bus Routes Using Genetic Algorithms	Region: 4 Exhibit: D10
Somerville Haxhimali, Era	Somerville High School Discipline : Chemistry What Effect Does Low pH Acid Rain Have on Different Coatings?	Region: 4 Exhibit: J28
Somerville Goldstein-Gelb, Brayden	Somerville High School Discipline : Computers The Evolution of Buses: Optimizing Bus Routes Using Genetic Algorithms	Region: 4 Exhibit: D10
Somerville Abrams-Greenberg, Aaren	Somerville High School Discipline : Physics & Electronics Concentrated Sound Waves and the Extinguishing of Flame	Region: 4 Exhibit: A24
Somerville Millette, Justin	Somerville High School Discipline : Physics & Electronics Concentrated Sound Waves and the Extinguishing of Flame	Region: 4 Exhibit: A24
Somerville Rossi, Ramon	Somerville High School Discipline : Chemistry What Effect Does Low pH Acid Rain Have on Different Coatings?	Region: 4 Exhibit: J28
South Boston Guerrier, Davidson	Excel High School Discipline : Engineering Super Magnets	Region: 6 Exhibit: P18
South Boston Cetinbas, Ece	Excel High School Discipline : Engineering Super Magnets	Region: 6 Exhibit: P18
South Boston Bravo, Hailey	Excel High School Discipline : Environmental Science Treated Plants	Region: 6 Exhibit: G12
South Boston Martinez, Pamela	Excel High School Discipline : Environmental Science Treated Plants	Region: 6 Exhibit: G12
South Easton Spooner, Nicholas	Southeastern Regional Vocational Technical High School Discipline : Engineering Smart Glasses	Region: 5 Exhibit: D22

South Easton Goncalves , Zelinda	Southeastern Regional Vocational Technical High School Discipline : Engineering DIY Stethoscope	Region: 5 Exhibit: K14
South Easton Reid, Jaden	Southeastern Regional Vocational Technical High School Discipline : Engineering Smart Glasses	Region: 5 Exhibit: D22
South Easton Seaver, Rachel	Southeastern Regional Vocational Technical High School Discipline : Engineering DIY Stethoscope	Region: 5 Exhibit: K14
South Grafton Shapally , Himasri	Grafton Memorial Senior High School Discipline : Chemistry DMS Produced by Phytoplankton as a Solution to Ocean Acidification	Region: 2 Exhibit: H19
Stoughton McSweeney, Emma	Stoughton High School Discipline : Biochemistry Shining a Light on Phototherapy: Using Blue Light to Stop Infection	Region: 5 Exhibit: G9
Stoughton Rush, Juliana	Stoughton High School Discipline : Biochemistry Shining a Light on Phototherapy: Using Blue Light to Stop Infection	Region: 5 Exhibit: G9
Swampscott Tribendis, Allison	Swampscott High School Discipline : Chemistry Impact of Increasing Liquids on Diluting Digestion	Region: 4 Exhibit: K17
Swampscott Tribendis, Madeline	Swampscott High School Discipline : Chemistry Impact of Increasing Liquids on Diluting Digestion	Region: 4 Exhibit: K17
West Roxbury Huezo-Santiago, Tashaina	Urban Science Academy Discipline : Biology The Effect of Nitrate Levels in Polluted Water on Daphnia	Region: 6 Exhibit: H15
Westborough Patta, Anoop	Westborough High School Discipline : Biochemistry Designing a Thyroid Hormone Detection System	Region: 2 Exhibit: B18
Westborough Sane, Eshan	Westborough High School Discipline : Biochemistry Designing a Thyroid Hormone Detection System	Region: 2 Exhibit: B18
Westfield Regnier, Elizabeth	Westfield High School Discipline : Chemistry Quantifying Effect of a Rapid Temperature Increase on Coral Bleaching	Region: 1 Exhibit: D7

Westfield Morrissey, Catherine	Westfield High School Discipline : Chemistry	Region: 1 Exhibit: D7
	Quantifying Effect of a Rapid Temperature Increase on Coral Bleaching	
Westfield Chisholm, Aiden	Westfield High School Discipline : Biology	Region: 1 Exhibit: D15
	Statistical and Cost Effective Lens on Computers at WHS	
Westfield Pease, Emilie	Westfield High School Discipline : Physics & Electronics	Region: 1 Exhibit: H3
	The Effects of Using App Functions on a Cellular Electromagnetic Field	
Westfield Sgueglia, Stephanie	Westfield High School Discipline : Engineering	Region: 1 Exhibit: D19
	Concrete's Strength Lies in Aggregate	
Westfield Rae, Mackenzie	Westfield High School Discipline : Physics & Electronics	Region: 1 Exhibit: H3
	The Effects of Using App Functions on a Cellular Electromagnetic Field	
Westfield Petzold, Emma	Westfield High School Discipline : Biology	Region: 1 Exhibit: N5
	The Effects of Homemade Water Filters	
Westfield Jury, Ellen	Westfield High School Discipline : Biology	Region: 1 Exhibit: F1
	Using Daphnia Magna to Examine Water Acidity	
Westfield Prenosil, Nina	Westfield High School Discipline : Biology	Region: 1 Exhibit: F1
	Using Daphnia Magna to Examine Water Acidity	
Westfield Morrissey, Brendan	Westfield High School Discipline : Biology	Region: 1 Exhibit: D15
	Statistical and Cost Effective Lens on Computers at WHS	
Westfield Duncan , Nicholas	Westfield High School Discipline : Computers	Region: 1 Exhibit: C28
	Multi-Scale GPA Conversion Calculator	
Westfield Menzel, Abigail	Westfield High School Discipline : Biology	Region: 1 Exhibit: N5
	The Effects of Homemade Water Filters	
Westfield Stathatos, Nicholas	Westfield High School Discipline : Engineering	Region: 1 Exhibit: D19
	Concrete's Strength Lies in Aggregate	

Westfield Hinck, Stephen	Westfield High School Discipline : Computers Multi-Scale GPA Conversion Calculator	Region: 1 Exhibit: C28
Westford Mendes, Ethan	Westford Academy Discipline : Computers Direct Anonymous Attestation with Subverted Platforms	Region: 4 Exhibit: K16
Weston Chen, Benjamin	Weston High School Discipline : Computers Using Machine Learning to Predict Flu Outbreaks	Region: 5 Exhibit: D26
Weston Malur, Neil	Weston High School Discipline : Computers Using Machine Learning to Predict Flu Outbreaks	Region: 5 Exhibit: D26
Worcester Nathan, Krish	Mass. Academy of Math & Science Discipline : Biochemistry Designing a Thyroid Hormone Detection System	Region: 2 Exhibit: B18



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2019 Project Abstracts

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Biology

Biology

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- A3 Ketogenic Diet in a *Drosophila* Model of Parkinson's Disease
- A8 The Role of Extracellular Matrix Arrangement in Cancer Cell Migration
- A15 The Effect of Garlic Extract on the Lysozyme Activity of the *B. Mori*
- A17 Effects of Methylene Blue on *Drosophila* Models of Huntington's Disease
- A20 Effects of Sensory Stimuli on Memory in Alzheimer's *Drosophila* Models
- A26 The Effects of Various Substances on β -amyloid Toxicity in *C. elegans*
- B3 Comparing Muscle Hemodynamics in Human Calves w/ & w/out a Thigh Cuff
- B11 The Effects of Cell Phone Electromagnetic Radiation on *C. elegans*
- B14 Saving Plants Using Automation
- B20 The Possible Effect of Nitrogen on Venus Fly Trap Action Potential
- B28 The Effects of Carbon vs. Phosphates on Algal Growth +Lipid Production
- C4 The Effect of Naturopathic Substances to Regenerate Planaria
- C7 The Effect of Wireless Fidelity on Planarian Regeneration
- C18 Effects of BDNF Inhibition on Hypoxia-Induced *Danio rerio* Development
- C23 Designing a Machine Learning Solution to Atrial Fibrillation
- D1 Do Your Plants Like Music?
- D2 A Real Slip-Up
- D3 Stride Length and Running Economy in Athletes
- D5 The Role of Intracellular Trafficking in Immune Response to Lyme
- D15 Statistical and Cost Effective Lens on Computers at WHS
- D18 Effects of Wax Worm Digestive Bacteria on Polyethylene Biodegradation
- D20 A Bioinformatics Analysis of Circadian Rhythms
- D23 The Effects of Juul Juice on *Saccharomyces cerevisiae*
- F1 Using *Daphnia Magna* to Examine Water Acidity
- F2 The Extension of Time before Growth of Mold on Food Via Silica Gel
- F9 The Effect of Duration of Light Exposure on the Color of *Artemia*
- F16 The Effects of Temperature on C3 vs. C4 Plants
- F17 The Time it Takes Painkillers to Dissolve in the Stomach
- F19 Engineering of Congenic Huntington Fibroblast Cell Lines, Using CRISPR
- F23 Phenotypic Diversity
- F26 Going Green to Prevent Breast Cancer

F27 Effect of Apple Cider Vinegar Solutions on Bacterial Growth
G6 Myelin Sheath Regeneration in the Neurons of Zebrafish
G8 Which Type of Sugar Elicits the Strongest Response?
G11 Ultrasonic Enhancement of Antibiotics on Bacteria
G14 Testing GMO and DNA Extraction
G15 The Effect of Temperature on The Rate of Fermentation of Yeast
G16 The Effects of Exercise on Aggression in a SIgA Model of Schizophrenia
G17 Testing the Inhibitory Effects of Straw on Algae
G18 The Effect of Preadult Malnutrition on Offspring Learning and Memory
G19 The Use of Essential Oils to Fight Fire Blight in Fruit Trees
G20 The Effect of Lithium on Learning and Memory in *D. Melanogaster*
G27 Effects of Alcohol on Flatworm Regeneration
H1 The Effect of Propolis on *E. coli*
H2 The Effect of pH on Enzyme Acitivity
H7 The Acidifying Ocean's Effect on Protease Activity in *Alteromonas*
H11 Does Caffeine or Sugar Have a Greater Effect on Heart Rate?
H12 Ajoene: The Silencer
H14 The Impact of Temperature Changes on the Coral Microbiome
H15 The Effect of Nitrate Levels in Polluted Water on *Daphnia*
H17 Evaluating the Safety of Baby Powder
H18 Development of a qPCR Assay for Quantification of Saccharibacteria
H20 The Efficacy of Subzero Storage Methods on Dietary Proteins
H21 The Effect of Sanitation Methods on Dirty Sponges.
H23 Sex Determination in Brine Shrimp
H26 Microbial Fuel Cell
J1 The Motion of Blood Flow through Different Aortic Heart Valve Models
J2 What Cleaning Solutions Are the Best for Disinfecting Wrestling Mats
J4 Ultrasensitive Detection of Early Cancer by ctDNA Sequencing with UMIs
J5 Phylodynamics of an Evolving Viral Population
J9 Effects of Alcohol and Aspartame on the Heart Rate of *Daphnia magna*
J14 Jack and the Glow in the Dark Bean Stalk
J18 Turmeric vs. Bacteria

- J19 Spill The Tea, Sis: Can Green Tea Prevent & Cure Cancer
- J22 The Impact of Benzo-Lipoxin A4 on Mesenchymal Stem Cells
- J23 Behavioral Response of Coral to Anthropogenic Noise
- J24 Extracting DNA from Spinach
- K4 Synthetic Biology for Treating Neurodegenerative Diseases
- K6 Identifying DNA
- K8 Composting Critters
- K10 How Sound Frequencies Affect the Growth of Plants
- K15 Bioluminescent Algae
- K21 Devel of Bdelloid Rotifers As Experimental Model For Cell Rejuvenation
- N2 Modeling and Treating Cardiac Arrhythmias using *Caenorhabditis elegans*
- N3 Organic Sulforaphane: A Novel Treatment to Reduce Malarial Progression
- N5 The Effects of Homemade Water Filters
- N6 Using Fourier Analysis to Distinguish Pancreatic Cysts
- N8 Isolating and Identifying Fungal Endophytes in Seaweed
- N9 The Effect of Sleep Deprivation on Cockroach Behavior
- N11 The Effect of Common Chemicals on *Daphnia* Heart Rate
- N12 Investigation of the Genetics of Smoking Behavior in the UK Biobank
- N14 The Classification of Fungal Derivatives with Clinical Potential
- N16 The Effect of Stressors on Telomeres Using *C. elegans* as a Model
- N17 Which Factors Increase the Risk of Contracting the Common Cold?
- N19 Effects of Magnetism on *Dugesia Tigrina* Regeneration and Growth
- N25 Creating a Noninvasive Glucose Monitoring System for Diabetic Patients
- N27 Decellularization of Spinach and Its Application to Medicine
- P1 Is the Efficacy of Soap Constant?
- P2 Antibiotic Cocktail
- P5 The Inhibition of *E.coli* Growth
- P7 Chemotaxis and Response to Stimuli in *C. elegans*: Vanilla vs. Bleach
- P15 A Novel Noninvasive Biomarker for Diagnosing Major Depressive Disorder
- P16 Does the Constant Region of the cMet Antibody Affect Its Function?
- P19 IL-6 in B-Cells
- P20 Testing the Potential of Marine Fungi to Bioremediate Crude Oil Spills

A1 The Effects of Metalloproteinase Inhibition on UV-Induced *Danio rerio*

Biology

Esther Ng

Mass. Academy of Math & Science

Skin cancer is the most common type of cancer in the United States; 9,000 cases are diagnosed every day. UV radiation gives rise to skin cancer by mutating tumor suppressor genes, which are responsible for regulating DNA repair and apoptosis. In turn, these genes malfunction, which causes damaged cells to divide rapidly and uncontrollably, leading to the formation of tumors. Angiogenesis is essential for tumor growth and survival, as blood vessels supply tumors with vital nutrients. Many proteins, including the family of matrix metalloproteinases (MMPs), are involved with this angiogenesis. Changes in MMP activity have also been linked to carcinogenesis, however, the extent to which the MMPs participate in carcinogenesis and angiogenesis is not well understood. To investigate this relationship, *Danio rerio* were exposed to varying concentrations of phenanthroline, an MMP inhibitor. The *Danio rerio* were then exposed to UV radiation, stained with acridine orange, then imaged under a fluorescence microscope. The effects of MMP inhibition were determined by using FIJI image processing software to count apoptotic cells, incomplete intersomitic vessels, and indicators of poor circulation such as tail curvature, pericardial edema, and yolk sac edema. The results suggest that MMP inhibition leads to impaired angiogenesis and an increase in apoptotic activity, with highly significant differences among groups. These findings indicate that MMP regulation may be helpful in protecting against UV-induced DNA damage, and that the MMPs may be viable targets for antiangiogenic cancer therapies.

A3 Ketogenic Diet in a *Drosophila* Model of Parkinson's Disease

Biology

Grant Gattuso

St. Mark's School

Parkinson's Disease (PD) is a neurodegenerative disease that causes the loss of dopaminergic neurons in the substantia nigra. This disease is chronic and causes tremors, muscle rigidity, difficulty speaking, and many other symptoms that debilitate the individual and deteriorate their quality of life significantly. Currently, there is no cure for PD. Previous research shows that mitochondrial dysfunction plays a significant role in the death of the dopaminergic neurons in PD. Since the ketogenic diet – a four to one ratio of lipids to carbohydrates – has been shown to improve mitochondrial function in diseases like Epilepsy and Alzheimer's, the ketogenic diet could delay or improve the onset of Parkinsonian symptoms.

This study measured the effects of the ketogenic diet in a PINK1 *Drosophila melanogaster* model of PD through lifespan, a mobility test, and observation of wing posture. Preliminary findings were inconclusive in measuring lifespan in PINK1 *Drosophila*. The ketogenic diet does not delay the onset of abnormal wing posture in this mutant. However, the preliminary results also suggest that the ketogenic diet does potentially increase the mobility of these *Drosophila*. The ketogenic diet may help some PINK1 flies by increasing their mobility and delaying their symptoms while hurting other flies by accelerating the aging process.

A8 The Role of Extracellular Matrix Arrangement in Cancer Cell Migration

Biology

Antara Pal

Acton-Boxborough Regional High School

Cancer metastasis contributes to 90% of cancer mortalities worldwide and is considered the final stage of cancer invasion. In this study, we focus on the interactions between cancer cells and the Extracellular Matrix (ECM) through the Cellular Potts Model (CPM), a lattice-based model that simulates the behavior of cellular structure. To investigate the significance of ECM arrangement in metastasis, we simulate cancer migration through parallel linear fibers and randomized curved fibers using the software package CompuCell3D. The results show that parallel linear fibers allow increased cellular motility with minimal fiber degradation, while randomized curved fibers restrict cellular motility with high fiber degradation. When analyzing MMP secretion of the varying arrangements, the parallel linear fibers were found to produce high MMP secretion, while randomized curved fibers produce low MMP secretion. Furthermore, the parallel linear arrangement allows high cell velocity, while the randomized curved fibers reveal low cell velocity. It is also believed that cancer cells remodel the ECM to express wavy characteristics in order to facilitate cancer cell migration. When investigating the effect of the wave-like fiber arrangement on metastasis, the results show fewer fiber degradation, higher MMP secretion, and higher cell velocity than the randomized curved fibers. To restrict metastasis, collagen fibers may be altered to form a circular structure to confine the cancer cells. Results show minimal fiber degradation, lower MMP secretion, and decreased cell velocity when compared to the parallel linear fibers. Overall, manipulating the fiber environment may decrease metastasis and ultimately save countless lives.

A15 The Effect of Garlic Extract on the Lysozyme Activity of the B. Mori

Biology

Chaimaa Hossaini, Alyssa Schastny

Pioneer Charter School of Science

The mysteries of how the immune system protects itself against bacteria and viruses have raised questions in medicine. Lysozymes are a specific type of enzyme in the immune system of the human body that many people do not take into consideration. These lysosomes function to defend the body against foreign particles that may invade the immune system. The enzyme is also found in the bombyx Mori. The b. Mori This experiment uses gel electrophoresis to explore the changes in this protein when it is enhanced with the active ingredient in garlic: allicin, and also with garlic powder. By doing this, it can be seen how to enhance the effects of the lysozyme in the immune system when the organism is exposed to foreign bodies.

A17 Effects of Methylene Blue on Drosophila Models of Huntington's Disease

Biology

Marissa Gardner

Mass. Academy of Math & Science

Huntington's disease (HD), a neurodegenerative disease that leads to physical and cognitive deficiencies, affects approximately 30,000 people in the United States. The exact cellular causes of the disease are unknown, but it is believed that symptoms arise from neuron death in the central nervous system caused by aggregation of the Huntingtin (HTT) protein. Methylene blue (MB) has been shown to modulate amyloidogenic disease proteins, and, due to the similarities between amyloid plaques and HTT aggregates, could also modulate HTT aggregates. In this experiment, both wildtype and transgenic *Drosophila* strains expressing an HTT protein with an extended glutamine repeat were exposed to methylene blue, and its effect on locomotive abilities were observed. The effects of MB on symptoms associated with motor decline was tested through a RING assay. Compared to groups fed normal medium, all *Drosophila* strains exposed to MB showed noteworthy improvements in locomotive ability, suggesting that MB improves symptoms of motor decline in fly models.

A20 Effects of Sensory Stimuli on Memory in Alzheimer's Drosophila Models

Biology

Arun Chintalapati

Mass. Academy of Math & Science

Over 5.7 million Americans are affected by Alzheimer's disease (AD). The symptoms of AD often cause anger in patients and inhibit their interactions with others. Many patients rely on therapies to provide palliative care. Studies have shown that therapy with auditory stimulations improves cognitive function in patients dealing with AD. This project looks at whether other sensory stimulations, specifically optic and olfactory stimulations, elicit similar responses to the auditory stimulations. These stimulations were tested on flies. Each stimulation was tested with a learning assay in which the flies learned to avoid a positive stimulus. A t-test was run to analyze the data and compare the groups. The olfactory stimulations were found to improve memory ($p = 0.000396$). The optic stimulations were also found to improve memory ($p = 0.001052$). Further studies are being conducted in flies with genes associated with AD. This approach should be integrated into therapies for AD patients, to help improve the memory of the patients. The results are currently being integrated into a reminder system for the elderly and dementia patients, with an optic stimulus being used as the reminder.

A26 The Effects of Various Substances on β -amyloid Toxicity in *C. elegans*

Biology

Ritvik Pulya

Acton-Boxborough Regional High School

Accumulation of β -amyloid 42, a sticky peptide, has been associated with the induction of Alzheimer's disease. The transgenic *C. elegans* strain CL4176 expresses β -amyloid 42 in its muscle cells which induces paralysis, making it appropriate to study. The CL4176 and CL802 (control) strains of *C. elegans* worms were used in this experiment. The substances tested include alcohol, turmeric, brahmi. Brahmi and turmeric are used in Indian Ayurveda and have proven neuroprotective effects. Alcohol is an NMDA antagonist meaning it indirectly decreases the amount of glutamate. An assay was performed for alcohol to determine an appropriate concentration since it is the most dangerous substance used in the experiment. The results indicate every substance tested in the experiment decreased the paralyzation of the CL4176 worms.

The implications of this project are twofold. First, it proves the effectiveness of ancient Indian Ayurvedic medicine. Secondly, the data indicates that brahmi, turmeric, and alcohol are promising treatments for Alzheimer's disease.

B3 Comparing Muscle Hemodynamics in Human Calves w/ & w/out a Thigh Cuff

Biology

Shubhecchha Dhaurali

Medford High School

This project will use near-infrared spectroscopy, a non-invasive method of measuring hemoglobin within tissue, to calculate hemoglobin, oxygenated hemoglobin, deoxygenated hemoglobin, and mean arterial pressure oscillation slope averages during rest and after low intensity exercise. Blood flow (BF) and oxygen consumption (OC) will also be calculated for each subject in each exercise intensity level. This was in order to determine a method of peripheral arterial disease (PAD) detection using NIRS. PAD occurs when a person has plaque obstructed blood vessels which is very painful and life-threatening. Current detection does not measure early PAD which limits patients' treatment options leaving them with surgery or other painful procedures. If early detection was available, they could steadily change their diets and exercises, and also their lives. The protocol for this experiment is a series of arterial and venous occlusions during rest and after low intensity exercise. A hypothesis for the first part of this experiment is if venous and arterial pressures are only applied to the right leg, then hemoglobin responses will be stronger in all intensity levels. If subjects will be tested during rest and after low intensity exercise, low intensity will have higher and cleared BF and OC responses. These responses will be shown due to standard deviation calculations. Determining values of hemoglobin, BF, and OC for each leg during different occlusions and exercise intensities will also add to the development of a PAD detection device by narrowing down the clearest data that could be viable for application.

B11 The Effects of Cell Phone Electromagnetic Radiation on *C. elegans*

Biology

Rianna Massoni-Nesman

Wachusett Regional High School

The purpose of this experiment was to investigate cell phone radiation as a plausible cause of memory loss and neurodegenerative diseases, and to investigate the optimal distance at which a cell phone can be held to minimize the effects. The radiation from cell phones has been shown to affect miR- 106b-5p and miR 107 genes involved with cell death in the temporal lobe. These human genes have a homolog in *C. elegans*, which is why this was selected as the model organism. It was hypothesized that if the distance between the radiation source and *C. elegans* decreases, then the memory of *C. elegans* will also decrease after avoidance training.

C. elegans were trained to negatively associate butanone (in methanol) with starvation. They were then exposed to 20 hours of cell phone radiation at different distances: 0cm, 8cm, 16cm, 24cm, 30cm and a control. Next, the *C. elegans* were tested to see if they remembered their training or, if they forgot and went towards the butanone. The radiation and testing process was repeated for three days.

All distances were proven to be statistically significant from each other, except between 0cm and 8cm, and 24cm and 30cm. The hypothesis was not supported because more *C. elegans* forgot their training when the radiation source was further away. The most severe effects occurred at a distance of 24cm. Overall, this study suggests that cell phone radiation could potentially be a factor in memory loss and neurodegenerative diseases.

B14 Saving Plants Using Automation

Biology

Amruth Seetharaman, Krish Suraparaju, Jonathan Fields

Grafton Memorial Senior High School

An analysis of the effect of Automated Systems on plants in comparison to natural/human care was observed while also aiming to develop such a system that might plan out necessities for plants based on their behaviors. Planning and testing circuits was a primary part of the project in addition to programming concerning the plant's environment. Furthermore, multiple tests ensured the actual probabilities of a successful automated system. The first prototype supports fully functional and automated watering and lighting services to the plant. While testing various circuits, we found the water system to work in tandem with an Arduino board and a 12-volt pump using water directly gathered from the source. Light systems could be harmful and costly due to personalization, and therefore, the watering system is more efficient and a better allocation of time. However, the advantages of the light system far outweigh the disadvantages, which is why it is still an integral part of the project. In addition, it is possible to regulate the system through an app that best connects with the Arduino, however, it is preliminary and requires further development. It is found that Automated Systems are costly, but as many materials of the sort are not in reach to ordinary citizens, this system could be very useful in adequately caring for plants if implemented effectively. Since this project is not very timely, more testing is required to explore the idea of automated systems further in order to save plants. Although the project is not entirely complete, the significance of it is not lost because, if implemented, it could bring a new era of convenience to the world of houseplants.

B20 The Possible Effect of Nitrogen on Venus Fly Trap Action Potential

Biology

Maya Lamm

Lexington High School

Venus flytraps trigger action potentials in order to move their traps so they can consume insects. The question asked if supplying Venus flytraps nitrogen through fertilizer would have an effect on these plants' action potentials. Since the plants would already have enough nutrients from the fertilizer, it was hypothesized that Venus flytraps fed fertilizer would no longer trigger an action potential because they wouldn't need to move their traps in order to consume insects. To investigate the effects of nitrogen on these plants, two Venus flytraps were given fertilizer while two were given nothing. Then, action potentials of each plant were measured and recorded using a spike recorder every two weeks. The action potentials were analyzed by the amount of time it took for the membrane potential of the Venus flytrap to return to pre-action potential levels. The data showed a trend of longer duration and less variability of action potentials for plants fed fertilizer. However, when analyzed with standard deviation, the overlapping of error bars revealed how the differences observed between fed and unfed plants were not significant. Although the data proved to be inconclusive, the methods of this project could be helpful for neuroscientists who wish to investigate how varying conditions affect the nervous system without harming animals or humans.

B28 The Effects of Carbon vs. Phosphates on Algal Growth +Lipid Production

Biology

Benjamin Dwyer

Wachusett Regional High School

Algae is a potential source of renewable energy when lipid and biomass are maximized for biofuel conversion. This experiment was designed to maximize growth and lipid levels in *Nannochloropsis oculata* via added nutrients. It was hypothesized that added carbon and phosphate to algal samples would increase algal growth and lipid levels significantly. Carbon is involved in the lipid synthesis cycle. Phosphate was hypothesized to increase both endpoints more significantly due to its connection to rapid algal blooms in natural settings.

Nannochloropsis and growth media were combined in standardized proportions and subdivided into four experimental conditions: 100% added carbon, 100% added phosphate, 100% both, and a Control, with no additional nutrients. These groups were grown in an algal photobioreactor with a standardized lighting, aeration and temperature system to mimic an industrial setting. Growth was measured by absorbance at 470 nm every 4 days. After about 40 days, lipid was extracted and its content was measured using a Lipid Oil Red Dye assay. Biomass levels indicated that phosphate and carbon significantly increased growth, both individually and cumulatively. Lipid levels were increased significantly with added phosphate, whereas carbon's effect was less substantial. These results indicate that added nutrients, specifically Phosphate, can be optimized to maximize algal growth and lipid in an industrial setting. As an extension, a plasmid was designed to compare these improvements with the possibility of genetic alterations.

C4 The Effect of Naturopathic Substances to Regenerate Planaria

Biology

Ana Thomas Cruz

Assabet Valley Vocational High School

Cell regeneration is the ability for a cell to communicate in order to repair or regrow a new organ or tissue. Scientists use animal models, such as planaria to study the process to further understand how cells can repair themselves. Naturopathic products are placed on the skin to help it recover from wounds. Vitamin E is a common vitamin that is used on the skin because it helps prevent the skin from scarring. Green tea has an antioxidant called epigallocatechin gallate (EGCG) that helps fight DNA damage from UV rays that causes skin damage. Hydrogen peroxide is used on the skin to help with wounds, such as minor cuts or burns. Free radicals are damaging to the skin because they take extra electrons from atoms in the skin; this causes damage to the skin's DNA. The length of the new growth was measured, and it was used to compare to all the trails of the same petri dish. The Vitamin E and green tea concentrations made the planaria grow a little more than the control and hydrogen peroxide.

C7 The Effect of Wireless Fidelity on Planarian Regeneration

Biology

Imma Kayzakian

Westfield High School

Planaria are a type of flatworm that is most commonly found in bodies of freshwater. While they look small and insignificant, they actually hold the key to one of medical science's most groundbreaking topics; stem cells. They are identified as having two anatomical ends: the head and the tail. Although they live in the water they do not have gills or lungs they simply just diffusion to obtain oxygen. Their bodies are covered in stem cells which give them the ability to regenerate when torn apart. This experiment tests the effects of wireless fidelity on planarian regeneration. This is important because this same stem cell research is being used in the medical field to create organs for transplant. This will save many lives and drastically improve the lives of those in need of transplants. Using the stem cell research a new heart can be made with the patient's cells along with the stem cells in order to create a perfect match. This would decrease rejection rates in transplants drastically. There are a lot of similarities between humans and planarians, and we have a lot of the same organ systems. Planarians have a central nervous system with a brain, eyes, musculature, intestine, epidermis, reproductive structures. Beyond organ repair and regeneration bone marrow creation and regeneration could potentially have life-changing effects on thousands of people. During the experiment, the planaria will be cut in half. Their heads with two eyespots will be disposed of and their tails will be monitored for regeneration over a two week period. The planaria will be fed chicken liver and their water changed daily.

After careful testing and evaluation, the results of the experiment disprove the hypothesis; which is, that the increase in wifi will decrease the rate of regeneration.

C18 Effects of BDNF Inhibition on Hypoxia-Induced Danio rerio Development

Biology

Shreya Balaji

Mass. Academy of Math & Science

Despite the usage of intensive rehabilitative treatments, about 15-30% of stroke victims acquire a permanent disability. Certain genetic polymorphisms that affect the release of brain-derived neurotrophic factor (BDNF) have recently been associated with a decreased motor learning capacity post-stroke. Studies conducted using human participants have not been able to confirm a correlation between this genetic mutation and stroke rehabilitation response. In this study, *Danio rerio* (zebrafish) were used in their embryonic and larval stages to test the effects of insufficient BDNF on physiological development post-hypoxia. It was hypothesized that BDNF inhibition would prolong the physiological delays instated by hypoxia. Nitrogen gas was used to lower dissolved oxygen concentration to induce hypoxia. BDNF was inhibited using the tyrosine kinase inhibitor K252a. The physiological development of the *Danio rerio* was monitored for three days and was analyzed using FIJI image processing software. Differences in head-trunk angle, body length, and yolk sac diameter were analyzed. It was determined that BDNF inhibition had a substantial effect on physiological development post-hypoxia.

C23 Designing a Machine Learning Solution to Atrial Fibrillation

Biology

Shashank Jarmale

Billerica Memorial High School

"Atrial fibrillation (also called AFib or AF) is a quivering or irregular heartbeat (arrhythmia) that can lead to blood clots, stroke, heart failure and other heart-related complications. At least 2.7 million Americans are living with AFib." As displayed by this passage from the American Heart Association, atrial fibrillation poses a real threat to the health of humans all over the world. Not only is it indicative of more serious health complications down the road like other heart arrhythmias, but it is also difficult to detect, unlike other heart arrhythmias. The difference here is that afib comes in many forms, one of them being a heart beating properly some of the time and displaying signs of the arrhythmia at other times. Thus, it is difficult for many to diagnose their condition of atrial fibrillation early and accurately, as it is essentially luck that allows this timing to line up with a physical or other doctor's appointment. Therefore, the problem I propose addressing is that of detecting atrial fibrillation in a way that is not only accurate, but convenient and reflective of patients' rights. This will be done through a machine learning algorithm that will train on data available through PhysioNet and take input data from a heart monitor to diagnose afib and other arrhythmias. This algorithm may or may not pair with a physical sensor to be designed specifically for this use.

D1 Do Your Plants Like Music?

Biology

Abigail Scholl, Brianna Martinez

Berkshire Arts & Technology Charter Public School

Do plants grow faster if exposed to classical music? We believe that they do. If we grow two groups of plants, one listening to music, and one not, we think the group exposed to music will grow faster. The vibrations from classical music will cause the plants to grow faster. To gather the data we set up two groups of plants under the same grow light in the same room. One of the groups has headphones around the pots, and the plants are listening to classical music, the other set of plants wasn't being exposed to anything. We then compared the two group's growth and weight after four weeks. Unfortunately, we couldn't find a trend in our data and because we couldn't find this trend, our hypothesis wasn't supported.

D2 A Real Slip-Up

Biology

Abigail Webster

Berkshire Arts & Technology Charter Public School

To test the effects road salt has on plants, 6 groups of cherry tomato plants were grown with differing amounts of road salt dissolved into watering solutions. The groups consisted of 9 seeds watered with tap water, 9 seeds watered with a solution of 1 gram of road salt per liter of water, 9 seeds with a solution of 2g/L, 9 with a solution of 3g/L, 9 with a solution of 4g/L and 10 with a solution of 5g/L. These plants were observed for 3 weeks and symptoms of leaf scorch and nutrient deficiencies were taken and turned into a Tomato Health Score (T.H.S.). At the end of the experiment the groups were measured for their average heights and germination rates. It was expected that the plants in the groups with 3g/L of salt or more would have higher T.H.S.s and lower germination rates and heights compared to the other groups. When all of the collected T.H.S.s were compared it was found that between all of the groups there was a positive trend between T.H.S.s and the time that the experiment went on. It was also found that there was a positive trend between the height of the plants and the amount of salt added before 3g/L, but after 3g/L there was a negative trend. The data partially supported the hypothesis because the 5g/L group had the highest T.H.S. at the end of the experiment with 47% as opposed to the lowest from the 2g/L group with 32.86%. The group with the tallest plants was the 3g/L group with an average height of 15.39 cm. as opposed to the control (0g/L) group with the lowest average height at 9.16 cm. There was no correlation between the germination rates and the amount of salt added to the solutions. From this it is concluded that the amount of salt added to a plant's water supply does effect that plant's health negatively, but not as much as what was predicted.

D3 Stride Length and Running Economy in Athletes

Biology

Rachel Prendergast-Tombeno, Hunter Whitbeck, Georgia Zarola

Acton-Boxborough Regional High School

Among high school athletes there is very limited data on the effects of variations in biomechanics on running performance and economy. Studies that we examined showed that in adult subjects, the most economical stride length was chosen regardless of running experience (1, 2). The research team investigated if experienced high school runners naturally select an optimal stride length for minimizing oxygen uptake when compared to high school non-running endurance athletes. Oxygen uptake was measured while athletes ran at a self selected pace with long, preferred, and stride lengths. Athletes were asked to lengthen and shorten their strides by around 3-4 inches. The team tested three female varsity cross country runners and three female varsity nordic skiers. It was concluded that there is no significant difference of VO₂ at different stride lengths for runners and non runners.

D5 The Role of Intracellular Trafficking in Immune Response to Lyme

Biology

Devesh Pathak

Lexington High School

Lyme Disease is an emerging disease caused by the bacterial spirochete *Borrelia burgdorferi*. The disease manifests in early skin infection, a bulls-eye rash and a long-term infection characterized by arthritis, carditis, and neuroborreliosis. The symptoms are largely the result of an over-exuberant immune response. The goal has been to characterize the important immune pathways that result in long term infection and excessive inflammation. Previous studies have focused on understanding how trafficking within the cell controls inflammatory responses. It has been found that cellular location regulates which inflammatory mediators are produced. Proper intra-cellular localization had an effect on the development of joint inflammation in a model of murine Lyme arthritis. The goal has been to characterize the signaling pathways that happen inside the cell and determine how those signaling pathways differ at different cellular locations and how they may control the inflammatory outcomes we observe in vivo. The focus has been on innate immune pathways. Toll-like receptor 2 (TLR2) is an important mediator of early pro-inflammatory mediators in response to *B. burgdorferi* infection. It can signal from multiple cellular locations and its signaling pathways at the phagosome, post pathogen phagocytosis, have not been fully elucidated. This project identifies a key mediator in TLR2 phagosomal signaling. In the experiments, confocal microscopy was used to identify molecules that are not recruited to *B. burgdorferi* containing phagosomal compartments in AP-3 deficient mouse bone marrow-derived macrophage (BMDM) when compared to wild-type. It was observed that TAK-1 kinase is the missing piece in the signaling complex and is critical for TLR2 signaling at the phagosome.

D15 Statistical and Cost Effective Lens on Computers at WHS

Biology

Aiden Chisholm, Brendan Morrissey

Westfield High School

This project was a microbiology experimentation designed for the purpose of determining if student computers have more microbes than faculty computers. The key swabbed was determined from last year's project, Analysis of Microbes Cultured from Keys of a Computer, where it was found that the "e" key has the most bacteria on average. The actual experiment used agar covered petri dishes, distilled water, and disposable swabs. The entire face of the "e" key was swabbed for each computer; data was collected from twenty-five chromebooks and twenty-five faculty computers from various locations: Main Office, Administration, Guidance Office, Health Office and Teacher Rooms. The petri dishes were then incubated at WSU, after this was finished the total number of colonies was counted for each computer. After this they were transferred to MAC, PEA and MSA petri dishes to measure for gram+, gram- or salt tolerant bacteria respectively. After experimentation concluded a Fisher's Exact Test and a Two Sample T-Test. These statistical tests found there is no difference in the actual average amount of white colonies between student and teacher computers; however, it was also found that student computer are more likely to have gram - bacteria. A cost analysis was also completed where it was found it was take the Westfield School district ~.022% of their budget to provide clean wipes to 150 computers for the whole year. Overall it was found student computers contain the lesser of the two evils regarding bacteria since gram - bacteria are countered easier b antibiotics, it would not take much for our district to fight sickness in our schools, and of course everyone needs to take better care washing their hands.

D18 Effects of Wax Worm Digestive Bacteria on Polyethylene Biodegradation

Biology

Carter Paul, Harrison Paul, Ian Minier

Marlborough High School

Purpose: Plastic materials take a significant amount of time to biodegrade depending on their chemical makeup and density. The Wax Worm larvae *Galleria mellonella* has been known to biodegrade small amounts of polyethylene. The Indian waxworm, a common name for the larvae of *Plodia interpunctella*, is proven to contain the bacterial strains *Enterobacter asburiae* YT1 and *Bacillus* sp. YP1. While these bacterial strains have been directly connected to the environmentally friendly biodegradation of polyethylene products (yields ethylene glycol), the species of the bacteria found in the larvae of *Galleria mellonella* is unknown.

Methods: 2 experimental groups (5 trials each of *Galleria mellonella* larvae were placed in jars that contained sheets of low density polyethylene (LDPE) as the only source of food . Both groups included control jars in which larvae consumed a natural diet. Larvae were dissected to extract gut content which was then used to prepare a homogenate solution (saline water). Larvae excrement was then tested for ethylene glycol content. Polyethylene sheets were then placed into conical tubes to measure their biodegradability in the gut content mixtures.

Results: Both experimental groups had an average survival rate of 93% and consumed less polyethylene than expected. Solution degradation was estimated at 1.56mg to 1.98mg after 300 hours. 16S rRNA gene sequencing of bacterial samples yielded full sequence compatible with bioinformatics software.

Conclusions: The larvae successfully ingested LDPE. Using the BLAST database, the possible bacterial identities found in the gut content of *Galleria mellonella* are similar to the strains found in *Plodia interpunctella*. Ethylene glycol content of larvae excrement tested positive at a high concentration.

D20 A Bioinformatics Analysis of Circadian Rhythms

Biology

Roshni Ray

Lexington High School

This project investigated the existence of co-expression between circadian rhythm genes and cancer-associated genes in order to gain insight as to how the disruption of one's circadian rhythms may initiate cancer development. Based on the vast influence circadian rhythms have in physiological processes, it was hypothesized that there would be a high degree of co-expression between circadian genes and cancer genes because circadian rhythms control processes that are conducive to cancer development, including DNA repair, gene expression, and cell cycle timing. To address this investigation, various bioinformatic analyses were used to quantify the associations between random samples of cancer genes and circadian rhythm genes. These techniques included cluster analysis, correlation analysis, and gene expression analysis using public microarray data from the COSMIC, COXPRES, and CIRCA databases. Out of the 60 cancer genes from the original gene sample, 15 genes exhibited statistically significant circadian expression patterns and associations with their corresponding circadian rhythm genes. Given the prominent role of oncogenes and tumor suppressor genes in the development of cancer, characterization of their lesser known features, such as circadian associations, can help refine cancer diagnosis and treatment.

D23 The Effects of Juul Juice on Saccharomyces cerevisiae

Biology

Mila Manic

Plymouth South High School

What is the effect of JUUL Juice on eukaryotic cells metabolism and reproduction? In this experiment Saccharomyces cerevisiae was used as a eukaryotic model to determine the effects of JUUL Juice on CO₂ production and zone of inhibition. Through multiple serial dilutions with different concentrations of JUUL Juice, a dose response investigation was conducted. Due to the carcinogens within JUUL Juice, including Benzene, Cadmium, and Arsenic, the higher the concentration, the bigger the zone of inhibition, and the lower the CO₂ production. Both reproduction and metabolism are thus negatively affected, for as the concentration of JUUL Juice is increased, the enlarged exposure to carcinogens will cause DNA mutations within Saccharomyces cerevisiae, obstructing the instructions needed to make vital proteins, and preventing cellular processes from taking place. When Saccharomyces cerevisiae is exposed to these conditions, the cells metabolism will not work at proper rates, and resultantly the cell will die, halting reproduction. Due to the similar molecular makeup of Saccharomyces cerevisiae to human somatic cells, it can be inferred that damage inflicted on yeast will be similar to the effects JUUL Juice has on human cells. Vaping although deemed “healthier” is not as safe as it has been marketed to be, and the current epidemic occurring surrounding the JUUL is directly targeting teenagers and future generations to come.

F1 Using Daphnia Magna to Examine Water Acidity

Biology

Nina Prenosil, Ellen Jury

Westfield High School

This experiment is to determine which local body of water is the most acidic based on the Daphnia Magna’s heart rate per minute when exposed to the water sample. The water was collected from Hampton Ponds, Congamond Lake, Otis Reservoir and Buck Pond. The goal of this project was to determine which body of water was the most unsafe for exposure. When exposed to water with a high acid content swimmers can experience itchy skin, burning of the eyes and nasal passages and a plethora of other side effects.

The daphnia then had to be monitored under a low power microscope to accurately count their heart beat. A dot test was used to tally how many times the daphnia’s heart beat every 10 seconds, this number was then multiplied by 6. The expected result was that if the Daphnia Magna were exposed to the Hampton Ponds water sample then their heart rate would decrease significantly, indicating a lower pH and the lower the pH the higher the acidity. The test for each water sample was done twice to ensure accurate results, it was then compared to the test in the control water.

The batch of Daphnia Magna that we used in testing had an average heart rate between 246 and 258. Our test results showed that the daphnia reacted to Hampton Ponds with a heart rate of 198 first, then 144 bpm. In Buck Pond water their heart rate was 234 bpm and 246 bpm. Otis Reservoir made their heart rate decrease a little bit with an all around bpm of 240. Lastly Congamond had a fairly dramatic effect on their heart rate with 204 bpm and then 192 bpm.

Our experiment concluded that Hampton Ponds was the most acidic and affected the daphnia's heart rate the most significantly, as it decreased the most.

F2 The Extension of Time before Growth of Mold on Food Via Silica Gel

Biology

Trent Stucenski

Westfield High School

The purpose of this project is to determine if silica gel can use its properties as a food mold preventative measure. Silica gel is a desiccant, meaning it takes in moisture, so therefore it is hypothesized if silica gel is placed in the vicinity of different food products, then the time until the beginning of mold growth will be longer than that of the food products without the silica gel. In order to grow, mold needs moisture. The experiment consisted of two groups with raspberries, apples, bread, and cheese with moisture on each (constant variables). One group had silica gel (independent variable) and the other didn't. The amount of days each food took to grow mold was recorded. Collectively, all of the food in the silica group took longer to grow mold by at least 4 days. From this it can be concluded that silica gel effectively removes moisture from food and elongates the amount of time it takes to grow mold on food. This is very applicable to society because consumers can save money by keeping their food fresh longer and it prevents non-biodegradable silica gel packaging from piling up in landfills, keeping our environment clean.

F9 The Effect of Duration of Light Exposure on the Color of Artemia

Biology

Liem Nguyen

North Quincy High School

Artemia have been hatched from cysts and grown for a total of seven days in different light conditions to ascertain the relationship between color and light exposure. It was hypothesized that if color is related to light exposure, then there will be a variance in color of Artemia from the low light (10.5 hr.) and high light (15.5 hr.) groups after seven days. Artemia were hatched in an incubator for 24 hours at 25-30°C with constant aeration in water with 5 g/l salinity. 20 ml of the resulting nauplii were then transported from the bottles via pipette to each of the nine test bottles. There they grew under 2000 lux of light in three groups with 10.5 hours, 13 hours, and 15.5 hours of light exposure per day, respectively, and in water at 30 g/l salinity and 1ml of Spirulina phytoplankton algae was added to each bottle at 6:30 A.M. every day. Color and shade of color results demonstrate that there was a variance in color between the three groups, and in particular the low light and high light groups. The average shade and color of the high light Artemia was light and grey. The average shade and colors of the low light group was dark, and brown and orange. This project succeeded in proving the dependence of Artemia upon the duration of light exposure and this information and the methods can be used in future Artemia studies and to improve environmental data collection.

F16 The Effects of Temperature on C3 vs. C4 Plants

Biology

Michelle Olofsson, Claire Lawrence

Lexington High School

With the rise of global warming comes the question of how plants will be impacted. Two major types of plants, C3 and C4, have different mechanisms of photosynthesis, and thus react differently to changes in temperature. This research project addresses the question of how the growth rates of C3 plants and C4 plants will differ with the predicted temperature increases accompanying global warming. Due to higher rates of photorespiration in C3 plants, the growth efficiency of C3 plants will likely be more negatively impacted by increased temperatures than that of C4 plants. In order to investigate this two trials of C3 and C4 plants were set up, one at a higher temperature and one at lower. The plants were left to grow at the consistent temperature under grow lights for a constant period of 18 days. At the end of the 18 days the dry masses and heights of the plants were collected. The results were unfortunately inconclusive in terms of the hypothesis, as there was no data for the corn plants from the cold trial. This was most likely due to the cold temperature being too far from the natural growing temperature. If further experimentation were conducted, another trial at a higher temperature would be set up, in attempt to stimulate more growth. However, some conclusions were still able to be drawn, between the two grass trials, and also the grass and corn in the warm trial. While the experiments thus far do not indicate much, the principle of investigating how plants will be impacted by climate change is one that should be further explored.

F17 The Time it Takes Painkillers to Dissolve in the Stomach

Biology

Tetyana Shvyryd

Westfield High School

The purpose of this experiment is to test everyday drugstore painkillers in acidity close to the stomach to distinguish which drugs dissolve faster, therefore diffuse faster into the bloodstream and ultimately function at a higher rate in the body to relieve pain. When cells are damaged they release a tuning chemical called arachidonic acid which two enzymes, COX-1 and COX-2, convert to other chemicals that ultimately raise body temperature, cause inflammation, lower the pain threshold, etc.. When painkillers, such as aspirin or ibuprofen, are exposed to acids in the stomach they're broken down and then the content travel to the active sites which stops pain symptoms. For this experiment, I purchased several different brands and forms (capsules and tablets) of painkillers from a drugstore that are relatively popular. To mimic the acidity of the stomach, I created a hydrochloric solution with a pH level of 2.5. For each tablet I measured 20ml, just enough so that the entire drug would be covered, and dropped it in. By knowing how fast these painkillers dissolve in the acid, I was able to assume that the faster dissolving drugs would consequently absorb into the blood in less time.

The results of this lab showed that the fastest dissolving painkiller tested was the Tylenol caplet at 9 min and 9s. My hypothesis was not proven because I thought the liquid gel caplet would dissolve at the fastest rate. Using a painkiller such as Tylenol, out of the painkillers tested in this experiment, will give you the fastest pain relief. Other painkillers kick in within 20 minutes including Ibuprofen tablet and the Advil tablet (16min3s and 15min12s). This project is helpful to those wanting to find the most efficient painkiller and better understand the construction of medicine.

F19 Engineering of Congenic Huntington Fibroblast Cell Lines, Using CRISPR

Biology

Elan Rosen, Shazain Khan

Hopkinton High School

Huntington's disease (HD) is a fatal neurodegenerative disease caused by expansion of CAG repeats in the Huntingtin (HTT) gene. Neither its pathogenic mechanisms nor the normal functions of HTT are well understood, and no permanent therapy currently exists to treat HD. In this project, the first aspect of the research was on the engineering of a novel protocol to develop congenic human fibroblast cell lines for Huntington's disease, which would allow for enhanced accuracy in HD research with genetic variability accounted for. Genetic dissimilarity is a significant factor to consider in growing a cell population research model and can often blur and mask findings. By removing this issue, we are providing a more refined method of analysis, which we are then utilizing for more comprehensive research in the phenotypic effect of the various alterations to the HTT gene. Under normal experimental conditions, possible effects are more difficult to distinguish and create accurate conclusions with. This project deduced two possible ways of achieving a congenic cell line with said alterations—one through pre-designed guide RNA CRISPR treatment and another with bacteria cultivated plasmid CRISPR treatment. While the first was utilized and optimized the latter is theorized to be far more adept to culturing a congenic colony, as it is a more direct method via its antibiotic cell selection procedure. Such testing will first provide insights into possible HTT protein function and expected results/benchmarks and considerations for one's creation of a congenic HD cell line, thus hopefully expediting the research of other scientists if applied.

F23 Phenotypic Diversity

Biology

Maryam Mohamud, Katia Pinto, Darian Motto

Jeremiah E. Burke High School

In this research project, we investigated the phenotypic diversity of human faces. Our goal was to research the different characteristics of humans that make individuals unique. We believe that people from certain races might have different facial appearances. We surveyed over 73 individuals asking about certain facial features and characteristics. We compiled the data and analyzed the results to determine if there were any correlations between observable phenotypes and racial background. Our results suggest there may be a link between certain phenotypes and racial background.

F26 Going Green to Prevent Breast Cancer

Biology

Ellia Sweeney

Bishop Feehan High School

Many people struggle with breast cancer, and while there is no cure, there are several studies being done on everyday substances that are believed to contribute to preventing the growth of cancerous tumors. Yet currently, many studies remain inconclusive. New carcinogens are found every year, as are new substances believed to fight the carcinogens. Green tea is one common substance believed to help prevent the growth of breast cancer tumors. This experiment is designed to determine if, as hypothesized, green tea antioxidants neutralize and interact with free radicals to prevent the growth of cancerous tumors in planaria worms, and the EGCG antioxidant in green tea best prevents tumor growth out of all tested antioxidants/vitamins/medications. Its results should support the idea that EGCG and other antioxidants can be used to decrease the growth rate of cancerous tumors.

In order to investigate this issue, planaria were exposed to EGCG, vitamin E, beta-carotene, and carboplatin, a chemotherapy drug. Some of these planaria were then gradually exposed to the carcinogens ammonium dichromate and tobacco. Control planaria without any carcinogens or antioxidants/vitamins/medications were also placed into Petri dishes.

After the first trial, the predicted, expected outcome was supported when the carcinogens caused the growth of tumors in the planaria worms in all but those exposed to EGCG. The second trial was conducted with lesser amounts of carcinogens, again causing massive tumors to develop. The third trial was conducted with even lesser carcinogen amounts, resulting again in EGCG best preventing tumor growth, followed by vitamin E, carboplatin, and then beta-carotene. Thus, the experiment supported that regular consumption of green tea may help prevent tumor growth.

F27 Effect of Apple Cider Vinegar Solutions on Bacterial Growth

Biology

Omar Sanchez, Julie Liu, Janet Tan

Boston Latin Academy

Our science fair team chose to further look into the effects of apple cider vinegar on microbial organisms. We thought this would be a good topic to look into because it provides a natural alternative to harsh commercial cleaning products such as bleach, hand soap, and hand sanitizer. Apple cider vinegar is biodegradable and nontoxic, so it is safer for the environment. Apple cider vinegar is an inexpensive alternative to commercial products, so it could save people lots of money. And as a bonus, apple cider vinegar has a more pleasant smell compared to other cleaning products. Many people know that apple cider vinegar has many uses, like cooking, losing weight, creating traps for flies, and many more. Our team has decided to investigate if being a great antiseptic is one of the uses of apple cider vinegar as well.

G6 Myelin Sheath Regeneration in the Neurons of Zebrafish

Biology

Jillian Dion

Marlborough High School

Multiple sclerosis is a degenerative disease where the body's own immune system attacks the myelin sheath on neurons, causing problems with communication throughout the central nervous system. The fundamental purpose of this experiment is to determine if there is a distinct benefit of an off-label use for the overactive bladder drug solifenacin, using it to initiate the remyelination of neurons destroyed by muscular sclerosis. When type III receptors on oligodendrocyte progenitor cells are activated, differentiation of neurons is halted which inhibits these oligodendrocytes from entering their myelination phase (Sim, 2015). It would then be investigated if solifenacin could then be used to block these receptors which could help boost the rate of differentiation (Sim, 2015). Researchers from a study published in the Journal of Neuroscience, transplanted oligodendrocyte progenitor cells from humans into mice that were previously modified to not make myelin. The treated mice showed an increased level of differentiation and myelin synthesis from the transplanted human cells (Sim, 2015). Extending this concept onto a model that fits the appropriate criteria for the International Rules for Pre-College Science Research, this experiment will use zebrafish 4 days post-fertilization that were bred in an environment containing solifenacin in the water. After isolating the cerebellum of the zebrafish, neurons will be cultured and the myelin will be quantified. Repurposing a medication that is already FDA approved could mean major advancements in the treatment and management of muscular sclerosis in humans. While current oral medications, such as Teriflunomide and Fingolimod are used to manage symptoms, solifenacin will target to the mechanism of the symptoms, in hopes of halting.

G8 Which Type of Sugar Elicits the Strongest Response?

Biology

Sharina Castillo, Cindy Ramirez

Edward M. Kennedy Academy for Health Careers

C. elegans are microscopic round worms that are a useful model species because of their simple body structure and rapid self-reproduction. They feed off of bacteria and rotting fruit materials and can easily survive on agar plates as long as there are enough nutrients. They do chemotaxis in response to chemical stimuli. The chemical signals are sensed by a neural sensory region at the head of the worm. They have been a helpful model organism in research about sleep, addiction, caffeine use, and neural responses to stimuli. For this experiment, the *c. elegans* will be exposed to different stimuli or obstacles in the way of stimuli. The question being explored is how *c. elegans* will respond to the stimuli they are exposed to. This experiment is important because it can help inform other research using *c. elegans*. Because humans and *c. elegans* have 35% of the same DNA this experiment also might provide insight into how humans could respond to similar stimuli or obstacles in getting to stimuli. This could impact society because it could give researchers more information about how *c. elegans* function which can help researchers better use these organisms in labs that do research to inform human disease or behavior research.

G11 Ultrasonic Enhancement of Antibiotics on Bacteria

Biology

Olivia Weber

Taunton High School

Bacterial resistance has become a large problem over time, and there is a need for more effective antibiotics and antimicrobials. Many investigations have been conducted to help discover new ways of fighting bacteria, several using ultrasonic waves along with antibiotics. This experiment investigated if ultrasound can enhance the effectiveness of antibiotics, to help fight bacteria better. It was hypothesized that if E. Coli is exposed to ultrasound than dosed with a gentamicin than it will have a larger zone of inhibition than E. Coli dosed with only gentamicin. To go about this investigation E. Coli was placed in a ultrasonic jewelry cleaner, than pipetted onto 10 agar plates, 5 plates dosed with gentamicin, the other 5 were controls, dosed with water filter disks. Five plates had just E.coli and water disks, and another five had E. Coli dosed with gentamicin. The twenty plates were then incubated for 24 hours, and the zone of inhibition was measured and recorded. The hypothesis was proved correct and the plates containing E. Coli exposed to ultrasound and dosed with gentamicin had the largest zone of inhibition, and was the most effective in preventing the E. Coli growth. This result is because the ultrasound perturbed the bacterias cell membrane, and the E. Coli became more sensitive. The plates with water disks grew no zone of inhibition, due to the absence of an antimicrobial. This investigation proves ultrasonic waves paired with antibiotics may be a strong option for fighting bacteria.

G14 Testing GMO and DNA Extraction

Biology

Myah Morales

East Boston High School

For my project I worked with corn/wheat based foods that were genetically modified and those that weren't genetically modified, to test whether or not these products behaved differently. Using PCR and gel electrophoresis I managed to test the presence of multiple genetically modified and Non- genetically modified corn based foods/wheat based foods. In which I analyzed and determined whether or not they were similar. In addition to growing seeds and isolating the DNA of Wild-type seeds and GMO sprout seeds, to then see the growth processes of a Non-GMO seed and a GMO seed. As a final result, I concluded that the foods that were not labeled Non-GMO contained a GMO gene, and those who had a Non-GMO sticker on their food packages were in fact Non-GMO. As well as the extended project I conclude that the Wild-type seed had a major growth pattern rather than the GMO sprout seed. Which resulted in a success.

G15 The Effect of Temperature on The Rate of Fermentation of Yeast

Biology

Faith Cole

Boston Latin Academy

When one bakes with yeast, the recipes most always say that you have to activate it in warm water and sugar. My question was then, why does the water have to be warm? Fermentation is a metabolic process that produces ATP, a form of energy, for the yeast to be activated. A byproduct of the process is CO₂. So my hypothesis is "If the temperature of the yeast's environment lowers, then the rate of fermentation will be slower." I tested the rate of fermentation by recording the amount of CO₂ that was being produced inside the bottle I activated the yeast in. My procedure was to put yeast, warm water, and sugar in one bottle, and yeast, sugar, and cold water in another bottle. I tested the rate of CO₂ produced by each bottle for ten minutes with a CO₂ probe. Once I calculated the rates and graphed the data, I saw that the rate of fermentation for the warm water was much greater. Therefore my hypothesis was supported. To apply this to a real world situation I decided to bake with yeast. If my hypothesis is supported by this extra experiment then the bread whose yeast activated in warm water will rise more. After I followed the directions in the recipes including letting the bread rise for an hour, I measured with a ruler to height of each bread piece. After seeing putting the data on a table, I found that my hypothesis was further supported.

G16 The Effects of Exercise on Aggression in a SlgA Model of Schizophrenia

Biology

Kerrie Verbeek

St. Mark's School

Schizophrenia is a partially hereditary disease that causes an array of symptoms, including hallucinations and decreased social behavior. Symptoms are classified into two main categories identified as “Positive Symptoms” and “Negative Symptoms”. Without a cure for schizophrenia, only treatments can be used to alleviate symptoms. Positive symptoms are caused by hyperactivity in D2 dopamine receptors due to the dysfunction of GABA. Since antipsychotics impair dopamine receptors, they are often prescribed to treat positive symptoms. The negative effects of this treatment include anxiety, depression, and over long periods of time, increases in the amount of dopamine receptors in the brain. It has been found that exercise increases GABA admissions into the brain, which could help to alleviate positive symptoms of schizophrenia without blocking receptors. In this experiment, a *Drosophila melanogaster* group that expresses the human PRODH homolog, SlgA-D, in clock neurons through the UAS-gal4 system were used to model schizophrenia in humans. The most prominent positive symptom in this model is aggression. The study exercised a control group as well as the group expressing SlgA-D through an apparatus that relied on negative geotaxis for exercise performance. After treatment was over, fights were conducted to measure the aggressive behavior of the exercise groups against the non-exercise groups. Following experimentation and data collection, preliminary results from this study suggest but do not confirm, that exercise reduces the positive symptom of aggressive behavior in a *Drosophila* schizophrenia model. Further trials are needed to confirm the suggested results.

G17 Testing the Inhibitory Effects of Straw on Algae

Biology

Eileen Xu

Wachusett Regional High School

The purpose of this project was to determine whether straw could be used as a natural algistat to control blooms, and if possible, what kind of straw would be most effective. In addition, an extension was done to determine which mechanism in straw explained its algistatic effects.

The experiment tested one control (no straw) compared to four types of straw (barley, rice, wheat, and millet). Barley was hypothesized to have the greatest inhibitory effects upon cell growth, because of previous research done with straw on cyanobacteria. Straw samples were left to decay in tubes containing *Chlorella* algae. Algae cell counts were conducted at the beginning of each trial and after each week for three weeks. Cells were stained with Trypan Blue and counted using a hemocytometer. The results contradicted the hypothesis, as all IV tubes had higher cell counts than the control with no straw.

An extension tested the main mechanisms of possible inhibition of cell growth from phenolic compounds within the straw. This used the primary experiment's data, and a separate setup that tested oxidative stress by reactive oxygen species (ROS). One control tube was grown alongside 2 levels of H₂O₂ and 2 levels of catalase. The ROS were supported as the primary mechanism of inhibition of cell growth.

G18 The Effect of Preadult Malnutrition on Offspring Learning and Memory

Biology

Katherine Schmalz

Wachusett Regional High School

The purpose of this experiment was to determine if there was an effect of parental pre-adult malnutrition on first filial generation learning and memory, using *D. melanogaster*. It was hypothesized that if larva were fed a low protein/high carbohydrate diet, then their offspring would have diminished learning and memory compared to the offspring of flies fed a high protein/low carbohydrate diet as larva.

D. melanogaster larva were raised on either a high protein/low carbohydrate, low protein/high carbohydrate, or equal protein/carbohydrate (control) diet, then switched to the control diet in adulthood. Their offspring were raised entirely on the control diet. To test the P and F1 generations' learning, a negative reinforcement assay was used, where flies were taught a negative association to the smell of vinegar. Then their memory was evaluated by timing how long it took the flies to forget that association.

The results suggest that there is an effect of parental pre-adult malnutrition on offspring learning and memory, and that the hypothesis was supported by t-tests. The more protein and less carbohydrates in the parental pre-adult diet, the quicker the offspring learned and the longer their memory retention. Also, the F1 generation had improved learning but diminished memory compared to the P generation, with the exception of the healthy flies, which showed no change between generations.

G19 The Use of Essential Oils to Fight Fire Blight in Fruit Trees

Biology

Gonzalo Anyosa-Galvez

Cambridge Rindge & Latin High School

Fire blight, a disease caused by *Erwinia Amylovora*, targets fruit trees resulting in severe orchard damage globally. The treatment for fire blight includes spraying the orchards with the antibiotic, streptomycin and this has led to the development of streptomycin-resistance *E. Amylovora*. Many essential oils have potential antibacterial properties. Thus, we hypothesized that the oils of thyme and oregano, will exhibit antibacterial activity against *E. amylovora* and the microbial community found on apple trees. Using culture-dependent methods, we tested the effects of streptomycin and the oils of thyme and oregano on the growth of microbes isolated from apple trees. In a broth dilution assay, we identified 4 bacterial cultures with varying degrees of sensitivity to streptomycin (0, 50 and 500 ug/ml). Using the disk diffusion test, we determined that all bacterial isolates were susceptible to the antibacterial properties of thyme and oregano. Therefore, essential oils may be a new treatment for fire blight caused by both streptomycin sensitive and resistant *E. Amylovora*.

G20 The Effect of Lithium on Learning and Memory in D. Melanogaster

Biology

Elise Mizerak

Wachusett Regional High School

Alzheimer's Disease is currently the world's most common neurodegenerative disease in humans. The disease is characterized by the accumulation of plaques and tangles of neurons in the brain. The plaques are believed to be comprised of the amyloid peptide while the tangles are believed to be formed by the hyperphosphorylation of the tau protein. Glycogen synthase kinase-3 (GSK-3) is the enzyme that is known for regulating tau phosphorylation. GSK-3 inhibitors are currently of the utmost interest to Alzheimer's research because they could be a prime target in preventing the accumulation of tangles in the brain.

This project made use of three different amounts of lithium chloride, a specific GSK-3 inhibitor, in examining how it can impact the learning, memory, and movement abilities of male and female *Drosophila melanogaster*. Male and female flies underwent a series of learning, memory, and geotaxis assays using apple cider vinegar after consuming the lithium chloride for four days.

After conducting the learning, memory, and geotaxis assays, it was determined that lithium chloride significantly impacted the learning and memory abilities of male and female *Drosophila*. After consuming lithium chloride, the males and females had quicker learning times and a higher percentage of the flies were able to pass their memory assays. The lithium increased the average distance travelled by a female fly, but decreased the average distance travelled by a male fly. Further analysis will investigate how lithium chloride affects tau neurotoxicity.

G27 Effects of Alcohol on Flatworm Regeneration

Biology

Alexander Pereira

Taunton High School

Ethanol exposure in utero affects neurodevelopmental processes, which can lead to a variety of physical and cognitive impairments known as fetal alcohol spectrum disorders (FASD). Alcohol acts as a central nervous system (CNS) depressant and it kills organisms by denaturing their proteins. Recent studies suggest that chronic alcoholism damages neurons and if alcohol is drunk during a pregnancy, the fetus is at risk to FASD because the fetus cannot metabolize alcohol because it does not have the enzyme, alcohol dehydrogenase (ADH). The purpose was to investigate the consequences of drinking alcohol while being pregnant by seeing the regenerative growth in *Planaria*. The hypothesis was if exposed to high concentration of ethanol, *Planaria* will have a decreased growth rate compared to the groups that have a low concentration. When it is exposed to no alcohol, then it will have the highest regenerative rate. The procedure was to dilute ethanol to make the concentrations needed and cut the planaria to see the regrowth. Then, insert the *Planaria* into the solutions and record the growth over period of four days. The hypothesis was proven true because when the *Planaria* was put into a solution without any alcohol concentration, the *Planaria* showed the highest change in length.

H1 The Effect of Propolis on E. coli

Biology

Alexa Volfson

Wachusett Regional High School

The effect of propolis was tested to see if it had any inhibitory effects on the growth of bacteria. Propolis is a resin like substance made by bees and is used to seal up their hives. It contains many bioactive and phenolic compounds that are said to make it antibacterial and antifungal. The purpose of this was to see if propolis could potentially be utilized in a clinical or agricultural setting to help curb antibiotic resistance. It was hypothesized that if propolis was administered to E. coli, it would inhibit the growth of the bacteria.

A disk diffusion assay was used in which six variables were tested. There were three controls (ciprofloxacin, blank, and polyethylene glycol disks) and three concentrations of propolis dissolved in polyethylene glycol (30%, 10%, and 1%). The resulting data showed the positive control disks developed 14-15 mm of inhibition, the negative controls developed none, and that the 30% propolis developed 0.5-1 mm (with half of the replicates). In this study, E. coli growth was slightly inhibited by propolis. Further testing will utilize plates with polyethylene glycol in them to help the propolis better diffuse out and test its antibiotic effects.

H2 The Effect of pH on Enzyme Activity

Biology

Amina Aitnouri

Boston Latin Academy

The objective of this investigation was to study the effect of pH on enzyme activity. I studied the effect of pH on lactase activity. Lactase is the enzyme that binds to milk sugar lactose (disaccharide) and breaks it down to glucose (monosaccharide) and galactose (monosaccharide).

Lactose (Disaccharide) ---Lactase-----> Glucose (Monosaccharide) + Galactose (Monosaccharide)

I used commercially available lactase pill (Lactaid) in my experiment. I hypothesized that lactase is strongly active in a neutral pH (pH 7.0) and is moderately active at acidic (pH 2.0) or basic (pH 11.0) pH. I incubated 1% milk with lactase at different pH. Then, I looked for glucose production using glucose test strips. Glucose test strip turned from yellow to green (0 mg/dL glucose to 300 mg/dL glucose) in lactase solution at neutral pH (pH 7.0). This confirmed my first hypothesis that commercially available lactase is strongly active at pH 7.0. However, at acidic (pH 2.0) and basic (pH 11.0) pH, the lactase pill was entirely inactive and the glucose test strip remained yellow (0 mg/dL glucose), most likely because the protein denatured at pH 2.0 and 11.0. This refuted my second hypothesis that the commercially available lactase is moderately active at both acidic (pH 2.0) and basic pH (pH 11.0). Different parts of the digestive system have different pH. Hence, it would be interesting to test the effect of narrower ranges of pH (pH 4.0, 5.0, 6.0) on the commercially available lactase pills (Lactaid) activity.

H7 The Acidifying Ocean's Effect on Protease Activity in Alteromonas

Biology

Noah Glasgow

Falmouth Academy

The breakdown of carbon from complex organic polymers to abiotic carbon populations is a known function of metabolic pathways in oceanic decomposer microorganisms, such as the proteolytic catabolism essential to eubacteria *Alteromonas*. The efficiency of this extracellular process depends on the external environment; falling ocean pH driven by anthropogenic carbon pollution and climate change may now endanger microdecomposer protein catabolism that helps stabilize the oceanic carbon cycle. The purpose of this experiment was to employ innovative spectrophotometric techniques to determine if acidified environments impacted growth or proteolytic activity of *Alteromonas*. It was hypothesized that *Alteromonas* grown in an acidic environment would have slower growth and lower proteolytic activity than samples grown in an environment at or above natural ocean pH. To determine bacterial growth, a spectrophotometric plate reader measured kinetic optical density in a series of pH-adjusted marine environments containing *Alteromonas* inocula. To measure the activity of the bacterial proteolytic catabolism, fluorescent proteolysis assay was conducted on *Alteromonas* samples in pH-adjusted environments exposed to fluorophore-tagged casein BODIPY. Consistent *Alteromonas* growth ($.099 \pm .002 \text{ h}^{-1}$) was observed across an extensive pH range of 8.0-6.4, and proteolytic activity surged in the most acidic environments (5.6-6.8) tested. Thus, the hypothesis was not supported; however, the results analyzed imply that strong *Alteromonas* growth in generally lethal acidity (6.4) is supported by a pH-resistant proteases designed to capitalize on denatured substrates in acidic environments, suggesting that acidifying oceans will minimally impact this marine decomposer's role in the global carbon cycle.

H11 Does Caffeine or Sugar Have a Greater Effect on Heart Rate?

Biology

Aracely Alicea

Taunton High School

Approximately 610,000 people die annually due to heart related complications. With these numbers rising, it is important to understand which factors of an American's everyday life can contribute to these deaths. It is also widely understood, across the USA, that household drugs such as caffeine and sugar can tremendously contribute to the health of a person's heart. Knowing this however poses the question: Does caffeine or sugar have a greater effect on heart rate? The experiment consisted of diluting sugar and caffeine into separate containers of water. A snail would then be removed from the aquarium and its resting heart rate would be measured. After, the snail would be placed in a beaker of solution for about three minutes, and once it is removed, then its heart rate would be measured. Initially it was hypothesized that if snails were given sugar, caffeine, and a control of water then the snails treated with the caffeine solution would have a more affected heart rate, meaning that their heart rates would be higher. The results of the experiment supported the hypothesis that the snails treated with the caffeine would be more affected, however the rates actually decreased. This could have been an indication of heart failure in the snails. This experiment helps us better understand the effect that such commonly consumed drugs, such as sugar and caffeine, could have on our health.

H12 Ajoene: The Silencer

Biology

Julianne Morse

Plymouth South High School

Will Ajoene affect the quorum sensing systems of *Pseudomonas Putida* bacteria? Research was conducted to truly understand the correlation between Ajoene and *P.putida* autoinducers. Ajoene is a organosulfur rich molecule that has been found to prevent quorum sensing. By micropipetting certain amounts of ajoene oil onto agar plates that were about to be incubated with *P.putida*. The data showed that high amounts of ajoene oil that bacterial quorum sensing is prevented very well for long periods of time. This can be used to see if *P.putida* is more susceptible to antibiotics when not quorum sensing. This supports the hypothesis of that ajoene would stop the quorum sensing systems of *P.putida*. It was found that even low amounts of ajoene oil prevented the communication of *P.putida*.

H14 The Impact of Temperature Changes on the Coral Microbiome

Biology

Silas Clark

Falmouth Academy

Corals are vulnerable to the stress of temperature change in the ocean and subject to a self-induced aposymbiotic state. A secondary response to stress can be corals' increase of DMSP, a sulfur compound that acts as a beacon for microbes, whether beneficial or not. The purpose of this experiment was to observe the microbial densities of the saltwater coral *Astrangia poculata* under different stresses. It was hypothesized that the density of microbes associated with coral would increase with stress, with a differential in microbes between the aposymbiotic and symbiotic corals. Four coral polyps were swabbed with a cotton tip for their mucus. 40 μ L of 10x SYBR® Safe dye solution was added to 0.4 mL of the filtered seawater and mucus sample in the centrifuge tube. 10 μ L of the coral mucus sample were transferred to the slide via a micropipette with a coverslip placed over. All slides were made in a low-light room to avoid light oxidation and imaged in three random sections at 200X. From the pre-experiment testing to the end of Day 5, there was an average 12% decrease in microbial population during symbiotic testing, and an average growth of 42.5% during aposymbiotic. The hypothesis was partially supported; with stress, the microbial densities of the corals grew, with fluctuations in percent change across all days. As the expulsion of microbes during bleaching created a lower starting point in microbial population, the aposymbiotic corals ended with fewer microbes than the symbiotic. The ensuing growth of possibly detrimental microbes could result in the death of corals, threatening rain and cloud coverage, given corals' role in the production of CCN.

H15 The Effect of Nitrate Levels in Polluted Water on Daphnia

Biology

Stefania Yee, Tashaina Huezo-Santiago

Urban Science Academy

Daphnia Magna are planktonic crustaceans that are commonly known as “water fleas”. The Daphnia live in multiple environments varying from freshwater lakes to acidic swamps. Although, they can only survive on a certain level of nitrate. These creatures can filter microbes from polluted water which can be used as a water treatment method. The Daphnia is a good model for larger organisms and how they could react to nitrate changes.

The experiment was conducted to test what levels of nitrate, and polluted water affect Daphnia’s heart rate, and movement. We tested this by treating Daphnia in 0.5, 2, 5 and 20 mg/L concentration of nitrate for different time intervals to simulate polluted water. We looked at heart rate and responsive movement intently under a microscope to see how these levels of nitrate affected each Daphnia.

We hypothesized that if Daphnia are exposed to polluted water containing high levels of nitrate, their heart rate and movement will increase, eventually leading to their deaths. By conducting the experiment we observed that our hypothesis is incorrect. When nitrates increase, heart rate decreases, along with the movement. When nitrates decrease, heart rate increases as movement decreases. Changes in nitrate conditions cause a change in heart rate with the highest level being lethal. In future experiments, we would like to create more accurate results by maintaining the same age and gender for all Daphnia.

H17 Evaluating the Safety of Baby Powder

Biology

Hadiya Giwa

Wachusett Regional High School

The objective of this experiment was to determine whether talcum powder had an effect on *D. melanogaster* reproduction rate, hatch percentage, and death count. Numerous claims and studies dating back to the 1970’s have drawn a link between long term usage of talcum powder on genitals and reproductive cancer. The International Association for Research on Cancer has classified talcum as a possible carcinogen. In this experiment, fruit flies were exposed to talcum powder through their yeast paste medium. In addition, each fly cage contained six males and six females. There were three levels of feeding for both talcum powder and cornstarch: 25%, 50% and 70%. Overall, it was evident that the 70% groups suffered the most with reproduction and death count. Cornstarch 70% showed a significant decrease in the number of eggs produced, while talcum powder 70% showed an increase in egg production. Across all groups, as the amount of talcum powder or cornstarch in the yeast paste increased, the survival rate decreased throughout the six days. *Drosophila* eggs were also observed under a light microscope. The regular oval egg shape seemed to vary between talcum powder exposed groups and cornstarch exposed groups. The study indicates that there might be a possible connection between the long term usage of large amounts of talcum powder on the health of the *Drosophila* ovaries.

H18 Development of a qPCR Assay for Quantification of Saccharibacteria

Biology

John Lin

Boston Latin School

Saccharibacteria is an extremely small (200nm) uncultivable microbe that lives an unique parasitic lifestyle on various host bacteria, including *P. propionicum*. Saccharibacteria was recently found in abundance in plaque samples of patients with periodontal disease. There is limited knowledge about the behavior of this intriguing microbe because of its evasiveness from traditional, bacterial quantification methods due to its minuscule size and inability to be cultured independently.

This study aims to develop a unique method to quantify this bacteria. Primers were designed and optimized to target conserved regions, specific to the Saccharibacteria genome. A plasmid was constructed using amplified regions of Saccharibacteria DNA and transformed in *E. coli*. The plasmid was extracted and diluted to a known number of plasmid copies. Serial dilutions were performed and run on a qPCR. A calibration curve was developed based on the qPCR data. Afterward, the assay was applied to compare Saccharibacteria growth with that of its hosts.

A highly accurate assay was developed with 91.38% efficiency for quantifying Saccharibacteria. In addition, analysis of the growth curves reveals that Saccharibacteria enters stationary phase earlier than its host possibly to conserve resources before the growth of its host slows.

These findings open the door to various applications. Clinically, the assay can be used as a tool to diagnose and assess the risk for periodontitis based on the number of Saccharibacteria present. In the research setting, the assay can be used to further examine the behaviors of Saccharibacteria, its interactions with its host, and its pathogenicity.

H20 The Efficacy of Subzero Storage Methods on Dietary Proteins

Biology

Nicole Servetnik

Westfield High School

This project is about the concern of safety in the packaging of meats. Salmonella and other food poisoning diseases are spread amongst America because of unsafe meats. I wanted to find a simplistic and cheap way that everyone could use to protect meats when storing them, using freezer ziploc bags that everyone can buy at the store. The different methods I used at the beginning was a bag with no air, a bag with air, and a double bag. My hypothesis was that the bag with no air would accumulate the least bacteria. My procedure included cutting the both chicken and beef into 20 gram slices and placing them into their designated bags. I did three trials of each. Then I placed them in the freezer for two weeks. After that, I swabbed each piece of meat with a sterilized cotton swab and set up the petri dishes. After 4 days of incubation, I used the colony counter application on my cellphone to help me count up the colony forming units (CFU). I came to find out that my hypothesis as incorrect and the double bags for both the chicken and the beef accumulated the least bacteria with 157.67 CFUs for beef and 87.33 CFUs for chicken compared to the no air bag with 174.67 CFUs for beef and 105 CFUs for chicken. I concluded with these results for my first presentation, but then I continued to find data with other methods. I added specifically a double bag with air and a double bag without air as well as a control which grew the bacteria on the same meat before freezing. The double bag air and no air average was 240 CFUs and 236 CFUs for beef and 241.33 and 214.67 for chicken. The control was 236.33 for beef and 228 for chicken. I can say that double bagging is the best method but more experimentation would be needed to come to a clear conclusion to bacterial growth in single bags.

H21 The Effect of Sanitation Methods on Dirty Sponges.

Biology

Margaret Dion

Bishop Feehan High School

The purpose of this experiment was to determine which selected cleaning method is the best at killing bacteria. This information could help many people limit their chances of getting ill from bacteria and make them more aware that bacteria is widespread. The scientist believed that the microwave would be the most effective because it uses heat, which is one of the elements needed to kill bacteria, and because other studies have shown that the microwave can kill 99% of bacteria on other objects. This experiment consisted of three sponges which were washed on the scientist's floor and then cut up into six pieces. Three pieces were soaked in bleach, three in vinegar, three in hydrogen peroxide. Three were put in the dishwasher, three in the microwave, and three were left alone as the control group. After the pieces were subjected to a cleaning method, a sterilized applicator was used to swab them and plate the bacteria gathered, onto a nutrient agar plate. These plates were then put into an incubator for three days. Each day the scientist counted the number of spores on the plates, which was the scientist's quantitative data. If there was a reasonable amount of spores, the scientist would count them, but if there were too many to count, the scientist would divide the plate into quadrants, count one quadrant, and multiply that number by four. After three days, the scientist calculated which cleaning method's nutrient agar plate had the least spores overall. The expected outcome was that the most bacteria would be killed by the microwave. The experimenter's hypothesis turned out to be incorrect. In fact, bleach and hydrogen peroxide killed the most bacteria. No spores appeared on the nutrient agar plates for the sponges subjected to these cleaning methods.

H23 Sex Determination in Brine Shrimp

Biology

Abigail Anger, Olivia Weber

Taunton High School

The twenty first century is faced with many difficult choices, one of them now being which bathroom is appropriate to use. The case of transgender people being able to choose whichever bathroom they personally identify with now poses the question of if this condition is genetic based or purely a gut feeling. Based on countless experiments and studies of the sorts it is appropriate to believe that this is something that is completely uncontrollable. When you are being conceived the chromosomes from both your mother (XX) and your father (XY) combine to create the embryo. Countless things have to go completely right in order to have a flawless pregnancy. However, there are multiple mutations in genes and chromosomes that can alter the likeness of your outward appearance and your genetic makeup. One of such mutations is the mutation of the Wnt4 gene which is like the control panel for femaleness, if something is wrong with this gene the XX embryo would drown in testosterone causing the outward appearance of the embryo to change despite it genetically being a female. Using brine shrimp as test subjects, different amounts of estrogen were added to the water they were being hatched in in order to test for ourselves whether or not the type of hormone the egg is exposed to during development affected the gender selection process. The results of this experiment proved the hypothesis, proposing that if there is a large amount of estrogen exposed to the embryo during growth than it is more likely to be a female, correct. It is reasonable to believe based on this experiment that being transgender is merely caused by a problem or mutation that occurred during fetal growth.

H26 Microbial Fuel Cell

Biology

Luke Harrington

Mary Lyon Pilot High School

This experiment we will be looking at how bacteria produces energy in a microbial fuel cell. The purpose of the experiment is to try to find new ways to generate electricity like the same with windmills and solar panels. Now what is a Microbial fuel cell it's, "a bio-electrochemical device that harnesses the power of respiring microbes to convert organic substrates directly into electrical energy." (alternative energy.com) My Hypothesis is that this experiment will be a success and the bacteria will be able to generate electricity. The materials that you'll need for this experiment is a Microbial fuel cell kit which can be bought online. You will need soil in order for this experiment to work. During the experiment I could not collect any data from the fuel cell. The experiment did not work out as it was expected to work. The fuel cell did not generate electricity the LED did not light up. Improvements could be made with this project.

J1 The Motion of Blood Flow through Different Aortic Heart Valve Models

Biology

Morgan Simco, Sarah Elkondakly

Medford High School

In this experiment, the velocity of blood through a mechanical aortic heart valve was analyzed in order to determine the most functional ball and cage mechanical heart valve design. The velocity of the blood will be stimulated through the design of three different ball and cage heart valves composed of metal alloys. Each of the three heart valves had a different type of ball for the ball and cage design: a glass ball, a metal ball, and a plastic ball. The velocity of the blood flow was stimulated using two water pumps that were pumped at a constant rate, the velocity was then analyzed using a Photogate and the Logger Pro software. The results from all three trials for each valve were analyzed and indicated that, overall, there was a linear position vs. time graph, a constant velocity, and no acceleration when the periods of pumping were overlooked. At the moments at which the apparatus was being pumped, there was an exponential increase and, shortly thereafter, decrease, in the velocity of the flow, causing a brief moment of acceleration then deceleration. The results indicate that the pumping of the water creates the acceleration, while the average flowing of blood has a constant velocity.

J2 What Cleaning Solutions Are the Best for Disinfecting Wrestling Mats

Biology

Anthony Suhocki

Westfield High School

For my experiment I tested different cleaning solutions on a wrestling mat to see which one removed the most bacteria. I used dawn dish soap and a water solution ,(1 tsp soap, 1 pint water), a bleach and water solution,(1 tsp bleach, 1 quart water), one spray of standard mat cleaner, and a hand held UV-C light sterilizer. I hypothesized that the UV-C light would work the best because of its uses in other industries to disinfect. For my experiment I marked off ten 3x3 in sections in the middle of the mat, separated by painters tape. For the control I took swabs straight off the mat, for the bleach and water and soap and water solutions I used one spray and wiped with a clean sponge going up and down,(which counted as one), three times. Then patted the area dry with paper towel. I used a fresh sponge each time. For the UV-C light I held it over the area for 2 min and 30 sec.The mat cleaner had instructions on the bottle which were to spray once and let it sit for 1 min, then I repeated the same sponge method I used for the bleach and water and soap and water solutions. After taking swabs I let it grow for 4 days. After these four days, I concluded that the UV-C light worked the best as it killed all bacteria; my hypothesis was proven correct. The bacteria was counted with an app called Colony count. The UV-C light worked the best because it has short wavelengths that break up the DNA of the bacteria preventing it from functioning. I am applying this right now by talking to my school Athletic Director about using UV-C light and calculating the potential cost. In the future I would like to see if UV-C light could disinfect oher sports equipment and if it would be more cost effective.

J4 Ultrasensitive Detection of Early Cancer by ctDNA Sequencing with UMIs

Biology

Elizabeth Ding

Lexington High School

Background: Early detection is critical for the overall survival of cancer patients. Circulating tumor DNA (ctDNA) holds promise as a highly specific cancer biomarker. However, the low amount of ctDNA in the blood, which can be less than 1% allelic frequency, presents significant challenges for reliable variant detection with NGS assays. Improvement of sequencing accuracy at low allelic frequency is a critical factor in the implementation of NGS in ctDNA liquid biopsy. Methods: I designed a novel ultrasensitive multi-gene panel that specifically targeted to lung and gastric cancer genome variations, and developed a sample-to-variant ctDNA duplex sequencing with UMIs assay for liquid biopsy. Results: I successfully optimized a ctDNA duplex sequencing with UMI workflow that enables simultaneous detecting 128 clinical relevant mutations including SNPs, indels, copy number variations, and gene fusions for lung, gastric, and esophageal cancers in a single blood test. The assay achieved a high sensitivity and specificity with limit of detection at 0.1% allele fraction(AF). Results from initial clinical sample testing show its promising applications for early cancer detection as a liquid biopsy.

J5 Phylodynamics of an Evolving Viral Population

Biology

Rayhan Ahmed, Sachiv Chakravarti

Lexington High School

Influenza is a virulent disease that is characteristically very hard to prevent against. With very few options for post-facto treatment the sole method which can prevent its spread is inoculation. The influenza virus is unique in that it mutates at an extreme rate. There are other viruses such as measles and polio also exhibit antigenic variation, however, the rate and magnitude of this variation is small and thus once exposure occurs (either naturally, or through inoculation) lifelong immunity is garnered. This is not the case for influenza, the high antigenic variation from year to year, or strain to strain, results in a lack of immunity even after exposure. The current mechanism for inoculation involves “predicting” the strain that will be the most present during that season. We have categorized strains according to virility and found a cyclical mutation pattern. More violent strains have larger magnitudes and shorter periods in its cyclic cycle as opposed to less violent strains. We have created a phylogenetic correlation between two which can predict a spread ratio and thus predict how many strains must be covered in future vaccines.

J9 Effects of Alcohol and Aspartame on the Heart Rate of Daphnia magna

Biology

Deeandria Nafreere

Foxborough Regional Charter School

Alcohol and sugar are substances that are commonly consumed by people of all ages. Alcohol is currently the most addictive and abused substance today. Alcohol is classified as a depressant, which slows down bodily functions and can severely damage the heart. Sugar is incorporated in our everyday diets. There has been research linking sugar to be addictive like other stimulants where dopamine and opioids are released. In attempt to lose weight many people use artificial sweeteners such as aspartame. Although reduction of calories is a benefit, there are many negative side impacts.

In this experiment, the crustacean *Daphnia magna* was used which is an organism that is commonly used for toxicological studies since it shows the strongest homology with the human genome. The goal was to identify how alcohol and aspartame will impact a *Daphnia magna*'s heart rate. I had two hypotheses: 1) with alcohol added to their aqueous environment, a *Daphnia magna*'s heart rate will decrease and 2) with an aspartame mixture added to their water, the *Daphnia*'s heart rate will increase.

There was a control and two experimental groups, with 5 trials for each group and different concentrations of each substance for each group. The *Daphnia*'s heartbeat was measured by examining each specimen under a microscope. In each of the two experiments, the data supports the hypothesis. The average heart rate for the experimental group was initially 166.8 bpm and with 14% alcohol concentration fell to 90 bpm, a 46% decrease. With the addition of 16% aspartame concentration, the heart rate increased to 198 bpm compared to the average of 181 bpm, a 9% increase.

J14 Jack and the Glow in the Dark Bean Stalk

Biology

Owen St. Aubin

Plymouth South High School

My project is an experiment to change bean plants to make beans glow. I did this by making E.coli take in a plasmid causing it to glow. I then made a bacteria called Rhizobium take in the plasmid from the E.coli. The Rhizobium was then put on bean seeds. The seeds then took in the Rhizobium and were genetically changed to have that new DNA. The beans then made a protein called luciferase causing them to glow. Our initial results showed that the beans did glow. I continue to conduct trials.

J18 Turmeric vs. Bacteria

Biology

Maria-Isabela Campos

Pioneer Charter School of Science II

This microbiology experiment determines the antibacterial effects of different types of turmeric. Pathogens, or infectious microorganisms, can cause infections and illnesses when they enter the body and multiply. Some types of bacteria release harmful toxins in the body to disrupt homeostasis and make the host ill. The immune system uses lymph nodes that release lymphocytes, a type of white blood cell, to defend the body against pathogens. People use medicine or drugs with antibacterial effects to eliminate bacteria and help the immune system.

Forms of turmeric are commonly used in medicine since turmeric contains curcuminoids, a compound known for its health benefits. However, the effectiveness of each kind of turmeric varies, so some kinds are more beneficial than others. For this reason, this project is dedicated to finding the most effective kind of turmeric on bacteria.

Based on this experiment, results showed that turmeric did not decrease the number of bacterial colonies and instead stunted the growth rate of bacterial colonies. Bacterial colonies double in number daily, but turmeric caused the number of bacterial colonies to increase by only 2% to 20.4% daily. Turmeric extract showed to have the smallest increase in the number of bacterial colonies while turmeric leaves showed to have the most substantial increase in the number of bacterial colonies. The effectiveness of each kind of turmeric varies due to the number of curcuminoids it contains. Since turmeric extract contains the most curcuminoids, it is most effective at slowing the growth of bacterial colonies.

J19 Spill The Tea, Sis: Can Green Tea Prevent & Cure Cancer

Biology

Fariha Fardin

Hopkinton High School

Cancer, an epidemic today, is the second leading cause of death in the US. Carcinogens including tobacco, ultraviolet light, silica dust, radon, or even the Round-Up, a very common weed- killer in everyone's garage, can cause cancer. In this project, Planaria, a flatworm, was utilized to evaluate the exposure of Round-Up on the regeneration of Planaria, and the effect of the green tea with its health-beneficial polyphenols to prevent and modulate the growth of cancerous tumors probably by inhibiting the function of neoblasts.

In this study, 100 planaria were divided into 5 equal groups where different groups were treated with only water, with water followed by Round-Up, with green tea followed by Round-Up (mimic prevention), with Round-Up then water, and with Round-Up followed by green tea (mimic cure) over the course of 4 weeks.

The healthy regeneration of experimental Planaria were 100% with only water (control) whereas it was 75% and 90%, respectively, when treated with green tea initially followed by Round-Up and treated with Round-Up followed by green tea. The regeneration was significantly lower (5% and 15%) when the planaria were treated with water followed by Round-Up and vice versa.

From this study, it was found that the exposure of the Round-Up can cause tumors in Planaria, and the green tea must have a role in preventing and reducing those tumors with its significant impact on the Planarian regeneration. As a proven antioxidant, green tea may even repair cell damage - helping Planaria and even cancer patients. Data from this study provides clues for future semi-synthesis of tea polyphenols derivatives to develop novel anticancer agents in the future.

J22 The Impact of Benzo-Lipoxin A4 on Mesenchymal Stem Cells

Biology

Umar Padela

Braintree High School

Periodontal disease is associated with unresolved inflammation and tissue destruction. Mesenchymal stem cells are important during tissue regeneration and may contribute to the resolution of inflammation. Specialized proresolving lipid mediators (SPMs) are a class of molecules that promote the resolution of inflammation. One specific SPM is Lipoxin A4; animal models have shown that transgenic rabbits that overproduce Lipoxin A4 have significantly less bone loss due to periodontal disease than control rabbits. Thus, finding ways to increase production of Lipoxin A4 in humans could have a huge impact in preventing bone loss due to periodontal disease. In this present study, I investigated the impact of Benzo-Lipoxin A4 (a stable analog of Lipoxin A4) on Human Bone Marrow-derived Mesenchymal stem cells. Lipid mediator metabololipidomics demonstrated that Mesenchymal stem cells biosynthesize significantly increased amounts of Lipoxin A4 and other SPMs when stimulated with Benzo-Lipoxin A4. Additionally, Benzo-Lipoxin A4, at lower doses, significantly enhanced the proliferation of the stem cells. These results suggest the potential for the development of a drug using Benzo-Lipoxin A4 and mesenchymal stem cells to prevent bone loss due to periodontal disease.

J23 Behavioral Response of Coral to Anthropogenic Noise

Biology

Saniya Rajagopal

Falmouth Academy

The purpose of this experiment was to determine coral polyp habituation to anthropogenic noise in the form of impact pile driving and their overall behavioral responses to the noise. Corals are important marine creatures that support 25% of all ocean species. Barely any scientific research has been conducted on the reaction of coral polyps to noise. It was hypothesized that coral polyps of Northern Cup Corals would habituate to pile driving sound. A GoPro camera recorded the opening and retraction of polyps in five coral colonies in a tank of seawater in silence for ninety minutes as a control. The next day, the camera recorded five new colonies as three rounds of fifteen minute long sound files of impact pile driving played through a speaker with fifteen minutes of silence played between each round. This process was repeated the next day as well. On the first day, an average of 30.8% more coral polyps retracted once the sound was played each round. On the second day, an average of 71% more coral polyps retracted once the sound was played each round. For both of the sound trials, the coral polyps retracted once the sound began but then would habituate as the sound would continue. The hypothesis was partially supported since the corals did not habituate between rounds of sound separated by silence, but they did within rounds. Sound startled corals into retraction, from which they did not fully recover within the given time.

J24 Extracting DNA from Spinach

Biology

Raceja Velavan

Ursuline Academy

I am very interested in the medical field and in hopes to find cures for diseases, cancer in particular. Cancer is a disease caused by uncontrollable cell growth. It spreads to tissues and sometimes it starts off with a solid tumor, or grows in the blood. Their abnormal replication increases metabolic activity and limits blood flow, which is why they thrive in acidic conditions. This is called the Warburg effect, proposed by Nobel Prize winner Otto Heinrich Warburg. An acidic environment is formed around the tumor for their sustainability, and this results in oxygen deprivation at cellular level, making the cancer cells grow under non-oxygenated conditions. This acidified setting is caused by the cancer cells' anaerobic respiration system (survival without oxygen). This process releases lactic acids with H⁺ ions, making it acidic (the more H⁺ ions, the more acidic it becomes). This scientific research helped me to create my statement of my project, which is "What effect does the acids of concentrated lemon juice, 3% hydrogen peroxide, and distilled white vinegar have on the extraction of DNA in spinach?". I am using three different acids to observe how much DNA it yields from spinach during its extraction. My hypothesis claims that 3% Hydrogen Peroxide will yield the most DNA. I believe that this is possible because of its pH level (it has the pH of 4.5), that as it is less acidic than the other two acids (concentrated lemon juice and distilled white vinegar), it will not denature the DNA as much. My results are positive and it supported my hypothesis. My experiments helped understand how DNA is affected in the acidic conditions during cancer growth — how does it affect DNA replication to endlessly grow by following the mutated DNA code.

K4 Synthetic Biology for Treating Neurodegenerative Diseases

Biology

Saad Mohsin

St. John's High School

100 Billion dollars are used to treat and care for Alzheimer patients. With the number of patients rising each year, I decided to focus my project on the Neurodegenerative disease. To do this, I used Synthetic biology is a new field of Biotech. It is a combination of engineering, CRISPR, biology, and genetic engineering. My goal for this project was to create a synthetic circuit, (Synthetically edited DNA), that was able to produce Brain Derived Neural Factor, in E.Coli bacteria. Research has proven, that patients with Alzheimer's have low levels of the protein, which is critical for Neuronal survival, Neuroplasticity, and Neurogenesis. Through my research and work, I have successfully been able to produce the protein, in E.Coli, using the Cello Program. My synthetic protein can be used as a novel therapeutic, against neurodegenerative diseases in the brain.

K6 Identifying DNA

Biology

Illum Youssfzai, Irma Yuman Revolorio

Mary Lyon Pilot High School

With today's technology, identifying DNA can be a simple process. When scientists want to separate DNA they use a technique called gel electrophoresis. For our science fair experiment, we will be building our own gel electrophoresis chamber to distinguish between the DNA in fruit, vegetables and that of E.Coli. We hypothesize that the DNA in fruit and vegetables should be more similar than the DNA in bacteria. For this experiment, we used a bunch of different materials but the most important materials were the gel casting trays and the chemicals that make the gels. We then extracted the DNA from potato, strawberries and to run on the gel comparing it with the DNA from E.Coli bacteria. Our results were inconclusive because we were unable to distinguish amongst the fragments for fruit DNA and E. Coli DNA.

K8 Composting Critters

Biology

Isaiah McConaga, Kiana Furtado, Marc Valcin

Brockton High School

Purpose: The purpose of this project is to help reduce methane production in landfills and reduce the amount of unnecessary trash that ends up in landfills. With the use of vermicomposting, we are not only able to help benefit the ozone layer but, able to give homes to many microbes and critters in an environment they could thrive upon. This composting also allows for local use as the soil made can be used in gardens, thus everything is put back into the Earth.

Hypothesis: If we incorporate decomposers into five different compost chambers and leave one as a control, then the rate of decomposition of the cardboard will increase because of the added enhancers the decomposers will bring.

Conclusion: The differences between the bio chambers were dramatic. All in all, the rate of decomposition increased with the added enhancers of decomposers. Decomposers such as woodlice and red wigglers had a 100% and 98.5% percent change. Two out of the three compost starter squares did not change at all and two out of the three centipede squares didn't change at all. Over the course of 4 weeks the CO₂ levels went down for all decomposers, which was unexpected because CO₂ is a product of cellular respiration which happens during decomposition. One improvement could be having a starting CO₂ value on the first day. Also, the number of centipedes decreased by more than half by the end of the experiment, perhaps the centipedes ate each other because they are carnivorous (which was determined by research after the experiment was concluded). The experiment showed consistent results between woodlice and red wigglers. However, with the other three decomposers, the results were not as consistent due to errors amongst the strings being misplaced.

K10 How Sound Frequencies Affect the Growth of Plants

Biology

Emily DeGowin

Bourne High School

Sound frequencies affect many different biological aspects of life and are known to have impacts on humans and animals in ways such as causing stress when in irregular patterns and variations. Can sound frequencies do the same for plants? If sound frequencies did have an impact on plants, would people rethink their ways of creating more gardening space today? In today's world, plants are being grown more commonly in places one wouldn't expect, such as in cities and on top of buildings. There are also people question whether eventually we will be able to grow plants in space. Both cities and space have very different sound frequencies than one would find in an open farmland where plants used to typically be grown. Overall though if the sound frequencies do have a negative impact on these plants, would people change their way of thinking? Should the large expense of money going to make city gardens actually be going to save agricultural land?

The hypothesis is that if sound frequencies have an affect on plants, then the plants that have exposure to the abnormal sound frequencies will not grow to be as healthy as those that don't have exposure to the sound frequency. This is tested by having one group of plants have exposure to these sound frequencies, about 56,000 hz, and another group received the same exact treatment for everything except for the fact that it will not have exposure to these sound frequencies. Overall, there was a difference in the growth of the plants, and the hypothesis was supported. The plants that received the abnormal sound frequencies have a significant difference in overall health then those that did not receive the sound frequencies, and the plants that didn't have exposure were healthier.

K15 Bioluminescent Algae

Biology

Samantha Collins

Mary Lyon Pilot High School

Bioluminescent Algae-The future of light source? The purpose of this project is to determine if algae can conduct electricity, which in turn would be useful to countries and cities all over the world to help in the preservation of energy. Bioluminescence is a chemical reaction that happens in the body of organisms. Organisms such as algae produce luciferin, a molecule that when it reacts with oxygen produces light. The types of luciferin produced varies depending on the organism hosting the reaction. Organisms can control when they use light, change the color and intensity of the light by regulating brain processes and their brain chemistry, Some organisms can bundle the luciferin with oxygen to form a “photo protein” which acts like a prepackage bioluminescent bomb, one that it ready to light up when a certain ion typically calcium is present.

For the purposes of this project, we capitalized on the reaction of dinoflagellates to generate enough electricity to light a small bulb. The materials we used were bioluminescent dinoflagellates, saltwater and freshwater medium, metals and small light bulbs. Our hypothesis was proven correct and we were able to generate electricity in both the fresh water and salt water medium. Thus proving that algae and other bioluminescent organisms are our future when using natural resources to conserve energy.

K21 Devel of Bdelloid Rotifers As Experimental Model For Cell Rejuvenation

Biology

Darian Motto, Orando Campbell , Marina Cuevas

Jeremiah E. Burke High School

Our goal was to learn about rotifers growing in our environment. In our research project, we collected dirt, rocks and filtered water and used a microscope to see how many rotifers we could find. We also checked what percentage of rotifers was alive or dead. From this project we learned that there weren't as many rotifers as we had predicted.

N2 Modeling and Treating Cardiac Arrhythmias using *Caenorhabditis elegans*

Biology

Connor Casey

Leominster High School

Long QT Syndrome and Familial Atrial fibrillation (Afib) are inherited Cardiac arrhythmias. Specifically, Long QT syndrome is caused by prolonged repolarization of the heart. This prolongs cardiac action potential and puts patients at risk for life-threatening cardiac arrhythmias. Familial Afib is characterized by a quivering of the atrial chambers of the heart. This leads to rapid heart rates and inadequate blood flow to the rest of the body. Arrhythmias are often treated with medications known as beta blockers (β -blockers). β -blockers have several undesirable side effects that primarily affect quality of life. Also, individuals with asthma and diabetes are discouraged from taking β -blockers due to undesirable consequences. Due to these limitations, herbal remedies were assessed as possible therapeutic alternatives to β -blockers. The model organism, *C. elegans* was used as a model for a mammalian heart. This was achieved through direct observation of the pharynx, a muscular pump that shares several strong characteristics with the mammalian heart. The *C. elegans* genes *unc-103* and *kqt-1* were used to model both Long QT syndrome and familial Afib. The gene *unc-103* is orthologous to the human gene *hERG* (Human ether-a-go-go-related gene). Mutations in this gene cause Long QT syndrome. *Kqt-1* is orthologous to the human gene *KCNQ1*. Mutations in this gene cause Long QT syndrome and familial Afib. The *C. elegans* were exposed to five different herbal substances. Since β -blockers lower heart rate and contraction force, promising results were represented by herbal remedies that lowered the overall pumping rate of the pharynx at $\alpha=.05$. The substance that deemed to be the most effective in terms of lowering pumping rate was ashwagandha. Pumping was lowered in all strains respectively.

N3 Organic Sulforaphane: A Novel Treatment to Reduce Malarial Progression

Biology

Olivia Rainville, Morgan Raun

Marlborough High School

Sulforaphane, a synthetic and bioavailable isothiocyanate derived from glucoraphanin, found in cruciferous vegetables has been found to induce eryptosis in leukemia cells. This experiment intends to expand on this research to study potential organic sources of sulforaphane. Malaria is a highly treatable disease that when treated promptly and properly results in minimal casualties. The global problem, highlighted by the lifestyles, subpar disease education, and limited access to healthcare within developing countries, arises when malarial symptoms are able to incubate in the host for an extended period of time before the host receives, or attempts to receive, treatment. Given that there is an amount of sulforaphane that is effective in triggering eryptosis, can a significant amount of bioavailable sulforaphane be obtained organically? Spectrophotometric analysis was used to find the concentrations of both bioavailable and standard of sulforaphane to then extrapolate the data to other known literature correlating sulforaphane concentration and eryptosis.

N5 The Effects of Homemade Water Filters

Biology

Emma Petzold, Abigail Menzel

Westfield High School

The purpose of this experiment was to determine the best possible way to construct an inexpensive, efficient homemade water filter to purify water to make it clean and drinkable. The initial prediction was if the homemade water filter is made with carbon, then it will filter out more bacteria than the filter made with sand. Materials added to each filter were known to purify impurities.

The efficiency of the filters were measured by the ability of the prototypes to filter out 100 microliters of E. Coli bacteria. Water filter one was constructed with charcoal, sand, small rocks, cotton balls and membrane filters set up in a two part filtration system. The second filter, after refinement, included carbon, cotton balls and coffee filters- cut up and kept uncut.

After experimentation, water filter one was deemed effective due to a water testing kit that tested its drinkability according to bacteria level. Water filter two came back positive for dangerous coliform bacteria, so it was eliminated as an option for safe drinking water, even though it had a higher efficiency.

All in all, the materials used to create water filter one were the most effective, mainly contributed to the multiple layers of filters that resulted in a greater amount of filtration. The findings of this experiment can be applied to further research to filter out color in the water. With the knowledge of how to make clear water combined with the current conclusion of how to get rid of bacteria, a new filter could be constructed. This new filter could be the perfect solution to billions across the globe looking for an efficient, inexpensive way to purify water.

N6 Using Fourier Analysis to Distinguish Pancreatic Cysts

Biology

Trisha Boonpongmanee

Deerfield Academy

Pancreatic cancer has the highest mortality rate among cancers after five years, yet the vast majority of pancreatic cysts are benign. It's often fatal because it's diagnosed in late stages. The current gold standard is endoscopic ultrasound-guided fine needle aspiration (EUS-FNA), which requires a physician to guide a needle to puncture the cyst. The objective of this project is to explore how sound waves distinguish benign and malignant cysts by differentiating mucinous or non-mucinous fluid, to observe how the Fourier transform could be used to analyze signal patterns for each type of growth. I hypothesize that fluids with higher viscosity and heterogeneity will return an ultrasound image with white, such as that of the growth's walls. Fluids that imitate non-mucinous cysts should return mostly black, anechoic ultrasounds. In this experiment, fluids in the cyst differ based on viscosity and complexity of composition, and the images produced using sound waves should similarly reflect a difference. For modelling purposes, dough mimicked the pancreas, encasing balloons that represented pancreatic cysts, which prevented the ultrasound's signal from echoing unnecessarily. The image of the container that held the fluid with the lowest viscosity, modeled with water, was mostly black and anechoic. The image of the container with the highest complexities, ketchup and mayo, contained many white echogenic structures. These fluids were used to model complex tissues because of their heterogeneity, or variable makeup, and the images mirrored this uneven composition. In conclusion, fluids in increasing heterogeneities and complexities, such as those that mimic a scale from benign to malignant cysts, appear as increasingly white and echogenic.

N8 Isolating and Identifying Fungal Endophytes in Seaweed

Biology

Maya De Luis

Newton Country Day School

This study asked the scientific question: do fungal endophytes share similar DNA sequences with known fungal probiotics? Seaweed possesses many health and nutritional benefits and is used in traditional Chinese medicine and modern-day medicine. Probiotics are live microorganisms that have health benefits when consumed in sufficient amounts. It is hypothesized that fungal endophytes isolated from edible seaweed will be related to those of known fungal probiotics. The Seaweed samples were collected at Wingersheek Beach in Gloucester, MA. The experiment was conducted at Solarea Bio, Cambridge MA. Isolation and culture of fungal endophytes were attempted from the seaweed samples. A single pink yeast endophyte was cultured from sea lettuce and its DNA was isolated using a DNA mini-prep kit. The nucleotide sequence from the isolated strain was compared to sequences of known fungal strains. A BLAST search with an E-value of 0.0 revealed a 99.44% homology between the pink yeast and *Rhodotorula mucilaginosa*, with 712 out of 716 nucleotides as identical matches. Gel electrophoresis of the pink yeast DNA indicated that the yeast DNA band ran at the same size as the positive control. *Rhodotorula* is used as a food coloring and studies show that it has potential use as a bioremediator. It was shown that the pink yeast found in sea lettuce can only be grown in saltwater and does not grow in a mix of salt and freshwater or in freshwater alone. Future studies may include further characterization of this yeast strain, including how the color of the yeast is affected by different environments and how *Rhodotorula* can help clean up polluted regions of the ocean. Although the experimental hypothesis was not supported, the findings of this project still have tremendous significance.

N9 The Effect of Sleep Deprivation on Cockroach Behavior

Biology

Natalie Todd-Weinstein

Falmouth Academy

Sleep is essential to most all living organisms, and it is typically one of the most underrated aspects of health. The purpose of this experiment was to see the effect of sleep deprivation on cockroaches' behavior and mortality rate and to analyze how this might relate to the human relationship with sleep deprivation. It was hypothesized that sleep deprivation would increase the time that it took for cockroaches to move away from peppermint oil and that it would raise the mortality rate. One group of cockroaches was sleep deprived via light, vibrations, and sound, while the control group was allowed to sleep normally. For testing, each group was herded into a corner of its enclosures, exposed to peppermint oil, and then timed for how long it took all cockroaches to cross the half way mark, in the tank. Generally, the control group was faster to react to the peppermint oil than the sleep deprived group. For instance, on the 8th day the control group took 19 seconds to move away from the peppermint oil compared to the sleep deprived group, which took 74 seconds to escape the oil. In addition, the normal sleep group had a 23% higher survival rate after 18 days than the sleep deprived group. This is a warning about the danger that extreme sleep deprivation can cause an organism. Further experiments could focus on environmental factors that could increase quality and quantity of sleep in humans.

N11 The Effect of Common Chemicals on Daphnia Heart Rate

Biology

Lauren Walsh

St. John Paul II High School

On average, an adult in the United States consumes about 300 milligrams (mg) of caffeine everyday, which is just short of the healthy amount of 400 mg. Caffeine can have positive short term effects, such as increased alertness and enhanced short term memory, however over consumption can lead to negative long term effects. The overuse of caffeine can lead to cardiovascular issues. Nicotine is another common, yet harmful, drug consumed on a daily basis by adults. About 60 milligrams of nicotine is enough to kill a person of about 150 pounds. Nicotine can lead to harmful effects in the cardiovascular system such as increased heart rate and blood pressure. Alcohol consumption can lead to diseases of the heart muscle (cardiomyopathy). On average, American drinkers have about 74 drinks per week. In order to observe the effects of these three common chemicals (caffeine, nicotine, and alcohol) on heart rate, a common indicator of cardiovascular and overall health, *Daphnia magna* were exposed to these chemicals and monitored for changes. *Daphnia* are commonly used as an indicator species to measure water quality and toxicity, and results here indicate negative changes that may occur in the human cardiovascular system after exposure to common chemicals such as caffeine, nicotine, and alcohol.

N12 Investigation of the Genetics of Smoking Behavior in the UK Biobank

Biology

Akshaya Ravikumar

Sharon High School

RESEARCH QUESTION: Smoking is thought to be primarily determined by behavioral choices. Recently, rs1051730, a single nucleotide polymorphism (SNP) located within the nicotinic acetylcholine receptor gene-cluster (CHRNA5-CHRNA3-CHRNA4) has been linked to smoking quantity (SQ) in humans. However, the precise contribution of this SNP to smoking initiation, smoking duration and smoking cessation are not known. I investigated the contribution of rs1051730 SNP to multiple smoking-related behavioral traits using the United Kingdom (UK) human Biobank.

METHODS: Using a “R” programming script I extracted: (a) rs1051730 genotype (AA, AG, or GG); and (b) smoking-related phenotypic data (SQ, initiation, duration, cessation, and smoking-related diseases) from 488,377 UK Biobank subjects. I then compared the proportion of subjects exhibiting these phenotypes within each genotype by creating a contingency table and used chi-square (χ^2) testing for determining statistical significance ($p < 0.05$).

RESULTS: The rs1051730 SNP showed: (a) significant association with increased SQ and decreased likelihood of smoking cessation but no association with smoking initiation or duration; (b) significantly association with lung cancer and peripheral vascular disease but not with coronary disease.

CONCLUSIONS: The nicotinic acetylcholine receptor signaling determines smoking behavior in humans. This pathway represents an ideal target for developing novel drugs to prevent smoking and smoking-related diseases.

N14 The Classification of Fungal Derivatives with Clinical Potential

Biology

Emma Keeler

Falmouth Academy

This research responds to the threat of antibiotic resistance and the concurrent depletion of sources of terrestrial microorganisms able to synthesize novel antimicrobial molecules. This crisis has necessitated efforts, such as bioprospecting in geochemically extreme environments, to augment the existing arsenal of antibiotics. The morphological and phylogenetic diversity of fungal communities colonizing Guaymas Basin hydrothermal vent sediment were explored through culture-dependent methods and analyses of the ribosomal RNA internal transcribed spacer and ribosomal RNA 26S subunit sequences. A fungal collection was established via inoculation, culture and isolation methods. Through modern molecular protocols (DNA extraction, precipitation, amplification), the fungal isolates were taxonomically affiliated with *Cadophora malorum*, *Xylaria feejeensis*, *Engyodontium album*, *Cladosporium lycopodium*, *Cladosporium halotolerans*, *Ramularia glennii*, *Aspergillus niger*, *Penicillium rubens*, *Rhodotorula mucilaginosa*, *Dioszegia xingshanensis*, *Aureobasidium pullulans* and *Torulaspora delbrueckii*. The inhibitory activities of these isolates against pathogenic strains of *Escherichia coli* ATCC-25922, *Staphylococcus aureus* ATCC-35556, and a drug-resistant strain of *Pseudomonas aeruginosa* ATCCMP-23 were explored through variations of the Kirby-Bauer antimicrobial susceptibility testing (AST) method. The natural products of *X. feejeensis* and *C. lycopodium* were able to kill *S. aureus*, while the derivatives of *C. halotolerans*, *R. glennii* and *T. delbrueckii* were able to kill both *S. aureus* and *E. coli*. Overall, the clinically relevant fungi identified in this study have augmented the finite source of known microorganisms able to synthesize antibacterial molecules.

N16 The Effect of Stressors on Telomeres Using *C. elegans* as a Model

Biology

Faith Jennings

St. Mark's School

Degradation of telomere length causes cell senescence and death. Short telomeres are related to old age and neurodegenerative diseases. Through cellular replication, DNA polymerase is unable to fully replicate the lagging strand causing a piece of the end of the DNA to be cut off. This piece is the telomere which is a repeating sequence of nucleotides that does not code for any genetic material. Research indicates that stress leads to the shortening of telomere length through causing cells to divide more frequently. In particular, heat stress could lead to the shortening of telomere length. In this experiment, two genotypes of *Caenorhabditis elegans* were exposed to heat stress over a period of six generations. After the six generations were cultured, the telomeres were measured through quantitative polymerase chain reaction (qPCR). The actin and telomere expression were measured in each of the DNA samples and averaged. The Pot-2 genotype in heat had longer telomeres in comparison to the Pot-2 genotype control. This was found by finding the number of cycles to reach the threshold value and averaging the values. While the data indicates that heat leads to telomere lengthening, the data is not statistically significant as the variation of telomere length is less than the variation of the actin gene. The actin gene is the reference gene and its expression is nearly the same throughout all the stressors and genotypes.

N17 Which Factors Increase the Risk of Contracting the Common Cold?

Biology

Elizabeth Leshner

Newton Country Day School

In this study, the question, “How does length and frequency of exercise, hours of sleep per night, and dietary choices affect a 14- to 16-year-old female’s susceptibility to the common cold?” was researched and tested. Background research proposes that higher immune function leads to fewer colds and previous experiments indicate many factors that could affect immune function. They suggest that acute exercise lowers immune function while chronic exercise improves function, that sleep quality and duration are important predictors of immunity, and that having a diet with enough protein, dairy, liquids, and fruits and vegetables helps avoid colds. Thus, it was hypothesized that if a person has excellent health, they will be the least susceptible to the common cold, and quantitative standards were created to determine if the data met the criteria. 74 14- to 16-year old females participated in this study and were asked to complete a survey which aimed to assess dietary choices, sleep, and exercise. The data were interpreted using chi-square and Cramer’s V strength test. It was found that sleep, liquid, and dairy all have negative associations with colds and that protein and the exercise variables have positive associations. Based on the results, the hypothesis was partially supported because dehydration, a low dairy diet, and little sleep were determined to be risk factors, while, in contradiction to the hypothesis, a diet high in protein and frequent, long exercise were also risk factors. To allow for further research on this topic, this experiment could be broadened in order to include more potential risk factors. The findings of this study contribute to scientific knowledge on the common cold, as identifying risk factors can help create effective methods of prevention.

N19 Effects of Magnetism on Dugesia Tigrina Regeneration and Growth

Biology

Sharani Nasankar

Pioneer Charter School of Science II

This year’s Science & Engineering Fair was conducted to assess the effects of magnetic field intensity emitted from neodymium magnets on the cephalic (head) and caudal (tail) regeneration in planaria *Dugesia tigrina*. The results obtained from this experiment will serve to scientifically approve or disprove the controversy whether magnets actually have a positive, scientific impact on human health or whether it is the placebo effect that appears to show that the exposure of magnets produce a significant impact on human health. Since these flatworms have a number of cell types, tissues and simple organs that are homologous to human cells, tissues and organs, planarians were used as the test subject for this experiment. For this purpose, adult stage planarians (*Dugesia tigrina*), were transversely cut from anterior to the pharynx, which resulted in eight heads and eight tails (Marbbn, 2008). Two of the heads were placed in a petri dish which had no exposure to magnets. Among the remaining six heads, two of each heads were placed in petri dishes with magnets of low, medium and high field strengths, namely: 1140, 1920, and 3190 Gauss under constant room temperature. This same arrangement was done for the eight planarian tails. Additionally, two petri dishes were dedicated for untreated, full-grown planarians: one of which was exposed to no magnets and the other was exposed to magnets of high field strength (3190 Gauss). Through this experimental setup, the cephalic regeneration and caudal regeneration experiment was conducted separately and was monitored and measured over the course of ten days. The results of this experiment have shown that the exposure to magnetic fields decreased the rate of caudal regeneration and increased the rate of cephalic regeneration.

N25 Creating a Noninvasive Glucose Monitoring System for Diabetic Patients

Biology

Yuchen Wang

St. Mark's School

Diabetes mellitus is a disease marked by chronic hyperglycemia, a dangerous condition that causes long-term organ damage and increased risks of cancer, heart disease, and stroke. It is crucial for diabetic patients to monitor blood glucose levels in order to avoid the health complications of hyperglycemia. The current approach for blood-glucose monitoring, glucometer, is an invasive device that causes pain and emotional distress, especially for those on an insulin treatment, as their blood glucose levels need to be monitored four or more times a day.

In this project, a novel bacterial strain named Glucoli was produced using *Escherichia coli* and genomic synthesis. The organism would ideally serve as a non-invasive glucose biosensor that can replace the invasive glucometer for diabetics. To achieve this goal, two DNA parts called “Sensor” and “Reporter” were designed, synthesized, and ligated onto a DNA backbone. The ligation product was then introduced into wild-type *E. coli* to produce the Glucoli strain that was capable of detecting glucose and reporting the result with a chromoprotein. Following experimentation and data collection, preliminary results from this study suggest that the current genetic construct in Glucoli does not yet respond to glucose with the expression of chromoprotein. Further investigations are needed to improve the designed organism.

N27 Decellularization of Spinach and Its Application to Medicine

Biology

Camille Gendron

Bishop Stang High School

Whenever someone has to get an organ transplant, one of the major risks is that your body could reject the new organ. If your body rejects the organ you would likely die if another is not found soon enough. There are different ways that you can prevent this from happening, like taking anti-rejection drugs or trying to 3D print an organ. 3D printing is very complicated and has not been figured out completely, and anti-reject medications do not always work, so scientists are turning to decellularization. Spinach leaves have a very similar vascular system and structure to our organs, especially hearts and lungs. If scientists can efficiently decellularize spinach leaves, and pump them with the cells of the patient needing the transplant, they could have a solution and save many lives.

For my project, I wanted to figure out what substance would most efficiently decellularize a spinach leaf. I decided to use the method of submersion, where I would soak the spinach leaves in the different substances for the same amount of time and record results daily. When a spinach leaf is efficiently decellularized it will turn a white/transparent color and you will be able to see the vascular system clearly. I used Isopropyl Alcohol, Laundry Detergent, and Tap water as a control group. I let the spinach leaves sit in their containers for 9 days, observing their progress daily. I had two leaves per substance, and both leaves in the Isopropyl Alcohol had been the most decellularized.

P1 Is the Efficacy of Soap Constant?

Biology

Vivian Tran

North Quincy High School

This project was designed to test the efficiency of the antimicrobial ability of regular soap. The null hypotheses stated that the soap would have a constant efficacy, or would create similar-sized zones of inhibition. There were 5 independent variables, each representing the time in which the soap was used for experimentation. The soaps were separately mixed with a beaker of distilled water to make a soap solution. These solutions were then used to soak sterile discs for placement on the inoculated bacteria. The plates were placed in an incubator at 37°C for three days. Based on the data collected, the soap was unable to create zones of inhibition on the inoculated bacteria. So, the null hypothesis was rejected. As a result, a second experiment was made, in which powders of saponin-containing plant roots were mixed with distilled water and were used to soak sterile discs for placement on newly inoculated bacteria. The hypothesis stated that these solutions would create similar-sized zones of inhibition on the inoculated bacteria. Zones of inhibition, with average diameters of the yucca root, soapwort root, and wild yam root solutions being 10.40 mm, 10.95 mm, and 10.35 mm, respectively, were created. Furthermore, the results supported the null hypothesis that these saponin-containing plants have the ability to prevent bacterial growth. In the future, it would be beneficial to create soaps from these plants and test the antimicrobial abilities of the soaps overall. This project is relevant because it furthers the discussion about and the production of more natural and healthier hygiene products, without the release of unnecessary, and possibly harmful, byproducts.

P2 Antibiotic Cocktail

Biology

Tiffany Ye

Boston Latin Academy

In this experiment, I will create a 'cocktail drug', which is a drug made out of many different antibiotics. I have done halo assays to find how much the antibiotic can kill the bacteria by measuring the zone of inhibition. I also did growth curves to see a kill curve, or the death rate by measuring the OD reading. I also did spot assays to determine the kill rate by counting the colonies from each time and comparing it to each other time. To make combinations, I try out which antibiotic combination will seem interesting, and test to see how effective it is compared to the original antibiotics. For example, I found that when the 2 antibiotics are targeting the same organelle. Then it becomes more effective. The reason for the experiment is to create a drug cocktail with the highest kill rate of E.coli. In the world, there are new strains of bacteria that have become antibiotic resistant, so doctors and researchers look for ways to create new drugs that will kill these strains. Also, maybe a new way to test the efficacy of drugs, so hospitals, research labs can save more money. Also create new drugs faster to save more lives.

P5 The Inhibition of E.coli Growth

Biology

Rim Bozo, Sarrah Naittalb

Pioneer Charter School of Science

The purpose of our project is to research and experiment if certain spices have enough antibodies and antioxidants to kill specified pathogenic bacteria such as Escherichia coli. This project is meant to test and receive results of which spices can inhibit or kill these illness serving bacteria. This is because Bacterias have developed a mutation that allows them to resist the active ingredients of Allopathic medicine. We decided to test bacterial resistance against homeopathic medicine and see if it can be deemed as an inexpensive way to treat treatable illnesses which result in many deaths worldwide.

P7 Chemotaxis and Response to Stimuli in C. elegans: Vanilla vs. Bleach

Biology

Ibrahim Bah

Edward M. Kennedy Academy for Health Careers

This project was conducted in order to gain insight into the chemotaxis response to different stimuli in C elegans. C elegans are microscopic round worms that a useful model species because of their simple body structure and rapid self-reproduction. They feed off of bacteria and rotting fruit materials and can easily survive on agar plates as long as there are enough nutrients. They do chemotaxis in response to chemical stimuli. The chemical signals are sensed by a neural sensory region at the head of the worm. They have been a helpful model organism in research about sleep, addiction, caffeine use, and neural responses to stimuli. For this experiment, the c. elegans will be exposed to different stimuli. These stimuli are vanilla and bleach, one sweet and one basic stimuli. The question being explored is how c. elegans will respond to these stimuli they are exposed to. The results of this experiment were inconclusive. While a very small number of worms went to the bleach and none went to the vanilla over the course of 20 minutes, there was not a large enough sample size to draw any preferential conclusions. Future investigations could be to consider testing other stimuli or ensuring that the worms are rid of their food source, which may keep them from exploring other stimuli like the vanilla and bleach.

P15 A Novel Noninvasive Biomarker for Diagnosing Major Depressive Disorder

Biology

Anvitha Addanki

Canton High School

Major depressive disorder (MDD) is a common mental disorder that affects adolescents and adults, causing staggering economic burdens, disabilities in the workforce, and suicidal thoughts. Invasive and expensive neuroimaging methods such as fMRI and magnetic resonance spectroscopy MRS have been routinely used to identify a number of brain regions that are functionally, neurochemically, and structurally abnormal in MDD. In this novel study, Region of Interest (ROI) and statistical analysis was performed for 2 trials on all brain regions using fMRI data. Statistical analysis was performed for 2 trials on the retinal nerve fiber layer and ganglion cell layer-inner plexiform layer thickness on all individual quadrants and the overall region in both eyes. RNFL thickness was measured in multiple sets of *Drosophila melanogaster*. In both trials, (1) MDD showed a statistically significant effect ($p_{\text{Anova}} < 0.05$) for all combined occipital regions measures. In both trials, (2) MDD showed a statistically significant effect ($p_{\text{Anova}} < 0.05$) on the RNFL and GCL-IPL thickness in each quadrant and on average in both eyes. (3) In 3 trials for each condition, MDD showed a statistically significant effect ($p_{\text{Anova}} < 0.05$) for RNFL thickness in the eye. A machine learning ensemble model, created with Decision Tree, KNN, and RFC, provided an accuracy of 0.9730 for fMRI data and 0.9444 for OCT data using Bagging Random Forest. Results from this first-of-its-kind study has suggested that by examining the optic nerve and the innermost layers of the RNFL and GCL-IPL, we can accurately diagnose MDD using a noninvasive and inexpensive routine OCT procedure. Results of this study will allow for early diagnosis and treatment of MDD in humans and can improve their overall health and quality of life.

P16 Does the Constant Region of the cMet Antibody Affect Its Function?

Biology

Emily Sun

Boston Latin School

Immunoglobulin G (IgG) is a “Y”-shaped molecule consisting of two identical heavy chains and two identical light chains connected by disulfide bonds. The two arms of the Y end are variable (V) regions, which can bind two antigens, whereas the stem of the Y is the constant (C) region, which interacts with effector cells and molecules. There are four IgG subclasses in humans (IgG1, 2, 3, and 4), which have different sequences in the C region. It is a long-held belief that only the antibody's variable (V) region contributes to antigen binding, while the constant (C) region is responsible for the interaction with Fc receptors. Recently, this concept was challenged in several publications, which demonstrated that the antibody's C region could affect the V region's biology. In this study, the DNA fragments encoding the light chain and heavy variable region were amplified from anti-c-Met hybridoma cells (clone 1D9), and antibodies in three different isotypes (1D9-hIgG1, 1D9-hIgG2, and 1D9-hIgG4) were constructed, expressed and purified. The activity of each antibody was then evaluated according to its effect on tumor cell growth. It was hypothesized that the C region of the c-Met antibody 1D9 may influence the structure of the V region and affect its interaction with the c-Met cells. It was found that the proliferation of MKN45 cells was significantly suppressed by the 1D9-hIgG2 antibody, while the 1D9-hIgG1 and 1D9-hIgG4 only have minor effects, suggesting that the C region could modify the function of the V region. The next steps in experimentation would be trying to identify the key residues in the C region that affect the function of V region.

P19 IL-6 in B-Cells

Biology

Christina Exilhomme

Boston Latin Academy

In this experiment, the production of IL-6 in B-cells when placed in different environments is tested and measured by doing an ELISA. The cells were placed in media, an environment with the solvent of LPS and an environment with LPS. The results of this experiment will determine if LPS causes a B-cell to produce IL-6. Knowing that B-cells produce interleukins in response to pathogens detected in the body, the variables chosen were an antigen and its solvent. From the experiment, it is shown that when a pathogen, in this case LPS, is added to the environment of a B-cell, IL-6 is produced. This evidence supports my hypothesis that when the antigen LPS is added, the B-cell will produce the most IL-6.

P20 Testing the Potential of Marine Fungi to Bioremediate Crude Oil Spills

Biology

James Goldbach

Falmouth Academy

The purpose of this experiment was to test the ability of *Rhodotorula mucilaginosa* (yeast) and *Penicillium rubens* (filamentous) to grow on a media whose sole nutrient source was a complex hydrocarbon, in this case crude oil. It was hypothesized that both *Rhodotorula mucilaginosa* (yeast) and *Penicillium rubens* (filamentous) would grow on the nutrient media which had a carbon component of 1% concentration of complex hydrocarbon material. Both strains were isolated prior to the experiment by another scientist in the lab and frozen until they were ready for use. Media was mixed, autoclaved and cooled. The crude oil was then added along with chloramphenicol, penicillin-G to prevent the growth of other bacteria on the plates. 10 plates were cultured for each strain and were incubated for four weeks. The *Rhodotorula mucilaginosa* grew an average of 3.8mm \pm 0.298142397mm and the *Penicillium rubens* grew an average of 0.0mm \pm 0.0mm. There are two primary reasons that it was a virtually ideal situation for *Rhodotorula mucilaginosa* to be able to grow. The first is that the temperature of the incubator was kept at 23 degrees C which allow for the fungus to more quickly metabolize it. The second is that the plates were kept in a fully oxygenated environment allowing for the catabolic process to occur easily. The application of the conclusive part of this experiment has endless applications in the real world as there are frequent and extensive oil spills occurring all over the world.

Engineering

Engineering

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N18 Hot Car Deaths
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P18 Super Magnets

A2 A Novel Wall-Climbing Hexapod Robot

Engineering

Xiandong Lin

Stoneleigh-Burnham School

This paper proposes a wall-climbing hexapod robot, which is able to climb on vertical surfaces, rough or smooth, using air suction motor and sand paper for attachment and friction. Due to its unique design, a high degree of modification and applications are possible. The robot is designed as hexapod. The hexapod robot is advantageous not only because it can deal with more complex terrain environments, but also has simple and reliable transmission structure. Various aspects of another relevant prototypes has been designed so far each having some limitations which this robot overcomes. The design in this paper have used vacuum pump as a suction mechanism which makes it cost effective and unique. It can reliably climb on a vertical wall and can crawl on ceiling too. This robot can be used for inspection and surveillance applications and hazardous conditions.

A9 Systems & Methods for Automated Programmable Dispensing of Medication

Engineering

Rohan Minocha

Hopkinton High School

The United States faces an epidemic of injury due to improper use of prescription medication. In fact, 1.5 million people are hospitalized yearly due to this misuse, which can either be unintentional overdosing, or underdosing. This means that 1 person every 20 minutes is hospitalized for this reason. Equally shocking trends can be drawn with both the elderly and the younger generation, as the leading cause of death for Americans under 50 is unintentional drug overdoses. Likewise, 15% of all elderly related hospital visits are due to improper medication use. Ultimately, this is due to a lack of strict adherence to a prescription medication schedule.

This device which pertains to the Systems and Methods for Automated Programmable Dispensing of Medication (Patent Pending) seeks to reduce the number of accidental overdoses by reducing the number of people who stray from their prescription medication schedule through hardware and software solution. The hardware is a connected pill bottle which works by connecting with the 2 software apps: patient and caretaker app. The patient application allows users to dispense medication and is connected to a server system which validates whether medication can be dispensed based on several factors. This app is connected wirelessly to a caregiver app. This app provides remote access to the device to a caregiver. This software allows a person to monitor medication use, process requests for additional medication, and most importantly, allows them to set up and monitor a prescription medication schedule. Ultimately, the patient app, the caregiver app, and the device seek to replace the standard orange pill bottles by promoting safe and easy medication consumption, while simultaneously enforcing a medication schedule.

A10 A Biologically Inspired Modular Robotic Arm

Engineering

Jack Adiletta

Worcester Academy

My project is a dexterous robotic arm to help humans perform dangerous tasks. To mimic human biology I designed and 3D printed: biologically inspired ball and socket joints; and worm gears and structures to act as muscles and bones. I believed that if the design incorporated biological mechanics the robot could be as dexterous as a human arm.

I began with the ball and socket shoulder joint. Multiple stepper motors mated to worm gears provided the movement. I designed in Sketchup for fit, printed the gears then experimented to determine realizable torque. The bicep and tricep each included two worm gears on the top and bottom of a 1/2" steel square tube which acts as the humerus. Moving to the forearm, I discarded initial mechanical approaches for a biologically inspired design using a radius and ulna bone structure for ease of muscle attachment. All finger bones were ball and sockets, the thumb required more freedom to make opposable and finely tuned to fit the palm volume. After arm assembly, I built and programmed an arduino system to control the arm. I then successively refined with focused experiments. To prove dexterity, the hand was programmed with the letters of the ASL Alphabet, and the arm with various human gestures. All letters and gestures were performed 10 times. If the robot could not perform the movement ten times correctly, than it would be tuned or design improvements included until reliable. All letters and gestures were accurately performed.

I was inspired after hearing that significant damage at the Fukushima Japanese nuclear reactor could have been averted if a robot could have opened a circular valve. My conclusion is that a dexterous robotic hand is possible and should be developed for emergencies and to help humans perform human tasks.

A11 Modeling Mass Flow Distribution in a Multistage Rocket Concept Design

Engineering

Albert Farah

Medford High School

The center of gravity of a rocket is imperative to the stability of the rocket during its flight. To remain stable over the course of a flight or a burn, the center of gravity of a mid-scale rocket is generally accepted to be stable if it is located at least 1 body diameter forward of the center of pressure. This relationship becomes particularly important when the center of gravity is varying in unexpected ways during the flight. Such is the case with the multistage rocket concept that was proposed that had, in its first stage, fluid, non-propellant mass being displaced from the forward end of the rocket while thrust-inducing propellant was naturally being ejected from the aft end of the rocket. This experiment utilized the displacement water from an oscillating balance, measuring the variable tangential acceleration in coordination with relative mass distribution of the balance to demonstrate the uniquely variable nature of the stage's center of gravity. Overall, a rapid, initial shift forward was observed, but was quickly reversed by a shift aft, from which the center of gravity then gradually shifted back to its natural geometric location for the rest of the flight. Such oscillations are necessary to consider for flight stabilizer design, and the results of the simulation suggested that a center of pressure that is significantly aft is best to enhance the first stage's stability.

A13 Under Pressure: Customized Insoles for Plantar Pressure Ulcers

Engineering

Hannah Puhov

Mass. Academy of Math & Science

There are approximately 30 million diabetics in the United States; 14-24% of them suffer from plantar pressure ulcers. These ulcers, which are essentially open sores, are caused by pressure applied to a given area over an extended period of time. They are commonly formed on bony areas such as the heels and ball of the foot. Diabetics with plantar ulcers are 15-46 times more likely to have lower limb amputations than those without them. There are many current treatment options, including casts and wheelchairs, but those are bulky, and significantly limit mobility. The goal of this project was to design a customizable insole for pressure ulcers which would reduce pressure at the area of the ulcer, thus allowing it to heal and reduce pain. Personalized insole molds were developed in SolidWorks, including flat and customized insoles. Proof of concept models were then created by casting polyurethane—a plastic that is commonly used to decrease pressure in insoles—into the 3D printed PLA molds. A variety of novel insole designs were then compared with controls. Pressure sensors were used to confirm that the insole selectively reduced pressure on model ulcers (p-value < 0.01).

A14 Helping the Blind: One Step at a Time

Engineering

Arnav Mishra

Shrewsbury High School

According to a study done by the World Health Organization, more than 285 million people in the world are blind. One of the most difficult factors of being blind is as simple as walking; especially for older people who are blind, as they have difficulty walking and can get seriously injured. This project set out to find a way to inform blind users of objects nearby them using a cane.

By using an ultrasonic sensor to test different angles, distances, and colors, the cane hoped to find a way to allow a blind person to know where they were walking. By using an Arduino UNO board and programming the ultrasonic sensors to connect to an active buzzer, the cane was programmed to beep faster and faster as the user got closer and closer to an object. The ultrasonic sensor was tested at 3 different angles: 75 degrees, 90 degrees, and 105 degrees to see the impact it had on the detecting of the object. By testing the sensor at distances 50 centimeters, 100 centimeters, 200 centimeters, and 300 centimeters as well as using a transparent, blue, and red object, this cane was tested in many scenarios and had many trials done.

After testing, it was shown that the 90 degree angle of the ultrasonic sensor in relation to the ground significantly had the closest distances detected. The 105 degree angle and 75 degree angle were thought to help in detecting tabletops and stairs, but they could not detect objects at 200 centimeters or further.

Thus, the 90 degree angle was used on the cane and the cane was programmed using intervals of distances detected by the cane to beep a certain frequency when an object was in the way. By using their ears, blind people will be able to use this cane as it is inexpensive, lightweight and durable to detect nearby objects with ease.

A18 Bio-ink: Evaluation of Protein as Biomaterials for 3D Bioprinting

Engineering

Jiwon Choi

St. Mark's School

Three-dimensional (3D) bioprinting is one of the most promising methods of tissue engineering as it provides unprecedented versatility and precision in delivering cells and biomaterials. However, limitations still exist in the availability of bioinks with natural bio-macromolecular components. In this research, chicken albumin is evaluated as a potential bioink for direct extrusion bioprinting of hollow constructs through alginate-templated crosslinking. Channel diameter, wall thickness, and bioink feed rates are calculated to assess the printing performance of the alginate-based bioink. It is shown that an albumin-based bioink with as low as 1.33% of total alginate concentration can be employed to successfully print microfibrinous hollow constructs with a uniform diameter.

A19 Self-Healing Circuit Networks in Resilient Power Distribution Systems

Engineering

Ashish Puri

Lexington High School

This project aims to demonstrate the efficacy of a Software Defined Network (SDN) controller in creating a resilient solar microgrid. It tests if the controller can sense which microgrids are operational, continuously detect faults and automatically reconfigure the network with minimum human intervention in real-time in case of failure. Four panels connected to individual loads and a central controller were used to test the system's resilience. For all of the 16 possible failure scenarios for this 4 panel microgrid, the SDN controller was able to restore system stability, keeping all of the 12 LEDs lit. For each of the 4 scenarios that required a battery backup, all 12 LEDs remain lit. This totals to a 100% success rate for this 4 panel microgrid. This seems to indicate that these techniques can be extended to stabilizing larger microgrids.

A23 Pharm: A Pill Dispenser Designed to Control Opioid Abuse

Engineering

Ajan Prabakar, Joshua Hollyer

Shrewsbury High School

Pharmaceutical opioids are prescribed on a daily basis to treat pain. These medications slowly build up a tolerance in the individual to the point where they begin abusing it and even beginning to take street-level drugs such as heroin. It would be inhumane to keep people away from these pills when they are truly in pain. This begs the question on how we can regulate these pills to prevent abuse but still allow people to live pain-free. Pharm is the solution. The proposed pill dispenser (Pharm) is expected to be more efficient and focused on opioid intervention than current offerings on the market. This includes using better security measures, allowing space for more pills, and offering more simplistic user interface. The device will also be portable, easy to use and travel with, and be small enough to be placed almost anywhere in a home.

A27 A Tool to Represent the Surroundings of a Blind Person

Engineering

Gaurav Savant

Worcester Academy

This project is aimed to provide a tool to the visually impaired. This tool will provide the user with enough detail of their surroundings so that they can properly maneuver obstacles around them. Current tools such as the white cane often do not give a detailed enough view of the user's total surroundings, as it can only hit one object at a time. This white cane also poses a danger to those around the user, and can also be tiring to use.

To construct this device, 5 9g servos were assembled on 5 sides of a decagon, and 5 sensors were placed on the other 5 sides of the decagon, 1 on each side. Attached to each servo was a rotational bit and a piston, which would fit inside the holes on 5 sides of the chassis. As an object gets closer to the ultrasonic sensor, then it's the corresponding piston on the opposite side would push out, giving a physical map of the surroundings.

This project can be used by the blind to give a more detailed view of their surroundings. This can allow them to respond more accurately as they now know the distance of objects near them, as well as the general amount. There is some ambiguity with small objects but large objects can be easily detected by the device.

When testing this object, it was found that the pistons did respond properly to each ultrasonic sensor however there was extra sampling from each sensor. However, when a filter program was added to the code, the pistons move more smoothly. The rest of the device worked as expected.

In conclusion, a miniaturized version of this prototype could be useful in real life scenarios when used by the visually impaired. This device can be used in real life when walking with large obstacles, however, a miniaturized version of this large prototype would be easier to carry.

B2 Scientific Study Comparing Adhesives as Threadlocker Alternative

Engineering

Charles Przechocki

Westfield High School

Introduction and Hypothesis-News articles cite serious accidents that were caused by a single loose bolt. One may wonder that some sort of threadlocker should always be used to prevent nut-and-bolt loosening. Whenever accidents occur from nut-and-bolt loosening, perhaps whomever assembled the part did not have any easily available. If strong general-purpose adhesives are used, then these should hold the threads of a nut-and-bolt fastener to roughly the same break-away torque as a commercial grade threadlocker such as two popular ones made by Loctite.

Methods-This procedure will use nine identical boards each with six nut-and-bolts for five adhesives being tested as well as one with no adhesive for a control; all bolts torqued to 30 Nm. The procedure will measure the break-away torque using a digital torque meter for each nut-and-bolt in different environments of a cold series in a freezer, a room temperature series, and a hot series where the nuts and bolts in an oven at 77 C (170 deg F), as well as measuring at different soak times of 30 min, 1 hr, and 2 hrs.

Results and Conclusions-The overall means and SD for each adhesive for all environments and soak times was computed, in order to compare values in graphically as well as using statistical tests. A data analysis software, Origin, was used to compare means of the data for Blue Loctite vs Crazy Glue, and Red Loctite vs JB Weld using a Two-Sample t-Test. At the 95% confidence interval the means of Blue Loctite Threadlocker and Crazy Glue were not significantly different, also the means of Red Loctite Threadlocker and JB Weld adhesive were not significantly different. Therefore Crazy Glue can be used as a substitute for commercial-grade Blue Loctite, and JB Weld can be used as a substitute for Red Loctite.

B6 Creating a Human Powered Flashlight

Engineering

Rohan Shenoy

Amherst Regional High School

This project focuses on harvesting heat from the human body and using this energy to power a flashlight. 1.3 Billion people in the world are left without electricity. The lack of electricity gives these people many disadvantages. Whether it is them being unable to do work at a late hour, not being able to go out at night, or the kids not being able to do homework, the lack of electricity is what is leaving them behind. I want to create a light source that needs nothing other than human heat so that these people without electricity can overcome these disadvantages and become excellent members of society once again.

B7 Seeing For The Blind

Engineering

Sidharth Anantha

Lexington High School

285 million people are legally blind, meaning they lack adequate eyesight to understand their surroundings. I have built a cost-effective device that uses technology to take in information of a user's surroundings and portray it to user to allow them to effectively navigate. This device is comprised of two systems, the echolocation system and the object identification system. In the echolocation system, the device uses a sonar placed on a pair of glasses and shoes, that works to determine the distance between the user and any obstacle in front of them. This distance measurement is then processed by an Arduino microcontroller, which interprets the data and returns a corresponding output either in the form of sound or vibration. As the user walks toward an obstacle, the pitch and frequency of the sound and the intensity of the vibration is increased to alert the user that they are nearing an object. This system allows the user to understand where objects are in relation to them. However, the user does not know what specifically these objects are. The next system is the object identification system. This system uses a camera to take a photo of the user's surroundings on their request. The image is then sent to a raspberry pi, which analyzes the photo in a deep learning neural network. The algorithm identifies the object, face or text, and the name or text is read back to the user through an earphone. The combination of both systems allows the user to fully understand their surroundings, by knowing where and what objects are around them.

B13 The Sound of Silence: Alternative Way for the Deaf to Experience Music

Engineering

Evan Gaus

Mass. Academy of Math & Science

People with any amount of hearing loss, especially those who are profoundly deaf, have great difficulty listening to music. Because of the common use of headphones and earbuds, nearly 12% of the global population is at risk for noise induced hearing loss. This project looks at a new way to mimic the sensation of listening to music, using tactile, rather than auditory, vibrations. The vibrations were created using an electric motor controlled by an Arduino microcontroller. The device can vibrate a calibrated frequency to match a certain musical note, therefore mimicking low frequencies of sound. An iterative design process was used to develop the current model, which successfully mimics sound using the calibrated vibrations generated by the motor. This product bypasses the use of the eardrums, allowing those with hearing loss or other auditory impairments to experience music in an alternate manner.

B24 Heating and Cooling Unit for Optimizing Short Sleep Periods

Engineering

Anna He

Mass. Academy of Math & Science

In January 2017, 35% of adults in the United States reported that they experienced uncomfortable temperatures when falling asleep. Sleep is critical for human bodily functions. Temperature is the environmental factor that most affects sleep; cooler temperatures promote sleep while warmer temperatures discourage sleep. This project used heart rate, a physiological change associated with sleep, to dynamically regulate room temperature during short sleep periods in order to help people fall asleep faster and wake up more refreshed. The system was made using a relay and an Arduino UNO controlled by code written in the Arduino IDE. A wearable device was built to collect human heart rates using an Arduino pulse sensor. Human tests were conducted on the final iteration and the MVP ($n = 12$, $n = 15$) and there were significant positive differences in self-reported refreshed feelings ($p = 0.00179$, $p = 0.00555$). Graphical analysis revealed that incorporating the device did not negatively impact the time participants took to fall asleep. These findings demonstrate that this form of ambient temperature regulation could help improve how people feel upon awakening from short sleep periods.

B27 Patient Specific Proton Beam Radiation Delivery

Engineering

Advait Nene

Hopkinton High School

This project explores a novel method for constructing radiation compensators used for proton beam radiation therapy. The proposed method uses a reusable apparatus for constructing the compensators. This would significantly reduce the cost of the materials and the time it takes to fabricate the compensators. This project demonstrates the feasibility of the new method with a working proof of concept of the apparatus. In order to determine the geometry of the compensator, the Bethe-Bloch equation for stopping power is used. This requires solving the Bethe-Bloch equation and finding its inverse. This project explores two methods to solve the equation: a Riemann Sum approximation, and a neural network based approach. The neural network is also used to find the inverse function. An original program utilizing the backpropagation algorithm for finding the weights and biases for a multilayer neural network is demonstrated. An alternate method using the Scikit-Learn Library to determine the weights and biases is also explored.

C8 Home Status Hub with Arduino

Engineering

Anzhuo Wang

Westborough High School

The home status hub was designed, built, and programmed for real-time monitoring conditions including home security status, temperature, humidity as well as adequately adapting to changes in a home environment. The system is comprised of an Arduino Mega 2560 and other sensors and components soldered onto circuit boards. The signals from the infrared, ultrasonic, and temperature/humidity sensors are detected and processed by the microcontroller and displayed. The system's accuracy and reliability were tested in a series of trials, and the system is feasible for monitoring home conditions.

C12 Are You Seeing What I'm Seeing? Analyzing Glaucoma Patient Data

Engineering

Neelasha Bhattacharjee

Shrewsbury High School

Glaucoma is a disease in which progression can be slowed greatly through regular adherence to medication. However, regular adherence is very difficult to attain and is often influenced by extenuating factors. Patients often have low adherence for certain days of the week, or certain times of the day. If a patient is informed of patterns such as these, then they will be able to become more adherent, thus slowing the progression of their disease. In order to identify patterns such as these, logistic regression machine learning models were applied to generated data and were evaluated on their ability to make accurate predictions based on previous patient data. Logistic regression makes dichotomous predictions based on an independent variable. One of the logistic regression models also used weighted classes as a result of imbalanced data, hoping to improve the accuracy of the model. The other model did not use weighted classes, and the metrics of both models were compared those of a base model which predicts only the value one. These models were evaluated on five patients worth of generated data, each patient with 30 weeks of data. The models were tested on datasets which had a correlation between a specific time slot to adherence, and datasets which did not. The findings were that both the machine learning models performed significantly better than the base model. The model which used weighted classes performed better when the generated dataset contained more zeros, and performed very similarly to the unweighted model as the datasets became primarily ones. There were very low standard deviations for the metrics which the models were evaluated on, thus showing very little variability between results and high credibility.

C14 How Does the Sweep Angle of a Wing Affect Its Lift Force?

Engineering

Michael Dubuisson, Stanley Chen, Thomas DeMasi

Boston Latin Academy

Today we see that jets burn much fuel to take off. This project offers a possible solution to that problem by altering the shape of airliner wings so they produce more lift and theoretically become more energy-efficient. Our hypothesis was that if we changed the sweep angle of the inward half of the wing to 0 degrees, that would increase its lift force to more than a 25-degree swept wing.

Our procedure was to first design and build our two wings from foam. They were then mounted on weights, put on a scale, and the wind was blown over them from a fan. Their force on the scale was recorded and compared against their original mass to determine their lift force.

We found that our new wing design held some promise as it created more lift in proportion to its original mass than the traditional wing did. The prototype wing generated 1.38 grams of lift on average, or 0.014% of its original mass, while the traditional wing generated 0.76 grams on average, 0.0074% of its original mass.

Therefore, we saw that this idea was open to further testing, as the experimental results showed a definite difference between the lift force of both wings, our new design performing marginally better in that aspect. We believe if this design is proven over multiple trials to have a positive effect on the energy efficiency of aircraft, it could be used by heavier jets that require more lift to take off.

C17 Detecting and Gathering PET in Landfills

Engineering

Shravya Aniseti

Shrewsbury High School

In the United States of America, 60 million water bottles made of plastic are disposed daily. Most of them end up in landfills, with only one fourth ever being recycled. In just a year, this number grows to 22 billion bottles in a landfill (container-recycled). Over the last twenty years the amount of plastic bottles consumed has quadrupled, in 2014 Americans threw away over 33 million tons of plastic, only a little over nine percent was sent to be reused. Most of this plastic ends up degrading, though it releases harmful toxins, such as methane into the atmosphere. Methane contributes to the greenhouse effect and global warming, harming ecosystems across the world. When it degrades, it can also travel to oceans and other water sources, where it gets consumed by heterotrophs (Columbia). If a robot uses design elements to increase its accuracy level of detecting PET, it will be able to differentiate a plastic bottle from other materials.

C19 Building a Better Tabinet (Table-Cabinet)

Engineering

John Kozak

Berkshire Arts & Technology Charter Public School

In this experiment I looked into the logistics of building a tiny house and the challenges that it presents. I decided to look closely into making a table that wouldn't take up all that room, nor would it take up valuable wall space if it folded. And so I designed a cabinet that would have a fold out table in it. I also set goals for the cabinet before I began designing it. It had to be strong, aesthetically pleasing, 5' wide, and as thin as possible (within reason). After building it, I tested the shelves' strength by applying a 50-lbs weight to each, and tested the appearance by having civilians rate it on a scale of 1-10 during my school science fair. All of the shelves were exceptionally strong, as each one held more weight than they would ever encounter with normal use without bending. This data allowed me to conclude that my piece did, in fact, meet all of the goals I set and solve the problem.

C21 Gun Control without the Politics

Engineering

Muneeb Syed, Saad Mufti

St. John's High School

Gun violence is an increasingly unavoidable issue in the United States and is almost an exclusive issue to the country that other developed nations do not encounter. So, in order to bypass the legal restriction of providing a solution to inhibit mass shootings and gun-related violence from occurring, the engineering goal of the project was to develop a mechanism capable of communicating via a RF transceiver to a stationary node placed within the vicinity of a potentially targeted institution, backed by an encryption algorithm to secure the communication medium from being manipulated by external efforts. In its current state, the mechanism has a motor situated as a secondary gun safety in order to block the functionality of the firearm when close proximity to an institution is recognized. In the event of the user attempting to manually break the implemented system from operating, an excess of adhesive substances will be dispensed onto crucial firearm components to permanently inhibit the firearm from operating. Because of the difficulty in acquiring a legitimate firearm, a model firearm mechanism was used for testing. The first design was only intended to function as a firearm in practice and not in its actual mechanism, but iterative designs negated this issue. Furthermore, a plethora of design caveats were encountered that eventually had to be solved in order to maintain the design as an effective solution, which included protection from manual user intervention, guaranteed reliability, and near indisputable avoidance of interfering with the traditional mechanism of a firearm.

C26 Smart White Cane

Engineering

Sayedazhar Peerzade

Advanced Math and Science Academy

There are ~250 million visually impaired people all around the world, and a lot of them rely on white canes to move around on a daily basis. The white cane is primarily used to scan the surroundings for obstacles. The white cane doesn't alert potential hazards from a distance, lacks a large range for sensing obstacles, and can't detect many overhanging objects. The Smart White Cane will help detect and alert the visually impaired about the obstacles from a programmable distance.

D8 Designing a New Wing Shape

Engineering

Andrew Elfman

Southeastern Regional Vocational Technical High School

The purpose of my project was to design an airfoil that would create more lift than the baseline airfoil tests. The approach I used was using baseline airfoils from an aviation project and use the design process to make airfoils that would create more lift. I also wanted to create a better airfoil not by just playing with camber, leading and trailing edge, but by messing with other factors. The way of testing was by putting the airfoils on a scale in a wind tunnel, measure the weight, then turn on the fan and measure the weight again. Then subtract the numbers and get lift created in grams. By the end, one airfoil was creating almost triple the amount of lift as the baseline tests. The best airfoil had achieved 16.9 grams of lift, while the baselines barely broke 6 grams of lift. An airfoil that creates more lift would help aircraft engines to not work as hard and use less fuel. I also had succeeded in creating a new type of airfoil, that worked very well.

D14 Dynamically Controlled First Person Viewing System For Drones

Engineering

Cole Whidden, Ryan Tierney

Silver Lake Regional High School

This dynamically controlled FPV system was designed to create an immersive birds-eye viewing system that can be mounted onto quadrotors or drones. The camera system must: be able to be controlled by the movement of an FPV headset, be able to pan and tilt, be vibration dampened, be compatible on a drone, and cost less than \$500. The construction of the camera system was split into two parts, one being the design and construction of the camera gimbal through CAD drawings and 3D printing, the other being the code and programming to the gimbal to react to motion of the FPV headset. In the design aspect of this project, the FPV system is built around 2 micro-servos and the RunCam Split Mini 2 camera. In the control aspect of the project, the FPV system is controlled by taking input from an accelerometer on the user's FPV headset which is used to control the servos on the gimbal. Overall, the camera system meets the requirements of being controlled by the headset, pan and tilt movements, vibration dampening, and costing less than \$500. However it does not meet the requirement of compatibility on the drone which is the next step in the process. This will involve designing a wireless interface to control the system from afar.

D16 Testing Bridge Length Based on Bridge Span

Engineering

Evelyna Legkoduks

Westfield High School

This project's idea originated based on the last three previous years science fair projects which dealt with cable designs in a suspension type bridge. This year's continuation project answered the question of whether a suspension or a cable-stayed bridge would be able to withstand greater tensile and compressive forces as the bridge span for both bridges increased.

Two model bridges were constructed at three different bridge spans using an engineering software called West Point Bridge Designer. Both the cable-stayed and suspension bridges were tested for their overall ability to endure stress within all of their beams and cables. The software gave results in tension and compression which were then used to determine the strength of the bridges.

In the 8m, 16m, and 24m bridge span, the compressive stress in the suspension bridge was 0.0254, 0.0346, and 0.0621 pascals greater than in the cable-stayed bridge. The tensile stress in the 8m, 16m, and 24m bridge span was 0.0177, 0.0391, and 0.0385 pascals greater than in the cable-stayed bridge. Overall, no matter the bridge span, it is evident that the cable-stayed bridge was stronger, withstanding both compressive and tensile forces with much more ease than the suspension bridge.

Bridges are a very important aspect in modern society and these results may help engineers and architects decide what bridge type they would want to construct in any given span.

D19 Concrete's Strength Lies in Aggregate

Engineering

Stephanie Sgueglia, Nicholas Stathatos

Westfield High School

This project is an engineering design experiment to find which recycled material could increase the strength of concrete beams. Our initial design was to use varying percentages of our three different recycled materials (paper, plastic, aluminum) as aggregates. Aggregates, which are often little rocks, are used as reinforcement for concrete. A concrete mixture was added to each different percentage of aggregate, then was poured into their forms. There were nine beams in total with three controls, three with fifty percent aggregate, and three with eighty percent aggregate. Weights were added to a basket that hung from the middle of the beams until they broke to determine how strong each beam was.

Each of the beams containing aggregate was not able to hold as much weight as the control beams. The beams with paper aggregate were very brittle and were not able to come out of the forms without breaking. The beams with plastic and aluminum aggregate were not brittle and were able to hold more weight than the beams with paper, but they were still not able to hold as much weight as the control beams that had no aggregate.

Overall the beams containing the recycled materials as aggregates were not able to hold more weight than the control beams that had no aggregate. With more research and precise ratios this design could be enhanced and would have an impact on the environment as well as concrete. By using recycled materials as aggregate, the chance of these materials going into landfills or the ocean would be reduced, while also being able to increase the strength of concrete.

D21 Bioelectrically-Controlled Robotic Hand

Engineering

Kyle Beatrice, Gordon Smith

Silver Lake Regional High School

The bio-electrically controlled robotic hand is designed to use muscle impulses from a person's forearm to move the fingers on the robotic hand. The hand and arm are modeled based on the project, inMoov Robot, designed by Gael Langevin and constructed using a 3D printer. The design is intended to resemble a realistic human hand in dimensions and weight. The mechanics of the hand incorporate an Arduino Uno board along with servos attached to tension cables made from fishing line. The servos rotate based on inputs they receive from the electromyography (EMG) sensors, which detect electrical activity of muscles. The sensors are strategically placed on a person's arm to pick up muscle signals from the different muscles involved in specific finger movement. The sensors gather values for these signals and store them on the Arduino. The Arduino then uses these values to actuate the appropriate servos in order to move the robotic fingers. Overall, the robotic arm is able to successfully mimic the opening and closing of the thumb using EMG signals but is not yet able to mimic all fingers simultaneously. To address these issues we plan to make future changes to our code to better differentiate between the various muscle signals in order to make all fingers respond appropriately.

Key Words: Robotic hand, Muscle, inMoov, 3D printer, Arduino Uno, Servo, Electromyographic (EMG) sensors

D22 Smart Glasses

Engineering

Jaden Reid, Nicholas Spooner

Southeastern Regional Vocational Technical High School

Our project is a device incorporated into a pair of glasses that connects to your phone through Bluetooth, and when a notification is generated on your phone, the notification contents appear on a glass prism in front of your eye. Smart glasses have been made by several different companies in several different forms. For example, the social media company, Snapchat, made a pair of glasses that takes pictures and sends them to your phone, whereas companies like Google are working on glasses similar to the ones in this project. These glasses are the future, and have and will continue to be made for a variety of uses such as gaming, social media, health and photography to name a few. The engineering goal is to make a device that connects to the user's phone using Bluetooth and forwards any notifications to their eyes, in a hands-free way, and to have the materials range from \$60 to around \$100. The importance of the project is based on its impact. The potential impact on society is astonishing; especially if this technology were to be improved upon and made more powerful. When it came to building the glasses, the code had to be made from scratch, the case was made from scratch, and as for the electronics, we knew what to buy, but the wiring had to be based on the code. This made the project difficult to do, especially with the time we were given.

D27 Building an Automatic Fish Feeder

Engineering

Kai Chen, Yasmin Nyman

Bourne High School

The purpose of the project is to create an automatic fish feeder that will simplify the feeding process of tilapia within the context of a school aquaponics lab. The fish requires tedious daily feedings with specific amounts of food, which varies as the fish grows. This becomes a problem during school breaks, during of which, people may not be available to manually feed the fish. Therefore, the implementation of an automatic feeder will allow fish to be fed with their regular food without human assistance and allow more customization than a commercially available feeder.

A feeder with an auger as its central component was built. An Arduino microcontroller was used to allow a user to input motor run times and the interim between feedings among other functions. The auger turns to move fish pellets in a process similar to a conveyor belt. Testing was done on the feeder to determine consistency and the amount of food released per second of motor run time. The first set of data was scrapped due to interference from low battery power. New data was taken with the feeder plugged in a wall outlet, which is more reliable and reflective of how the fish feeder may be used.

As of now, the automatic fish feeder is capable of being adjusted by changing the amount of time between feedings and how long the motor turns for. By referencing the average grams of food released per second, the user can fine tune the feeder to meet their needs. The basic design is applicable for any animal and greatly reduces human labor in the feeding process of fish. However, the incorporation of a simple LCD display, an improved hopper, and a digital interface to alert the user via text when the hopper is nearly empty will further enhance the device.

F4 Economical Device for Detection of Pneumonia Causing Pathogens

Engineering

Nilay McLaren

Mass. Academy of Math & Science

Lower respiratory illness accounted for 85% of deaths in low-income economies in 2015. This project focused on three common pathogens responsible for pneumonia infections: *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Legionella pneumophila*. Problems with misdiagnosis arise because current methods of pathogen identification sample areas of the body where pneumonia-causing pathogens are not present. Sputum sampling is a superior method of sampling compared to existing solutions because sputum production correlates with these pathogens. Artificial sputum samples with indicators of each infectious agent were produced (1 mM of hydrogen peroxide, 1 mM of ferritin, and 6-6.7 mg/L of oxygen). The sputum samples were added to a cup that contained test strips for detecting hydrogen peroxide and ferritin. Color change was detected in both test strips, demonstrating the presence of *Streptococcus pneumoniae* and *Haemophilus influenzae* in sputum samples. The indigo-carmin method accurately measured 7 mg/L of oxygen in the sputum samples. This cost-effective method of pathogen identification will allow doctors to quickly and correctly prescribe medication to treat pneumonia and save lives.

F12 Testing Lasering Under Pressure

Engineering

Charlie Kleindinst

Upper Cape Cod Vocational Technical High School

It was hypothesized that the transverse electrical discharge LASER worked at below atmospheric pressure with only air and the effect. Originally I made a TEA Laser that stands for Transverse Electrical discharge in gas at Atmospheric pressures or Transversely Excited Atmospheric for short. This year I changed the laser from only working at atmospheric pressure to working below atmospheric pressure.

This project was built using very common items except for the neon sign transformer that was borrowed and glass-housing spear, which was going to be recycled. The electronic components were bought from Digikey and mouser electronics online. The first steps were to design the circuit and determine what kind of power was to be used and then build the circuit on perfboard and make the design for the sensors to go on a PCB (Printed Circuit Board) if there was time. The next steps were to change out the capacitors, spark gap and laser gap for from the ones from the first year to better ones that were more reliable. Originally, two types of laser gaps were made after the first did not work because it was anodized in the first year and a new type was made for this experiment out of aluminum and was machined on a milling machine.

There are several reasons why the laser did not work but there is no real way to fully test what the problem is without a lot of time and several different setups and designs of this laser system. The first problem seemed to be that the different resistances seemed to happen when the supply current came from only one spot. Unlike the previous laser setup and design, the resistance in the aluminum spread out from it and increases the resistance. The aluminum bars did not spread the voltage equally across the laser gap.

F14 Predicting College Admissions Using AI

Engineering

Niya Doddipalli

North Attleboro High School

The goal of my project was to use machine learning AI to help predict college admission efficiently by optimizing the AI Neural Networks. My question was, Do computer systems have the capability to learn data and use the experience from the data to make predictions without human intervention? AI is making a computer think and act like a human. Machine learning is a way to achieve AI by using an algorithm and data to make a computer artificially intelligent. The data was collected from 10 colleges on their websites, in CSV form which contained the most important factors in college admissions - GPA and SAT scores. As the more data was added, the more the model was trained, and the more accurate the predictions were. The CSV data was then used with TensorFlow python API, to generate and train a model. After I trained the model, I feed it to the website module, which is then used for predicting college admissions. The website module was developed using Python, Javascript, and HTML to create a user interface. To get to the website you would have to first run the program in the command prompt and then type in localhost:5000 in the browser which will bring you to the website. On the website, you would pick 1 out of the 10 colleges I choose to train and enter in your GPA out of 4 and sat score out of 1600. Then you would click on chance me, bringing you to a page that tells you if your admission is likely or unlikely into that specific college. If I were to further my project I would incorporate many more criteria like extracurricular activities, volunteering, gender, residence location, and many others because there are many other factors that contribute to college admissions.

G3 Water Purification with UVc Light

Engineering

Sadie Jude

Burncoat Senior High School

I believe that the UVc treatment combined with the activated carbon treatment will kill most of the bacteria, and will be a good solution for water purification in developing countries. The power system composed of the solar panels, car battery, and inverter will be able to power the UVc light for more than a day, in case there is no sunlight for an extended period of time. The cheap materials that will be used to make the apparatus should be durable and easily disassembled yet still allow the support needed to hold the weight of the water.

Most importantly I believe that I can bring the cost of the inverter, activated carbon, the UVc light, and the major subsystems to under twenty-five dollars. This is a huge task to accomplish. However, I have faith that I can bring the cost of this apparatus to under this value.

H13 Optimizing Efficiency of Pelton Turbine Based On Euler's Equation

Engineering

James Gow

Concord Academy

The purpose of this study is to investigate which variable(s) of Euler's equation has the most significant impact on the efficiency of a Pelton Turbine (producing the most electricity). This experiment is a continuation of a study based on my previous 2016 California State Science Fair project. This experiment is carried out by using various types of Pelton Turbines. The construction of the enameled magnet coils with magnets formed a generator. This device converted the kinetic energy of the rotor to electrical energy when the moving water jet hit the cups of the water turbine, rotating the wheel of the turbine. All cups will have an optimal tilt angle of 45 degrees (based on the previous study). The control Pelton Turbine has an eight-cup with a 45-degree tilt and the radius of x cm. The experimental turbines will have eight-cup or ten-cup with a rotor radius of $\pm 20\%$ of x cm (the control rotor's radius). The hypothesis of this study is based on Euler's Equation. The scientist believes that the efficiency of producing electricity with a Pelton Turbine is related to fluid velocity, number of cups on the turbine and the radius of the turbine. The higher number of cups of the turbine and the larger radius of the rotor will decrease the total generation of electricity. In addition, higher fluid velocity will compensate for the negative impact of the higher number of cups on the turbine and the larger radius of the rotor.

J12 Autonomous Cars

Engineering

Missoura Wiggins-Howard

Dearborn STEM Academy

I will build a model car using mindstorm legos and then add a proximity sensor to the front of it. Then use the Mindstorms robot to act as an autonomous car and travel through a series of mazes. To get an insight on, how autonomous cars work, how the sensors work, and help the car navigate. To get an insight on how our future cars will work and the sensors they use.

J15 ACL Tear Prevention: Engineering a More Efficient Knee Brace

Engineering

Bharath Heggadahalli

Mass. Academy of Math & Science

One of the most severe injuries that occurs in sports is an Anterior Cruciate Ligament (ACL) tear. In the U.S., over 80,000 people tear their ACL every year. These tears take over a year to heal and create an increased risk of knee osteoarthritis, a condition where the cartilage in the knee wears away. Although there are many braces that exist currently, the frequency of ACL injury still remains the same. These braces prevent the extension of the ACL, but they also limit the range of motion, de-incentivizing brace use in athletics. However, braces that allow the fluidity of motion that athletes require do not provide enough support to prevent ACL tears. This project provides a solution for reducing the rate of ACL tears. The brace uses data from an electronic goniometer, a device that measures angles, to selectively apply pressure on the knee only when it is extended, allowing free range of motion if the ACL does not need additional support. The maximum angle of the knee during a sudden movement was significantly lower than that allowed by other braces ($p = 0.0145$). The brace reduces the time that the ACL is in a vulnerable position, therefore reducing the chance of an ACL injury.

J20 Programmable Water Bottle Heater from Arduino and 3D Printing

Engineering

Jiho Shin

Miss Hall's School

I am a boarding student. Living at a school without my parents has taught me the value of self-care. Dehydration, for instance, was an issue because I forgot to drink when immersed in my studies. I found a plastic water bottle to carry around as a reminder. Once I started drinking more, I realized that cold or even lukewarm water makes my stomach churn. However, my bottle could not withstand high heat due to the nature of its material. Frankly, purchasing an insulated tumbler would have easily solved the problem. I sought a creative outlet instead. In the process of rethinking common items such as liquid containers and electronic coffee pots, I was inspired to design a detachable heater that curves along the bottom of mugs or bottles. I studied the relationship between resistance and heat dissipation to build a series of resistors that produces an ideal amount of heat. I also disassembled a coffee pot to analyze the circuitry, which I modified into a simpler version before incorporating a heat sensor and a microcontroller. Lastly, I used a computer software called SketchUp to design the exterior geometries of my product and 3D printed the individual pieces. My prototype is a compilation of the circuit and the articulating container pieces. Powered by four 1.5V batteries, my mini heater initially dissipates heat through a resistance ladder and distributes heat across a thin copper sheet between the ladder and the sole of a bottle.

J21 Identifying EEG Correlates to Intentional Motor Movement

Engineering

Emma Hartman

Newton Country Day Sch/Sacred Heart

The purpose of this study is to identify Electroencephalography (EEG) correlates for intentional motor movement in healthy individuals. Subjects will undergo a series of EEG tests meant to mimic the action of typing on a computer keyboard. EEG data will be analyzed with a Fast Fourier Transform (FFT)/spectrogram and time-trigger averaged EEG signals using MATLAB software. Conclusions drawn from analysis would provide a basis for the development of a basic, noninvasive brain-machine-interface (BMI) with the purpose of enabling motor impaired individuals to type and work on a computer, which would improve their quality of life through potential better communication, entertainment, and mobility. These objectives were pursued through construction of an inexpensive EEG machine capable of evaluating neuronal activity in subjects and development of a MATLAB experimental paradigm with an accompanying Arduino data acquisition paradigm to isolate EEG correlates that precede and follow motor initiation. Nearly end to end testings of Arduino data acquisition and MATLAB experimental paradigms were completed; a data sampling rate of over 120 Hz and successful signal differentiation were achieved, albeit through the use of photoresistors rather than electrodes. Future experimental testing with this paradigm will provide for isolation of EEG correlates to motor movements associated with button pushing. Additional EEG-based studies may be expanded to isolate correlates for additional motor movements (e.g., grabbing, applying pressure) and to develop a more detailed understanding of coordination between various neural regions before, during, and after motor movements. Applications of this research include development of more advanced brain-machine-interfaces and myoelectric prosthetics.

K3 Making Astronomical Observations Using the Electromagnetic Spectrum

Engineering

Charles Togneri

Hudson High School

The goal of the project is to detect exoplanets and identify the properties of the planet. The exoplanet will be detected by observing the brightness of the target star using the Micro Observatory telescopes. The Micro Observatory is a group of remote-controlled telescopes the public can request images from. The brightness of the star will dip periodically, indicating the transit of an exoplanet. The objective of the observation is to find the dip in brightness because it indicates that an exoplanet is transiting, blocking light, decreasing the star brightness.

K14 DIY Stethoscope

Engineering

Zelinda Goncalves , Rachel Seaver

Southeastern Regional Vocational Technical High School

The purpose of our project is to build a homemade stethoscope and see if it will be applicable enough to be used in the medical field. Our goal is to create an efficient stethoscope but inexpensive as possible. Our research is extremely important because it will show us if it is possible to make an even more advanced piece of work without exceeding the price range we set in place. This project can have an immense impact on society because it is more affordable when compared to ones sold in retail. The importance of a stethoscope is that it is a instrument used by all medical professionals on a daily basis to do performances such as apical pulse reading and blood pressure reading.

K24 Water Purification Through Solar Disillation

Engineering

Maryam Ngokila

Pioneer Charter School of Science II

The problem being addressed is water purification through solar distillation. The reason why I conducted this project was because many people in rural areas around the world do not have access to sanitary water. Water is the most essential part of life, and most people take it for granted.

N10 Permeable Concrete for Flood Sustainability
Engineering
Katherine Molloy, Isadorah Amazan, Courtney Sacchetti
Brockton High School

Flooding has been a major cause of distress and harm to the environment. One way to lessen the effects of flooding is to install permeable pavement, which is a type of concrete that allows for water to seep through its pores. In comparison to impermeable pavement, permeable pavement lacks sand, which absorbs water and does not allow it to pass through. The scientists is trying to prove that he permeable pavement, made without sand, will allow for water to run through it and collect beneath it, whereas the impermeable pavement, made with sand, will not allow water to run through it and collect beneath it. The independent variables in the experiment are the two different types of concrete being tested, permeable and impermeable, and the dependent variable is the amount of water collected that has gone through both the permeable and impermeable pavements after being tested. The scientists will test their hypothesis by building a model of both impermeable and permeable pavement (the permeable pavement has no sand whereas the impermeable has sand). When built, the scientists will test each pavements ability to absorb water by pouring 1000 mL of water onto each and collecting the amount of water that soaked through it and determined the difference. The experiment proved that water does go through permeable pavement much more than it does impermeable pavement by a lot. On average, the permeable pavement absorbed 898 mL of the 1000 mL of water poured and the impermeable pavement absorbed 360 mL of water. The scientist's hypothesis was correct. The fact that the permeable pavement allowed more water through it proves that this type of pavement would be beneficial in collecting water during floods. Issues include cracks allowing water to flow through and saturated pavement.

N18 Hot Car Deaths
Engineering
Gaurang Karpe
Chelmsford High School

Sometime people intentionally or accidentally leave the babies unattended in the car and due to hot weather cause the raise the temperature inside the car and causes deaths of baby's inside the car. I install the smart sensing feature in the vehicle and deploy on the rear seat. When driver is not in the car and temperature raise scanner sense the high temperature and unattended baby in the car bips the alarm. So the outside person also hear the bipping alarm. It helps to save the baby.

N23 Active Aerodynamics for Automobiles

Engineering

Colby August, Ben Schiffer

St. John Paul II High School

The basis behind our project was testing the concept behind adding active rear elements to automobiles to allow for maximum aerodynamic efficiency when in regions where the automobile has more space around it yet stay compact when being driven in smaller more congested areas. For people who have to commute into a busy city every day this type of technology would be very useful as it would allow them to get better fuel economy on their commute and still be able to park/maneuver their car in the city. Through utilizing an aerofoil shape we are trying to optimize the airflow across the vehicle removing negative pressure or drag pressure created from stationary air behind the vehicle. The aerofoil allows for the airflow to stay attached to the back of the vehicle for longer creating a smaller wake behind the vehicle lowering the amount of drag pressure. In doing this the vehicle would take less force to power it forward allowing for the engine to use less gasoline allowing for improved fuel economy. We designed three models in an online CAD program based of an e60 BMW 5 series and 3d printed a scale model of our extending rear element. In order to test the efficiency we built a wind tunnel and used a sting with a spring scale in order to measure the drag force in newtons. This number was then converted into the drag coefficient of the model and then compared against each other to see if our concept would prove correct.

P18 Super Magnets

Engineering

Davidson Guerrier, Ece Cetinbas

Excel High School

Imagine traveling by land from Boston to New York in less than an hour? In our experiment, we have figured out that a maglev train would become more efficient and stable using an electromagnet as the main engine. When we used the fan, as the main source of energy, the train would often time become unstable which when put into a safety perspective, would make our project unable to be used on a larger scale and make it impossible for it to be used for human transportation. Therefore, we decided that using an electromagnet as the main power source was the more efficient and effective method when constructing a MagLev train.

Behavioral Science

Behavioral Science

- A4 Predicting Opioid Use Disorder (OUD) Using Machine Learning
- B19 Episodic vs. Semantic Memory
- C2 Activation of R26E01 Neurons/dsx Enhance Aggression in Drosophila
- C5 Correlative Study between DiSC Personality Type and Conformity
- C13 Listening to Music with Your Bones
- D4 Evaluation and Resolution of Reading Literacy in Rural China
- F6 Investigating Economic Influence on Homeless Populations in Boston, MA
- F22 The Impact of Induced Social Anxiety on Health and Well Being
- G2 Comparing the Diets of German Cockroaches (*Blattella germanica*)
- G7 The Law of Attraction
- G13 Multitasking: Gain or Drain?
- G22 Where We Live
- J13 Memory In A Tech Savvy World
- K25 The Effects of Mindfulness on Amygdala Volume and Perceived Stress
- P3 Effect of Music Exposures on High School Student Cognitive Performance

A4 Predicting Opioid Use Disorder (OUD) Using Machine Learning

Behavioral Science

Adway Wadekar

St. John's High School

Opioid Use Disorder (OUD), defined as physical or psychological reliance on opioids, is quickly becoming a public health epidemic. This project demonstrates the potential of supervised machine learning in predicting individuals at risk for OUD by considering interactions between various demographic, socioeconomic, physical, and psychological features in an integrated manner. A labeled data set is built from the responses to the National Survey on Drug Use and Health (NSDUH) conducted by the Substance Abuse and Mental Health Services Administration (SAMHSA). This labeled data set is used to train a decision tree classifier while accounting for class imbalance. The decision tree classifier can identify adults with OUD with high accuracy. The average sensitivity is 0.857, average specificity is 0.743, and average AUC is 0.8592. Early, prior to 18 years of age, use of marijuana emerges as the most dominant predictor for developing OUD in adult life. This is surprising for two reasons. First, it dwarfs mental illness and disability, which are often comorbid with substance abuse. Second, early marijuana use only affects some demographic and socioeconomic groups including individuals with no college degree, no full-time employment, an income less than 20k, between 18-25 years of age, and of the Hispanic/Native American heritage. The key takeaway is that curbing early marijuana use is the best prevention strategy, which highlights the crucial role of educators, counselors, and parents in alleviating America's opioid crisis.

B19 Episodic vs. Semantic Memory

Behavioral Science

Lavanya Goel

Prospect Hill Academy Charter School

Are there differences in how teenagers (14-18), memorize images and numbers that do or don't relate to their lives when they have different levels of glucose and/or stress? I hypothesized if semantic and episodic memory are tested, episodic memory will result in more accurate recollection because of the associations people have with episodic memories. I also hypothesized stress will negatively impact memory since it could lead to poor recall (Lupien, Fiocco, Wan, Maheu, Lord, Schramek, & Tu, 2005). Additionally, glucose should improve memory by improving brain function. Similarly, early tests should improve memory because people have high energy and function better (Baddeley, Hatter, Scott & Snashall, 1970). A set of images and a set of numbers were given to each participant; on the first day, they triggered episodic memory, on the second they triggered semantic memory. Half the participants received candy to increase their glucose and all were asked to indicate their stress on a scale 1 (low) to 3 (high). The test began with images. Immediately after viewing a set, participants recalled images in their order. After 30 seconds, they repeated this with numbers. The memorization and stress were measured on a scale 1 (best) to 3 (worst). I recorded the consumption of candy within an hour before the test to measure glucose. Time was measured as early (Monday/Tuesday) or late (Thursday/Friday). The set with the most 1s for memorization was best. Altogether, results showed episodic numbers were the most accurately memorized, other factors made less significant impacts.

C2 Activation of R26E01 Neurons/dsx Enhance Aggression in Drosophila

Behavioral Science

Thrusha Puttaraju

Hopkinton High School

A great challenge facing neuroscience is to understand how genes, molecules, cells, circuits, and systems interact to generate social behavior. Fruit flies (*Drosophila melanogaster*) offer a powerful model system to address questions of this magnitude, as these animals display genetically specified patterns of fighting behavior. Here, we show that sexually dimorphic behavioral patterns displayed during aggression are controlled by specific subgroups of neurons expressing female isoforms of doublesex proteins (*dsx*). Using the GAL4/UAS system to manipulate *TrpA1* expression, we intersectionally thermo-activated cells specifically in both the R26E01 subset of neurons which express doublesex. By crossing R26E01Gal4/UAS>STOP>TrpA1 female fruit flies with a ET-flp/*Dsx* male fruit fly, the progeny obtained a small subset of cells that contain both the Gal4/UAS system and the Flp Recombinase enzyme. Under control of a UAS promoter, the Flp excises the STOP cassette, allowing expression of *TrpA1* only in those subsets of cells of R26E01 neurons that are doublesex positive. When this genetically modified progeny population is studied under a heated environment of 30 C, only *TrpA1* invoked cells are activated and can be specifically observed as the intersectionality independent variable promoting any behavioral abnormalities, including increased aggression. Given that *Drosophila* often display sex-specific behavioral patterns, aggression was tracked in terms of wing threats and charging, along with head-butts. Such experiment concluded with a confident determination that the intersection of R26E01 neurons expressing *Dsx* selectively enhance aggression in female *Drosophila*.

C5 Correlative Study between DiSC Personality Type and Conformity

Behavioral Science

Annabelle Huffman

Bancroft School

Conformity is a key component to group dynamics. Nowadays, as the nation is split so deeply by politics, it is critical to study how people's opinions form and change based on the people they talk to. This experiment aims to examine a possible correlation between specific DiSC personality types and an individual's likeliness to conform to a small group of their peers. Conformity, in this study, is indicated by a change in the subject's initial opinion. High school students were asked to take the I-Sight Personality Test to determine their personality type, to take the Entry Survey where they indicated their level of agreement to a predetermined statement on a forced-choice scale, and then to participate in a small group session where they were instructed to come to a group consensus about the statement within 10 minutes. Immediately following and two weeks after the group session, they were asked to answer the same survey. The D personality behaved uncharacteristically as some changed their initial opinion. At this time, there is no researched explanation for this result. The i and S personalities behaved as expected initially by conforming to the group; however, instead of reverting back to their initial opinion as expected, they maintained that changed opinion. At this time, it cannot be concluded whether or not the C personality behaved as expected as the majority of their initial opinions matched the group consensus. Therefore, there was no opportunity for them to conform. Phase 2 will consist of the experimental group sessions which will examine the effect on specific personality's likeliness to conform if they are the personality minority. Groups will be formed so that the minority personality has a different opinion than the majority.

C13 Listening to Music with Your Bones

Behavioral Science

Brian Ramos Chavez

East Boston High School

Background: There is a whole separate way we can perceive sound that is not through the air, and many of us haven't even tapped into it yet. Bone conduction allows someone to "hear" sound through the vibration of their jaw and cheek bones of their face. Listening to music through the vibrations of your bones can provide aural perceptions you didn't know you were capable of hearing.

Purpose of research: The goal of this study is to investigate the effectiveness of bone conduction as a supplement to open ear hearing by accessing the ability to hear two musical chords, C major and C minor, at two different piano frequencies, while listening through the air and through an air and bone combination.

Methods: Test subjects listen to a thirty-minute audio recording of C major and C minor divided into two equal sections that separately test open ear air conduction and an open ear air and bone conduction combination. Each section plays both chords at two different piano frequencies, two-octave and six-octave, and at decibel levels of 20 dB, 32 dB and 45 dB. Subjects attempt to correctly identify the chord played during 120 trials of open ear air conduction and 120 trials of the open ear air and bone conduction combination.

Results: Our calculations and results indicate a 99.999% confidence interval between the two modalities. This means that our hypothesis is correct and that over 50 % of the subjects were able to hear C major and C minor more often while listening through the air and bone combination.

Conclusion: It was determined that it is 99.99 % certain that there is a difference between the two modalities and that the combination of open ear air conduction and bone conduction enhances hearing over open ear air conduction alone.

D4 Evaluation and Resolution of Reading Literacy in Rural China

Behavioral Science

Edward Pan

Northfield-Mt. Hermon School

The purpose of this research is to analyze the factors that contributed to the low reading literacy in rural China, based on a school in Anhui province. The term reading literacy can be defined as one's ability to understand texts, which can be influenced by one's reading interest, habits, education, and the accessibility to books. By recognizing reasons that led to the lack of reading literacy, we can invent new, creative solutions or utilize existing methods that have been applicable to the urban Chinese and American education to ameliorate the situation.

F6 Investigating Economic Influence on Homeless Populations in Boston, MA

Behavioral Science

Megan Frisella

Mass. Academy of Math & Science

Homelessness affects more than 550,000 people annually in the US. Boston has the nation's 9th largest homeless population. There is less known about trends associated with youth homelessness compared to general homelessness because data on youth homeless populations in the US was not standardly collected until recently. This study investigates how economic fluctuation, indicated by annual gross domestic product, personal income, unemployment rate, and government expenditure, influences change in the size of subpopulations of the general homeless population in Boston, MA. It was hypothesized that economic downturn is associated with an increase in general and youth homeless populations, regardless of shelter type. Data from public archives was analyzed using SAS University Edition. Linear regression models using scaled economic data showed that the subpopulation of individuals in transitional housing has the strongest economic association, with an R² value of 0.9828 ($p=0.0003$). Correlation analysis showed that this association is negative. Economic association with the number of individuals in emergency shelter is positive. Youth subpopulations have weaker economic associations than general subpopulations. The results indicate that economic fluctuation is associated with change in homeless population size in Boston, MA but has a varying influence depending on the type of shelter. Further research is warranted using additional years of data points to produce more robust results.

F22 The Impact of Induced Social Anxiety on Health and Well Being

Behavioral Science

Teyah Davis, Sophia Bereus, Steve Dillon

Jeremiah E. Burke High School

In last year's science project, our team looked at the body's physiological response to stressful stimuli. Building on this previous research, we decided to explore how our brains respond to situations of stress by monitoring changes in electrical activity in the brain wave patterns. In particular, we tracked Theta, Alpha1 and Beta1 brain waves. While we first attempted to look at stressful situations in terms of social anxiety, we were having trouble getting results given our experiment set up. As a result, we decided to monitor the imposed stress on our body during a quick workout, such as a sprint. We know from our research that Beta waves are characteristics of being alert/working and an engaged mind, Alpha1 waves are activated when we are in a state of physical and mental relaxation while Theta waves are activated when in a state of drowsiness or idealing with reduced consciousness. Brainwaves were monitored using a Brainwave Monitor and the Brain Express App. Our hypothesis was that Beta1 waves would increase during exercise while Alpha1 and Theta waves would decrease. The results from our experiment show a decrease in Beta1 and Theta waves at rest and an increase in Beta1 and Theta waves during exercise.

G2 Comparing the Diets of German Cockroaches (*Blattella germanica*)

Behavioral Science

Feven Seifu

Boston Latin School

Millions of American homes are infested with cockroaches in dark corners like cabinets. Being cautious of the foods available for roaches may help decrease their speed and make them easier to exterminate. It was hypothesized that a high carb to protein diet will increase compared to a low carb to protein diet because sugar sources can be used to produce the energy source, ATP. Each of the two habitats contained 6 Madagascar Hissing Cockroaches in a plastic bin containing broccoli or blueberries and water. The time it takes for the roaches to run through all 6 circle loops in a cardboard maze, guided with a finger if needed, is recorded. The cockroaches that were given only broccoli, a low carb to protein diet, were able to finish their obstacle course faster than the cockroaches given blueberries with a high carb to protein diet. The average difference of speed was 47.71 seconds, but when a T-test was run the p-value was greater than .05 suggesting the difference was due to chance. The null hypothesis, that the ratio of carbohydrate to protein does not affect the speed of the roaches, was accepted. With a larger sample size it is possible that a protein filled diet will significantly increase the speed of cockroaches. Cockroaches use their legs to switch motions: the stronger the muscle fibers the better their maneuvering. With a high source of amino acids they can build leg muscles to absorb energy and stabilize their bodies when they run.

G7 The Law of Attraction

Behavioral Science

Brianna Harley

Edward M. Kennedy Academy for Health Careers

Have you ever started off your day rough, and as the day progress things only turned worst ? This is one of many examples of the Law of Attraction. The main Purpose of conducting a research project on the Law of Attraction is because learning this you can improve and transform your life. By just simply using your mind, you can attract more positive and life-changing opportunities, on the other hand by having this awareness you can use this too also try to persevere through any negative or unpleasant circumstances in your life. Through my research project, I hope my audience will walk away with a new perspective on their own being.

G13 Multitasking: Gain or Drain?

Behavioral Science

Rachel Joseph

Taunton High School

This project is about finding out if multitasking is an efficient way of completing a task or if it mentally draining and inefficient. A lot of people consider multitasking to be a a quick and easy time saving method to get chores, homework, and all their day to day tasks completed, but this might not be true. I hypothesized that if the test subject uses the multitasking method to complete two tasks, then it will be less efficient than doing the tasks separately. To test this hypothesis, a group of thirteen people were each asked to complete and tangram puzzle, then listen to an audiobook excerpt and take a ten question test on it. Then they multitasked, by completing a tangram puzzle while listening to another audiobook excerpt. This process was repeated two more times, and for each person. The total average of all test subject's tangram times and audiobook test scores for multitasking and non multitasking were taken. For the non multitasking section, the average for tangrams was 276 seconds and the average for audiobook tests scores was 8.3/10. For the multitasking section, the average for tangrams was 303 seconds and the average for audiobook test scores was 6.9/10. The tangram scores were faster and the audiobook test scores were higher while non multitasking, making non multitasking the more efficient option.

G22 Where We Live

Behavioral Science

Christine St.Louis-Severe

Edward M. Kennedy Academy for Health Careers

This research project will focus on studying the neighborhoods around Boston. I picked this topic because I wanted to research the causes that impacts the life expectancy and what could be done to change the outcome. I believe that if a person lived in a poorer neighborhood their life expectancy would be low. The neighborhoods I thought had the lowest life expectancy was Roxbury and Mattapan. After very much research, the cities who had the lowest life expectancy was South Boston and Roxbury with the age of 77. I learned about the reasons why the lifespan in Boston can vary from a neighborhood to another.

J13 Memory In A Tech Savvy World

Behavioral Science

Hirni Patel

North Attleboro High School

With many schools turning to chrome books, laptops, and ipads to teach kids, the issue of whether the use of screen to teach is actually helping the kids or harming them. The question is: Does learning on paper versus screen affect how much the children actually retain? The purpose of this experiment is to see whether people remember things better off paper or screen. Based off this information, it can be used to determine whether the switch to the usage of devices, in school, for learning is beneficial to the students or not. The hypothesis was: People will have a higher memory retention of information when reading off paper than off screen because memory is stronger with multiple encodings and since a paper has more topography than a screen, it has a stronger tactile encoding. For this experiment, one needs 2 stories, both about a paragraph long, 1 -2 laptops, 1-2 paper(s), and an answer key. For the first step, write down the gender and age of the participant. Then have the participant read a paragraph, on paper, within 8 minutes. After a minute, have them take a 10 multiple choice quiz, on paper, within 5 minutes. After, record how many answers they got correct out of 10. Then give the participants a 2 minute break. Next, have a participant read a different paragraph on a screen of a device within 8 minutes. After a minute, have them take a 10 multiple choice quiz, on a device within 5 minutes. Then, record how many answers they got correct out of 10. Then, switch the stories around and do the steps all over again with the rest of the participants. In the end, the paper average was 82.8 % recall and the screen average was 87.2% recall. However, in context with the experiment, one can not state screen is better than paper.

K25 The Effects of Mindfulness on Amygdala Volume and Perceived Stress

Behavioral Science

Renny Gong

Belmont Hill School

The literature suggests that, in adults, mindfulness based stress-reduction is associated with right amygdala volume decrease (Hölzel et al., 2010). Studies also show a positive correlation between right amygdala volume and higher reported stress (Murakami et al., 2012). However, these studies focus only on adults and there is still a lack of insight with regards to studies in adolescents. To address this gap, 40 middle-school students (12 male and 28 female) were randomized to either a mindfulness or a coding training (i.e., active control) intervention for eight weeks during part of the school day. Outcome measures were ratings of perceived stress using the Perceived Stress Scale and right amygdala—a brain region associated with stress and emotion processes—volume using magnetic resonance imaging. We hypothesize (1) significant correlations between right amygdala volume and adolescent perceived stress at baseline and (2) reduced right amygdala volume and perceived stress in the mindfulness group after the intervention compared to the control group. If we find decreased amygdala volume in correlation with perceived stress in middle school children after 8-weeks of mindfulness training, we will use the results to propose implications regarding the effects of mindfulness meditation on right amygdala structure.

P3 Effect of Music Exposures on High School Student Cognitive Performance

Behavioral Science

Matthew Cole

Newton South High School

Americans now spend, on average, slightly more than 32 hours a week listening to music, and teenagers frequently listen to music while completing homework and other school-related tasks. The purpose of this study is to investigate the effects of classical, jazz, rock, pop, and rap background music on high school students' cognition. Students (n=60) were given standardized reading comprehension and math tests while being exposed to a specific genre of music versus no music as a control. Students also completed a questionnaire seeking to determine their musical preferences, study habits, musical training, and academic classification. The test was given within a time-pressured scenario and outcomes looked at test scoring (% correct) as well as speed of cognition. The average test score for all participants in the study was 65.9%. As anticipated, students were found to score best under conditions without music (\bar{x} =75.5%) and worst in the setting of rap music (\bar{x} =52.5%) with all other genres also negatively impacting their performance. Of note, girls scored, on average, higher than boys (72.7% vs. 68.7%) and boys and girls both overwhelmingly preferred listening to music while studying (80.0%/81.8%). Interestingly, students who preferred to study without music scored significantly better than all other students in the no music exposure group. I conclude that listening to music decreases cognition in high school students regardless of musical genre. As over 80% of students evaluated listen to music while studying, my research suggests that such practices are unlikely to be beneficial for cognitive functions and may, in fact, hinder cognition.

Biochemistry

Biochemistry

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- A16 IFN γ Susceptibility in Chordoma
- B4 Artificial Pancreas: Making Lives Easier
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A5 Electrospun Polymer Materials for Endothelialization on Stent Grafts

Biochemistry

Megan Christy

St. Mark's School

Abdominal aortic aneurysm (AAA) is a type of heart disease that alters the path of blood flow in the aorta and can lead to rupture, which is extremely fatal. The two current treatment options for AAA are flawed. Open chest surgery to remove the aneurysm is a permanent solution but is risky and extremely invasive. Endovascular aneurysm repair (EVAR) is the less invasive solution where a stent graft blocks blood flow into the aneurysm to prevent aneurysm expansion and rupture. The stent graft is only temporary and still leaves the possibility of rupture due to problems such as movement or endoleaks. The present research investigated ways to make EVAR a permanent solution to AAA through the use of a biodegradable, regenerative stent graft. The first step towards this goal was to assess the regenerative properties of materials for their potential use in this stent graft. Human fibroblasts were used as a model to test cell growth, as they are the foundation of wound healing. Cells were seeded onto electrospun PCL, and FGF was incorporated to an experimental material via emulsion electrospinning. Using an Alamar Blue cell viability assay, measurements of fluorescence of each material and control were taken at regular intervals to observe change in cell number across time. Each material condition had significantly higher fluorescence readings than each control condition, indicating that the presence of a material increases the cells' ability to survive, adhere, and proliferate. However, there were no statistically significant differences between each material condition, suggesting PCL with FGF has no advantage over PCL for applications as a biodegradable, regenerative stent graft. Due to high variability in the data, further experimentation is necessary to confirm results.

A16 IFN γ Susceptibility in Chordoma

Biochemistry

Ananthan Sadagopan

Westborough High School

Purpose: Chordomas are rare spinal neoplasms uniquely characterized by their high expression of the transcription factor brachyury. Recently, defects in endogenous antigen presentation, a well-known tumor immune evasion mechanism undermining the efficacy of immune checkpoint inhibition, has been reported in solid tumors. The purpose of this study is to utilize the tumor suppressive cytokine gamma-interferon (IFN γ) to upregulate these components rendering cells susceptible to checkpoint blockade.

Procedure: The expression of human leukocyte antigens (HLA) and HLA class I antigen processing machinery (APM) components, proteins critical to endogenous antigen presentation, were monitored via intracellular flow cytometry in IFN γ treated cells. Resistance mechanisms were delineated through genomics analysis and Western blotting.

Results: Upregulation of HLA class I APM components follows high-dose IFN γ treatment (250 IU/mL, 1000 IU/mL) in chordoma cell lines CH22, MUG-CC1, MUG-Chor1, and U-CH1. However, both CH22 and MUG-CC1 possess IFN γ resistance at lower doses (50 IU/mL). Further investigation reveals that defects in the IFN γ signal transducer Janus kinase 1 (JAK1) confers this resistance. Genomics analysis and in-vitro work corroborate that these defects arise as a result of aberrant brachyury upregulation.

Conclusion: Several factors contribute to chordoma pathogenesis and limit the efficacy of immune checkpoint blockade. This exploratory investigation established that brachyury-mediated JAK1 downregulation conferring low-dose IFN γ resistance may play a role.

B4 Artificial Pancreas: Making Lives Easier

Biochemistry

Shakaani Nasankar

Pioneer Charter School of Science II

Insulin cannot be produced to normalize glucose levels by patients with type one diabetes and shots were taken to insert insulin in the body. A life or death situation could be proposed for these patients by having high blood sugar. A device known as the Artificial Pancreas was released for type one diabetic patients in 2016 by the FDA. Normalizing glucose levels were immediately done by the Artificial Pancreas. The device was easily hackable and was prone to hurting patient was conveyed by a report by Johnson and Johnson The multi-thousand dollar device created by biomedical engineers known as the Artificial Pancreas was explored by this engineering project. Creating a simpler version of the Artificial Pancreas and developing a solution that made sure that the pancreas would not add insulin in the body when there is low blood sugar was something that was accomplished from this project. Moreover, the identification of how responsive and effective the device was was conducted from this experiment. A solution in finding a way to prevent other outsiders from hacking the device was formed by this pump. From this experiment, it was concluded that the device was responsive and one could personalize the device by changing the glucose level during the process of normalization (first step). This product is important to society as the number of people facing type one diabetes is increasing and finding an easier and functioning device will reduce the work that a patient has to do every day.

B17 Let's Yeet This Wheat: Removing Gluten from Fryer Oil

Biochemistry

Alisa Stolyar, Alannah Miller

Hopkinton High School

Gluten is a protein of which different forms are found in wheat, rye, barley, and possibly oats. Four percent of all people have been diagnosed with a wheat allergy and one percent of the world population suffers from celiac disease, an autoimmune disease that causes the body to reject gluten. There is no cure or official treatment for celiac disease besides adhering to a strict gluten-free diet. Not following this diet may cause harm to the gastrointestinal tract, as well as increased risk for fertility complications and possibly death if gone completely ignored. Restaurants currently do not have a procedure for frying gluten-free foods without designating a separate fryer to those menu items or replacing oil every time a gluten-free order needs to be made. These processes are time and space consuming which makes them impractical for many restaurants. A strainer with uniform pores of 150 microns can be used to strain gluten out of contaminated oil so it registers below the FDA-approved 20 parts per million (ppm) threshold. A fryer basket made out of metal with 150-micron mesh and a rim that surpasses the surface level of the oil would allow for restaurants to fry gluten-free food in contaminated oil, as the gluten content inside the basket would register under 20ppm. This basket would only be used for gluten-free orders to decrease the risk of cross-contamination.

B18 Designing a Thyroid Hormone Detection System

Biochemistry

Eshan Sane, Anoop Patta, Krish Nathan

Westborough High School

This project will help individuals who suffer from chronic thyroid disease such as hypothyroidism by making it easy to check one's thyroid hormone levels in the comforts of home. Thyroid disease affects twenty million Americans and hypothyroidism, the most common form, occurs when not enough thyroid hormone is produced in the body. Consequently, deficient levels of thyroid hormone lead to symptoms such as constant tiredness, hair loss, and a host of other issues related to metabolism. Although there exist thyroid hormone tests which can be accessed at the doctor's office, they are time consuming, costly, and inconvenient to access. As a result, many individuals with hypothyroidism don't get hormone levels checked frequently enough, which causes the disease to progress and worsen. Early and frequent screening will help reduce cases of hypothyroidism, but there is no convenient way to do this. This project aims to create such a system which will help individuals with thyroid issues receive adequate treatment through frequent and cheap monitoring of their hormone levels in the comfort of their own homes.

C1 HeLa and NIH/3T3 Activity on Plastic Tissue Culture and PDMS Substrate

Biochemistry

Sreeanvitha Emani

Shrewsbury High School

Organ transplant is one of the most heavily explored fields of medicine. Medical workers are always trying to find a way to higher the rate of success. A current problem is that the plastic tissue cultures utilized do not represent the environment of the body, so cells cannot acclimate to the environment when they are transplanted. In this experiment, HeLa and NIH/3T3 cells were surfaced on Corning and Falcon® polystyrene cell culture vessel, as well as on polydimethylsiloxane substrates of varying stiffnesses. From this, it was found that the cells on the regular vessel are weak because they are confluent and are growing on top of one another. However, on the PDMS substrates, the cells were spread out and had not reached confluency. Furthermore, the cells that were treated with Trypsin-EDTA were better able to attach themselves to the environment. Beta Tubulin, a cytoskeletal protein, was analyzed to see where it was larger, and it was found to be the largest in the 50:1 PDMS substrate because the cells were most acclimated to that environment. The results of this experiment can serve to be very impactful to the medical field, and be of great relief to organ transplant patients and surgeons alike. This information is useful because it argues against the currently used plastic tissue culture vessels and suggests an alternative. It allows the public to realize that cells on the standard culture vessels tend to die before they even reach the body. It informs that a 50:1 PDMS substrate is ideal for cells to replicate without confluency in the substrate, and also to replicate that action once they have entered the body. In addition, the general public can learn that many organ transplant failures are not caused by human error, but by error of material to surface cells in.

C3 Reef Safe SPF 30 Sunscreens

Biochemistry

Cloey Parlapiano

Taconic High School

This project is about reef safe sunscreens, how effective they are compared to a normal sunscreen in protecting from ultraviolet rays and how they affect living organisms. Reef safe sunscreens may be able to protect marine life from the harmful effects that are caused by normal sunscreens. This project was done to either prove or disprove the effectiveness of selective sunscreens. The initial idea was that all of the reef safe sunscreens would be better for the environment than the normal sunscreen, and that the normal sunscreen would give better uv protection. For this experiment, two tests were done. The first test was to test the protection that the sunscreens provide, using uv beads, which change color in sunlight. Before starting the testng, the percent active ingredient must first be found. The other test involved using a spectrophotometer to see the change in density that would happen to a population of phytoplankton. Before starting the testing, the stock solutions with 1.25 plus or minus .02 grams of sunscreen had to be made. From there, the stock solutions were split into 50%, 25%, and 12.5%. After this was done, the densities could be found.

The results supported that the hypothesis was correct. The regular sunscreen had the highest percent coverage after the three trials were averaged. The reef safe overall were safer for the marine life that the regular sunscreen. This project has proved that reef safe sunscreens are better for the environment than normal sunscreens. This has also shown that certain ingredients are better for the environment than others.

F3 Engineering a Hybridized Pentameric HIV-1 Antibody

Biochemistry

Katerina Krstanovic

Matignon High School

A model of an HIV-1 antibody, which contained the variable regions of a mouse, the constant regions of a human, and CD4 binding sites, was tested using online simulation apps. The antibody is designed to compete with CD4-positive cells for HIV in order to lure the virus and chemically combine with gp120, a glycoprotein on the envelope of HIV which plays a critical role in the virus' spread. The experiment tested the immunogenicity and the efficiency of the pentameric chimeric antibody using the tools AbDesigner and EpiPred respectively. Using AbDesigner, the antibody was shown to perform well. The peptide chains of the antibody model demonstrated high levels of immunogenicity near the binding sites of the antibody. This suggests that the antibody will be able to interact positively with the epitope on HIV's envelope. Additionally, EpiPred generated the three epitopes that were most likely to interact with the antibody. The tool revealed that gp120, the epitope in question, was ranked as the second most likely epitope to bind to the CD4 binding sites of the pentamer. The results of the experiment reveal that the antibody model that was proposed will probably be relatively efficient at neutralizing the virus particles. While AbDesigner showed that certain areas of the antibody have low levels of immunogenicity, the binding sites are demonstrated to be more reactive in the immune system. The model supports the experimental hypothesis and even shows a possibility of interacting with various other epitopes, making the antibody a potential candidate for curing multiple diseases. The antibody would likely, if constructed, be a promising cure for HIV.

F10 Spectroanalyzing Commonly Used Bottled Water

Biochemistry

Jillian Taylor

Upper Cape Cod Vocational Technical High School

The purpose of this experiment was to investigate an important issue, as the results of the experiment will help individuals better understand what exactly is in their drinking water. The results of an investigation will help increase the knowledge of individuals and perhaps influence future decisions. Oftentimes, bottled water is just tap water. But this water may be safer than the bottled water that is not. This is because the EPA regulates tap water and requires different limits than the FDA. Essentially, the EPA's MCL for municipal water are, in some cases, different than the FDA's for bottled drinking water. This means that one might buy bottled water that is acceptable to the FDA but is not acceptable for use as ordinary tap water.

The hypothesis created states that the number of inorganics detected in all types of bottled water will meet the FDA's safe drinking water standards, but will not meet the EPA's safe drinking water standards. The data gathered from this experiment can help society better understand what is in the water they are drinking.

The experiment was conducted over a series of three weeks, in which nine brands of bottled water were tested for five parameters using a spectrophotometer and test strips. The nine brands chosen were: Aquafina, Dasani, Poland Spring, Évian, Fiji, Nestlé Pure Life, Life Water, Glaceau Smartwater, and Crystal Geyser, with the control being Distilled water. The five parameters tested for were: fluoride, total chlorine, nitrate, copper and cyanide. After the testing was completed, the results from both methods were compared to the FDA and EPA MCLs. Based on the data collected from both testing methods, the results did not exceed the limits set by the FDA and EPA for all five parameters.

F25 Testing Methods of Lipid Extraction from Microalgae

Biochemistry

Silvia Toncelli

Bishop Feehan High School

The purpose of this experiment and research was to find out which method of lipid extraction produced the most lipids. This research was based on the experiments of Martin Axelsson and Francesco Gentili, who experimented with different methods of lipid extraction from microalgae. They found that when different chemical solutions were applied to chlorella algae the chemicals reacted with the cell membranes of the algal cells and produced lipids. The two of the ratios of chloroform and methanol used in the reactions in this experiment were derived from this research. Therefore, the hypothesis for this experiment was derived from this research, because when two solutions, the Folch method and the Bligh and Dyer method, were compared to each other, the Folch method produced more lipids from chlorella algae. To perform this experiment the algae cultures were subjected to a 3 week growing period under a white light. Then half of the algae cultures were subjected to the Folch method solution and the other half were subjected to the Bligh and Dyer method solution. When the lipids were extracted from the algae, they were measured in ml. The expected outcome of the experiment was that the Folch method would be successful and the Bligh and Dyer method would not produce results. The Bligh and Dyer method did in the end produce results but significantly less lipids were extracted when compared to the Folch method. In conclusion, the hypothesis of the experiment was supported by the results when the Folch method cultures produced 10, 13, and 15 ml of biofuel and the Bligh and Dyer method produced 5, 6, and 7 ml of biofuel.

G4 Antimicrobial Affect of Silver

Biochemistry

Jenna Miller

Shepherd Hill Regional High School

Using Silver nitrate, I decided to test the antimicrobial affect of silver. On E. coli K-12. There is a numerous amount of metals known for there antimicrobial properties, silver being one of them. Silver is difficult to get a hold of and to work with so silver nitrate was the obvious solution to test its effect on bacteria. Most public schools have door handles made of silver and door handles are known to be the most dirtiest and germ infested thing in the whole school. I decided to test that theory and got unsurprising results being that silver does has a negative affect on bacteria. To get a more enhanced silver effect, I boiled it and added hydroxycitric acid. The effect was a lot greater. Out of curiosity, I also decided to test antibacterial soap which also had a great effect on the bacteria.

G5 The Efficacy of Gefitinib in Lung Cancer Causing EGFR Mutations

Biochemistry

Neha Perumal

Mass. Academy of Math & Science

Epidermal growth factor receptor (EGFR) mutations cause 70% of non-small cell lung cancer in non-smokers. The most common treatment, a tyrosine kinase inhibitor (TKI) called gefitinib, is suspected to vary in binding affinity, and therefore efficacy, for different mutants. This project investigated gefitinib's affinity for common EGFR mutants. First, the EGFR structure was obtained from the PDB. Five mutants were made in PyMOL, Rosetta, and Chimera, then docked with gefitinib in AutoDock. Binding affinity was first predicted from the RMSD of the mutant/WT. Then, binding affinity was calculated in the CSM-lig server. The RMSD values of the mutants from the WT were heavily varied (range = 0.656), suggesting that gefitinib is not a universal treatment. Furthermore, the exon 19 deletion mutant indicated the highest affinity for gefitinib ($K_d=1.300\text{nM}$), while the exon 20 insertion showed the least ($K_d=240.2\text{nM}$); this correlates with clinical trial data that predicts gefitinib to be specifically targeted to exon 19 deletions. This research presents the need for personalized medicine to treat different NSCLC-causing EGFR mutants. In line with this, several existing, FDA approved TKIs were screened with the exon 20 insertion, and afatinib demonstrated the highest affinity ($K_d=5.200\text{nM}$) for this mutant. This drug possesses comparable binding constant values to gefitinib and the exon 19 deletion mutant, but further drug development is currently being done to obtain higher potencies. In vitro testing is also being done to confirm the computational predictions of this project.

G9 Shining a Light on Phototherapy: Using Blue Light to Stop Infection

Biochemistry

Emma McSweeney, Juliana Rush

Stoughton High School

In this project, research was conducted to experimentally compare the bacteria killing effects of HEV blue light and various topical ointments versus white light. It was hypothesized that if one tests the sensitivity of the bacteria *Escherichia coli* to blue light, acne cream, and combinations of the resistors, then a combination of blue light and topical ointment will reduce the growth of bacteria the most. This is because blue light has greater bacteria killing properties than white light, due to its deep penetration into the skin's surface. In combination with antibiotic creams, it was predicted that blue light would have the greatest potency in the bacteria *E. coli*. This hypothesis was tested by placing various disks with either benzoyl peroxide, neosporin, or nothing in petri dishes with agar and bacteria, and allowing it to grow for twenty-four hours under blue light and white light to see which combination of light therapy and topical cream worked the best to prevent the spread the *E. coli*; the zone of inhibitions or areas where the bacteria did not spread could be compared for each product and light. The results of the experiment proved the hypothesis to be true, because the disks of benzoyl peroxide and neosporin placed under the blue light were able to kill a greater amount of bacteria around it, creating a larger zone of inhibition than the white light. Additionally, the experiment proved that blue light has potential bacteria-killing properties, because the controlled disk created a larger zone of inhibition under the blue light than under the white light.

G23 Bioplastic from Banana Peels

Biochemistry

Izabel Paiva, Ellie Sullivan

Bishop Stang High School

Plastic offers a variety of benefits and is a price competitive with other materials that offer similar advantages in industrial applications. Plastic is lightweight, strong, flexible in size and shape, and is a cheaper price. However, the mass use of plastic leads to harmful effects. Plastic takes an estimated 500 years to degrade and becomes toxic after it is decomposed. Plastic negatively affects lands waterways and oceans, as well as a disruption in the human thyroid hormone axis or hormone levels. "Biodegradable plastic is plastic that decomposes naturally in the environment. This occurs when microorganisms in the environment metabolize, and breakdown the structure of biodegradable plastic. In return, the end result is less harmful to the environment" (Biodegradable Plastics, 2015). The objective of this project is to produce biodegradable plastic from banana peels as a substitute for conventional plastic. This would prove that the starch in the banana peel could be used for the production of bioplastic. The strength of the experiment was determined by placing lab weights on the stretched plastic. Based on our testing, we determined that the biodegradable film could be used in the plastic industry, for molding and packaging. In return, the harm to the environment from synthetic plastics could be reduced.

H4 Impact of ApoE on IGF-1 Signaling in Alzheimer's Disease

Biochemistry

Haley Dion

St. Mark's School

Alzheimer's Disease (AD) is a devastating neurodegenerative disease that currently has no cure. There are multiple risk factors for AD including resistance to insulin/insulin-like growth factor 1 (IN/IGF-1) signaling and the apolipoprotein E (ApoE) variant ApoE4. Research has shown that ApoE binds to the IN/IGF-1 receptor and that ApoE4 may trap the IN/IGF-1 receptors in the endosomes after internalization. This research investigation on fibroblasts that model human cells from AD patients and healthy controls, measured if there is a mechanistic interaction between ApoE and endosomes through IGF-1 receptor numbers, colocalization, and intracellular localization of endosomes and IGF-1 receptors. Skin fibroblast cells transfected with plasmids expressing the human ApoE2,-3,-4 variants as well as treated with and without starvation and IGF-1 were stained with antibodies against IGF-1 receptors and Transferrin (TF, CD71) receptors using immunocytochemistry. Images were taken in immunofluorescence microscopy and analyzed using CellProfiler Software. The following parameters were determined: IGF-1R/TFR positive speckle numbers and sizes, and marker colocalization. Following experimentation and data collection, preliminary results from this study suggest but do not confirm, that there are different effects of ApoE variants on IGF-1R numbers, potential association with CD71-positive endosomes, and intracellular localization in response to starvation-induced cell stress and IGF-1 activation. Further research is needed to verify the suggested results.

H9 A Pill's Pathway

Biochemistry

Abida Husain

Foxborough Regional Charter School

In today's world many people take medication everyday, in many different forms: liquid, pills, through Iv, and much more. The purpose of the lab is to test the solubility of a commonly used drug, used to reduce fever and pain: acetaminophen. In the lab we will be testing the difference in solubility of the pills based on their coatings; gel coating versus compressed coating in different locations in the body. The solutions in which the two pills were placed in were lemon juice and water, these two solutions were chosen because they represent the two main locations within the GI tract. It is in these two locations in which food will be decomposed into nutrients for the body, most of the medications we take will also go through a similar process. Lemon juice has a pH of about 2 which is the pH of the stomach and the water has a pH of 7 which is the pH of the small intestine. The pH of both solutions impacts how fast the pill's coating/outer shell breaks down. The time it took for the pill's coating to break apart was recorded and analyzed in the lab. In the end the gel coated pill took longer to dissolve in both solutions in comparison to the coated pill. After analyzing the data and looking through the research completed it can be noted that the gel pill is more effective because after passing through the harsh conditions of the stomach the integrity of the pill has remained. Since the pill hasn't completely fallen apart after going through the stomach, it will completely fall part in the small intestine upon its arrival. The coated pill ends up falling apart completely in the stomach and will pass straight through the stomach, rendering the pill almost useless.

H22 The Effects of Silver Nanoparticles on Drug Resistant Bacteria

Biochemistry

California Muratore

Taunton High School

In today's medically advanced world, antibiotics are overused by those looking to cure even the most minor ailments. Because they are mistreated, over 70% of all bacteria are resistant to at least one antibiotic. Many scientists are searching for cures. One of the possible cures is nanoparticles. In this experiment, silver nanoparticles and antibiotics will be used to treat drug-resistant bacteria to see if it stops bacterial growth and kills the microbes. If silver nanoparticles, coupled with antibiotics, are applied to drug-resistant bacteria then the bacteria will have a low percentile growth and the bacteria will be killed off. To test this, silver nanoparticles were made using glucose solutions and mixed with the antibiotic ampicillin. There were other mixtures used to test the effects of just nanoparticles and just antibiotics. Each mixture was applied to three Petri dishes covered in ampicillin-resistant bacteria. After three days of incubation and observation, the Petri dish AN3, which feature both antibiotics and silver nanoparticles, had the smallest percentile growth of bacteria with 2.16%. The Petri dish labeled N3 which featured solely bacteria had the largest overall growth rate at 94.44%. The Petri dishes that just featured nanoparticles also had a low growth rate with an average percentile growth of 4.47%. Based on the results shown in the experiment it can be concluded that silver nanoparticles significantly decrease the development of bacteria. Silver nanoparticles can be introduced into the pharmaceutical industry to help fight drug-resistant bacteria and stop the need for excessive amounts of antibiotics, ending the cycle which promotes nosocomial diseases.

J3 Vitamins and Their Effectiveness as Antioxidants

Biochemistry

Mairead Baker

Boston Latin Academy

This project was created in an effort to test how water-soluble antioxidants differ from fat-soluble antioxidants in limiting oxidative stress, a harmful process that occurs in environments when there is an imbalance between free radicals and antioxidants. It was also created to address clinical research regarding diseases such as cancer, cardiovascular disease, diabetes, Parkinson's, Alzheimer's, and macular degeneration, which all progress with oxidative stress. Apples were used to mimic human cells as they undergo oxidation in the chemical equation: $2O_2 + 4PPO \rightarrow 3C_6H_4O_2 + 2H_2O$, where a brown pigment, melanin, is produced, a byproduct of oxidation.

Five cups were each filled with 250 mL of water, and 500 mg of each vitamin was inserted into each cup. 1 Red Delicious apple was divided into 8 parts, and 1 slice was placed into each cup. Observations were taken every 12-24 hours. After 72 hours, their level of oxidation was tested using a computer program called Adobe Photoshop CS5, which measures the color of a image (pictures were taken of the apples in a shoebox, limiting ambient light) using histograms and RGB analysis (colorimetry).

This project can be used to show which antioxidants can limit these conditions when ingested as supplements. There are aqueous regions of the body (such as the brain or cytosol in cells) in which fat-soluble vitamins cannot prevent oxidative stress. This project demonstrates that water-soluble antioxidants prevent oxidative stress in aqueous environments, showing why humans need to intake water-soluble vitamins to prevent oxidative stress in aqueous regions of the body.

K2 RNA-based Early Detection Method for Prostate Cancer Using Nanotech

Biochemistry

Daisy Wang

Boston Latin School

Purpose: Prostate cancer is the second leading cause of death by cancer among men in the U.S, mainly due to late diagnosis. The current detection method based on blood protein prostate-specific antigen (PSA) suffers from low specificity, low sensitivity, and poor patient compliance. The goal of this study was to combine nanotechnology and biotechnology to develop a fast, non-invasive, and sensitive method for the early detection of prostate cancer.

Method: This project uses a biomarker of prostate cancer antigen (PCA3) RNA for its high specificity (about 95%), and Surface Enhanced Raman Spectroscopy (SERS) is employed for its ultra-sensitive biomolecular detection. Silver nanoparticles are selected to enhance the Raman effect and the mixtures of PCA3 RNA solution and silver nanoparticle were applied onto silicon wafers. The Raman spectrum was obtained with a Horiba Raman Spectrometer with Confocal Raman Microscope.

Results: The SERS method was optimized by exploring different Ag nanoparticle size and sample concentration. The sensitivity for PCA3 was found to be ~ 0.2 fg/mL, which is about 6 orders of magnitude (one million times) higher than the current PSA-based method.

Conclusion: The SERS method developed is non-invasive and highly sensitive, thus showing promise for the early detection of prostate cancer.

K5 Saving the Environment One Utensil at a Time

Biochemistry

Gianna Arace

Taconic High School

Many people don't realize that humans produce a large amount of garbage. Polystyrene (plastic) utensils are a major problem for the environment. Plastic utensils accumulate in landfills and take hundreds of thousands of years to biodegrade while releasing harmful toxins that are bad for the environment. The goal of this project was to see what kind of biodegradable plastic would biodegrade increasingly the best by 3D printing strips of biodegradable plastics and testing them in soil. The hypothesis for this project was, if the algae/Polylactic acid (PLA) filament (plastic) was put in moist soil then it would biodegrade more than the other plastics.

The test began by printing small strips of each plastic thin enough so the biodegradation would be measurable in such a short time. Then, each of the strips were put in a jar of soil and sat for three weeks. The types of filament used for this project were PLA, algae/PLA, PLA/Polyhydroxyalkanoates (PHA). Also, a homemade strip of a dough was tested to represent edible spoons that can be used. Surprisingly, the algae/PLA filament biodegraded the least. The dough strip biodegraded the best because the nutrients in the soil broke the strip down. The PLA/PHA biodegraded the second best because the PHA in the plastic is produced from microorganisms which was broken down by the nutrients in the soil.

Overall, this project proved that biodegradable plastics break down faster than the time it would take for regular plastics to break down. If biodegradable utensils are used, then the amount of toxins such as Bisphenol A (BPA) would be reduced. The objectives of this project were met because the PLA/PHA plastic biodegraded the most out of all of the plastics but the dough strip biodegraded the most out of the materials tested.

K12 Harvesting Energy from Photosynthesis-Related Bacteria

Biochemistry

Emily Pike

Bourne High School

With energy crises all over our planet caused by the dangerous amounts of harmful gasses in the atmosphere, we are in desperate need of new energy sources. The future of our energy consumption lies in the decisions we make for our planet now. By using plants as our newest source of energy, we can generate voltage while simultaneously producing oxygen and clearing our air.

During photosynthesis many electrons are emitted through electrolysis. By harnessing these electrons and collecting them for applicable energy, we can make not only an environmentally friendly energy source, but an environmentally beneficial energy source.

The environment in which a plant grows in can determine a lot about its processes and functions, as a plant will react differently in different environments. By altering the bacteria present in a plants habitat, we are able to manipulate the intracellular energy production of the plants and increase the overall voltage output.

N22 Which is the Most Effective Sunscreen?

Biochemistry

Nidhi Kumar

Upper Cape Cod Vocational Technical High School

Sunscreen is an everyday item that many seem to overlook. Its properties allow it to protect those who use it from harmful UV rays emitted from the sun. It is known that UV light is necessary for the body to produce Vitamin D, which is necessary for the body to function normally. This experiment is done by setting out a few handfuls of UV light reacting beads in the sun and later coating the beads with sunscreen. The same experiment is done with a UV flashlight to create a control environment. This tests the reactivity of the beads when exposed to UV lights, determining effectiveness of the sunscreen. From the experiment it is determined that SPF 100 sunscreen was the most effective in protecting the beads from UV light, when exposed to the sun. However, when exposing the beads to the UV flashlight SPF 70 proved to be more effective. This was not something expected, and could be due to many factors, but with as many variables controlled, 70 SPF worked better against direct UV light, while 100 SPF worked better against natural UV light.

N24 Can You Go "All Natural" With Antibiotics?

Biochemistry

Tess Billo

Stoughton High School

Some household items such as garlic are known to have antibacterial properties. My research in "Can You Go 'All Natural' With Antibiotics Part 2" explores the ability of garlic to kill E. coli based on the concentration of the enzyme allicin within the garlic. It was hypothesized that if E. coli is exposed to a higher concentration of allicin while growing, then it will inhibit the growth of the E. coli more effectively than lower concentrations, because of its antimicrobial properties.

When bacteria is cultured, the clear area without bacteria surrounding the added substance added is known as the zone of inhibition. By diluting garlic juice to different levels, along with testing the effectiveness of garlic extract on E. coli, the effects of allicin in garlic juice can be determined by comparing the zones of inhibition. After conducting my experiment, it can be concluded that there is a positive correlation between the amount of garlic juice and effectiveness at preventing further E. coli growth, as the more concentrated garlic juice created a larger zone of inhibition.

Earth & Space Science

Earth & Space Science

A6 A Theory for Ring Formation Around Asteroid Chariklo

B1 Wood Ash in Fire Prevention

C22 An Algorithm to Uncover Exoplanets Using Stellar Spectral Properties

A6 A Theory for Ring Formation Around Asteroid Chariklo

Earth & Space Science

Dongyup Kim

Deerfield Academy

Asteroid Chariklo is unique in that it was the first asteroid found with rings. These rings, at radii of 395km and 405km respectively, have been a source of mystery due to their unclear origins. This research was aimed at validating a possible ring formation mechanism. The hypothesis was that Chariklo experienced collision with another object in space, giving it an angular velocity. This, in turn, sent off particles of rock on the surface with a tangential direction. With this initial velocity along with the inverse-square law acting on the particles, the particles would have launched into elliptical orbit only to return to the surface without forming a ring. However, if particle pairs collide with each other midair while obeying the conservation of momentum, this may result in ring formation. Particles of rocks on the surface, by having different initial points of departure, can intersect at the height of the rings. The velocities at that intersection, along with the conservation of momentum, determine the final trajectories post-collision. The mass ratios between the two particles as well as the elasticity of the collision enables one particle to go into a circular orbit around Chariklo. Simulations showed that all orbits that physically intersected with the rings were shown to have appropriate conditions for ring formation with a variety of angular velocities. This is an extremely flexible theory, because this means that as long as the initial angular velocity of Chariklo is in a wide range of velocities, ring formation is possible.

B1 Wood Ash in Fire Prevention

Earth & Space Science

Olivia McElhinney

Matignon High School

The point of my experiment is to find new ways that could better prevent cases of fire. I wanted to find out what could possibly work to better aid people in preventing fires. Fires are a widespread epidemic that a lot of people have to face. It takes lives, people's prized possessions, and it costs them a lot of money in damages. Firefighters are people who hold jobs who are called to help put out the fires. Fire extinguishers are used to put out fires, and even with little ones, buckets of water can be used. But what if there could be less fires and more prevention methods? I tried to figure this out and I did. Through research, I found out that fire can be prevented through wood ash. Wood ash is the tiny remnants leftover from fireplaces leading this prevention method to be extremely ironic. The wood ash can be placed inside paint and used on furniture items, moldings, and walls and this is said to help prevent fire. I tested this out by painting twenty pieces of drywood and leaving ten pieces unpainted. Ten of the painted pieces that also was inclusive to wood ash. Letting them dry overnight, I lit them on fire with a lighter and recorded down my results. Wood ash, this tiny, insignificant thing, actually has so many uses and so many purposes. It can be used in gardening, helping people, preventing pollution and dangers by snow salt. What we think of as the leftovers is actually something so much bigger and you can actually connect this to life. The little things that you don't think matter, you will someday realize that they were the big things. This being the wood ash, which if used properly, has the potential to save lives, homes, and a whole lot of debt.

C22 An Algorithm to Uncover Exoplanets Using Stellar Spectral Properties

Earth & Space Science

Garima Prabhakar

Shrewsbury High School

The search to uncover exoplanets is one of the fastest expanding fields in astrophysics, allowing for the discovery of thousands of exoplanets in only a couple of decades, and revolutionizing the generic outlook on planetary system physics and habitability. However, many times exoplanetary detection is hampered by poor observation conditions and stellar noise, which prevent exoplanets from being easily characterized and rechecked without experimental bias. This project attempts to look at this problem in a new light. A new methodology to perform noise-reduction analyses on exoplanet data is developed, by focusing on signal orbital parameter patterns instead of signal variance in the data. First, an algorithm is developed to extract important orbital parameter data from signals in time-series data. Then, an analysis is performed to assess the correlations and differences between parameters for noise and exoplanets. Lastly, a new noise-reduction model is developed to more efficiently and accurately filter noise from exoplanet data. The results indicate that the novel model almost always outperforms the control, with an accuracy of 97.53%. The standard deviation of the developed model is also considerably less than the control. This model may help to uncover previously undetected planets, and provide an accurate and efficient method to confirm existing exoplanets.

Environmental Science

Environmental Science

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- B16 Determining Effectiveness of Water Filtration Methods Using *D. magna*
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A7 Carbon Dioxide Capture Using Polyethylenimine Infused Silica Gel

Environmental Science

Aiman Najah

Pioneer Charter School of Science II

Carbon dioxide levels today are higher than at any point in at least the past 800,000 years (noaa.gov). CO₂ is the largest contributor due to its high content in the atmosphere contributing to 60% of global warming effects, with 39% of total emissions released from electricity generation, 23% from transport and 22% from industry (Mardiana A). While there are advantages to carbon capturing method, such as scalability, there are also several drawbacks to using liquid based amines. Unlike polyethyleneimine, Monoethanolamine requires constant regulation of CO₂ solvent to avoid evaporation and is often incredibly corrosive. To introduce a new and effective measure, it is hypothesized that polyethylenimine-infused silica will yield higher CO₂ uptake values compared to experimental liquid amine values and standard SG as an absorption agent.

As a result of the experimentation, there was a clear positive trend and increase between the uptake rate of CO₂ as well as the amount of absorbent added. SG-PEI had higher rates of CO₂ uptake, especially at the highest weight of 20 g at time 0 and thus absorbed the most CO₂. As for the pH, it started off at relatively similar values for all trails. This is due to the fact that no CO₂ had leaked into the water, thus turning it acidic. SG-PEI also maintained the highest pH, closest to the initial value and that of water, indicating its safe measure and efficiency in absorbing CO₂. Thus, Polyethyleneimine is an applicable means of CO₂ absorption for real world applications compared to MEA.

B16 Determining Effectiveness of Water Filtration Methods Using D. magna

Environmental Science

Tyler Gaffney

Somerville High School

What is the most effective way to purify water so it is safe to drink? This is the question I aimed to answer through the completion of this experiment, using the health and behaviors of *Daphnia magna* as a metric for how clean the water was. I first filtered the water, which came from the Mystic River, via 5 different methods — distillation, filtration using a coffee filter, boiling, filtering it through charcoal, and using the sun's UV light. I put 5 *Daphnia* in each group, 1 group for each of the 5 purification methods, plus a control group of unfiltered Mystic water), and observed them every other day for 10 days. Prior to beginning this experiment, I predicted that distillation would be the most effective method, as it inactivates or kills most microorganisms and removes most substances with boiling points higher than that of water. The results gathered during this experiment support my hypothesis, as the group of *Daphnia* that we in distilled water had the lowest average amount of deaths, and the second-lowest average amount of pregnancy and birth rates in both trials among all of the *Daphnia*. Along with this, they also showed signs of food deprivation, signaling that most of the bacteria they feed on was removed.

C11 Utilizing Algae Based PhotoBioreactors To Reduce Carbon Dioxide

Environmental Science

Mymoon Bhuiyan

Burncoat Senior High School

The emission of Carbon Dioxide from the industrial sector is progressively worsen the climate change issue. Moreover there are no solutions that are implemented in a large scale in order to counteract the climate change problem. This paper intends to outline the implementation of a Microalgae based photoreactor into large carbon emitting factories in order to reduce the Carbon Dioxide into Oxygen, and to generate biomass which can be repurposed into biofuel. The general idea of this paper is rooted in technology that already exists. The paper outlines a photobioreactor on a large scale, which would utilize the carbon dioxide produced in a factory, in order to sustain a microalgae ecosystem, and for the microalgae to convert the carbon dioxide into oxygen. This would result in the generation of oxygen dissolved in solution, as well as biomass which could be utilized as biofuel. his being said Five companies generate approximately 12.5% of the carbon dioxide emissions. [1] These companies accomplish this by having a vast infrastructure, ranging from pipelines to oil rigs. Thus to combat the existing infrastructure, there must be new additions to the infrastructure. Looking into the past, the earth was capable of regulating its temperature via a natural carbon dioxide cycle. The industrial revolution led to men having the ability to vastly unbalance the scale, which leads to the current predicament of increasing global temperatures and the climate change associated. However, it is useful to look at how the carbon cycle would operate normally, and see what humanity can glean from the earth. Looking at the carbon dioxide cycle, we see that the plant life uses photosynthesis to absorb the carbon from the carbon dioxide, and release oxygen as a byproduct.

F15 Reduction of Atmospheric CO2 Using the Algae Scenedesmus and Ulothrix

Environmental Science

Driss Bourzgui , Kylie Taylor

Berkshire Arts & Technology Charter Public School

Certain type of photosynthetic algae are known to reduce atmospheric carbon dioxide levels more efficiently than other types of algae. The hypothesis is that due to scenedesmus' high potential at carbon sequestration, it would surpass the Ulothrix algae in reducing carbon levels to a lower PPM. This was tested using a handmade CO2 scrubber, two types of algae were inserted into the scrubber individually for the duration of a week, and then data was collected and compared to see which algae reduced carbon more efficiently. The results showed that neither algae was as effective as previously predicted. The data refuted the hypothesis by showing that scenedesmus does not reduce atmospheric CO2 as efficiently as the research had showed. In the future, a wider range of algae's could be used to compare their effectiveness to scenedesmus which would provide more data to analyze and compare.

F18 Injection of Oryzalin: Transformation of Daylilies into Tetraploids

Environmental Science

Stefan Goretskiy

Westfield High School

This project in its present form involved the effects that Oryzalin had on diploid daylilies when induced into their seedlings. Converting a diploid cell daylily into a tetraploid plant enhances the plants' abilities of defense against insects, resistance against diseases, greater protection against the sun's ultraviolet rays, and a better substance and texture to the majority of the plant. The initial idea of this experiment was to modify the chromosome number in the mitotic phases in order to actually transform the daylilies into tetraploid celled plants.

An in-depth treatment process of the preparation to inject the oryzalin into the seedlings of the plants was mandatory. Specific criteria were carried out to increase the plant's survival rate when the oryzalin was injected, such as the controls, trimming of foliage, and providing water to the plant in a distinguished schedule. Calculating the value of 5.4 mL, signified the amount of oryzalin induced into the plants to transform their ploidy. Rates of photosynthesis and heights of the plants were collected and calculated weekly through definite forms.

Differences in growth curves between the recently induced tetraploids and diploids in their inherent states raised the suspicion that the oryzalin had indeed taken effect of the spindle formation during metaphase of mitosis. Since the oryzalin prevented the microtubule formation during cell division, the chromosomes did not separate in the normal fashion, resulting in a different ploidy for the cell. Further analysis, portrayed by the differences in growth patterns and rates of photosynthesis, corroborated the notable aspect of the plants actually experiencing higher ploidy levels than their diploid progenitors.

F24 Food Waste At The Burke

Environmental Science

Victoria Adeyemo, Martha Ogbemor, Merit Omorodion

Jeremiah E. Burke High School

Unused food wastes money, time, energy and resources such as water and plants. At Burke High School in Boston, we estimated how much food is wasted during lunch periods and surveyed students to determine why food is wasted. We asked students why they didn't eat certain foods on their tray. Our result showed that students waste more vegetable than main dish served on their tray. the main reason why they didn't eat the vegetable is because it didn't taste good. We hope that this work will create awareness to others about food waste (specifically food not eaten by student) and possibly find solutions to it.

G1 Let 'Em Worm!

Environmental Science

Sandy Racela

Berkshire Arts & Technology Charter Public School

My experiment involved making compost in two separate buckets by feeding red wiggler worms with either fruit scraps or vegetable scraps. I believe that it is important for people to be informed that composting is a great way to get rid of food scraps instead of throwing them away, as well as a very healthy alternative to artificial fertilizers if you want your plants to be stronger.

To see which compost worked the best on basil plants, I grew 12 of them in total, with 4 getting veggie-based compost, 4 getting fruit-based compost, and 4 getting no compost. I charted the growth of each individual plant for about 3 weeks (making sure to water them almost every day), then at the end of the three weeks I recorded which plants were starting to mature to figure out which ones were the healthiest by the end of the experiment.

My hypothesis for this experiment was that the compost made by the worms that were fed with fruit was going to grow a bigger and healthier plant because decomposed fruit adds more nitrogen to compost, as well as moistening it in the process, which is good for the compost and the worms, and keeps the plants more moist so that they don't get dehydrated as easily.

The most important results that were found by the end of the experiment were that the plants that were given the fruit-based compost were the strongest, because $\frac{3}{4}$ of the plants in that section were starting to mature, whereas only $\frac{1}{4}$ of the plants in the section with veggie-compost were maturing.

The data and results did end up supporting my hypothesis, because the plants that were given the fruit compost mostly ended up maturing at a faster rate because they didn't dehydrate as easily as the other plants, and were the tallest plants on average.

G10 Using Microorganisms to Reduce Nitrogen Pollution in Water Ecosystems

Environmental Science

Arianna Schiffman

Bishop Feehan High School

The purpose of this experiment was to determine if types of bacteria capable of denitrification could be used to reduce eutrophication due to nitrogen pollution on water ecosystems, specifically, by preventing algal bloom. The hypothesis for this experiment was that if algae growth is measured in water with a high nitrogen content treated with *Serratia marcescens*, *Bacillus subtilis*, and *Micrococcus luteus*, then the samples treated with *Bacillus subtilis* will have the least algae growth because of the species' ability to cycle nitrogen in low oxygen conditions. The experiment was conducted by treating distilled water with nitrogen, algae culture, and the three bacteria species and keeping them under an ultraviolet grow light for a 30 day period. The concentration was determined by measuring the amount of light that was prevented from passing through the samples using a colorimeter. The expected outcome was that the *Bacillus subtilis* would reduce the amount of nitrogen in the samples to the greatest degree and therefore the concentration of microorganisms, resulting in the least percentage light absorption. The results of the experiment supported the hypothesis, as *Bacillus subtilis* displayed 26.32% less absorption compared to the control group and a 39.5% decrease in the percentage light absorbance from the initial readings to the final readings, compared to the 3.1% decrease in the control group, while *Serratia marcescens* readings fell by about 6.9% from initial to final readings, and *Micrococcus luteus* readings fell about 6.5%.

G12 Treated Plants
Environmental Science
Pamela Martinez, Hailey Bravo
Excel High School

According to Harris Interactive poll, approximately eight million adults in the US eat no meat, fish, or poultry, several million more have eliminated red meat and two million have become purely vegans. With the increasing consumption of vegetables available year round, this project hypothesized that plants exposed to different concentrations of chlorine will grow slower than the plants tested with water only. Different solutions of 0.1 M HCl (as representative of chlorine) and water were created and treatment were made to growing vegetables. The set-up was then placed in controlled conditions, watered daily and response to treatment was recorded. Results confirmed the hypotheses and revealed promising contributions that will lead to increase yield and better methods in growing vegetables. Results further showed the danger of the substance in plants thus further studies are recommended not only on chlorine but also other substances plants are exposed with.

G24 How Climate Change Affects Water Quality
Environmental Science
Sofia Coholan
Bishop Stang High School

The purpose of this paper is to explore how the dissolved oxygen in water is affected as water heats up. The researcher hypothesized that the lower the salt levels in the water, the more the percent saturation of oxygen will be affected by the rise of temperature in the water. In the procedure, the researcher took water samples at 8 different locations. Then she tested them at three different temperatures for dissolved oxygen levels, total dissolved solids, and sodium chloride levels. The first test was taken at the initial temperature of the water, the second test was taken at 5°C higher than the average initial temperature, and the third test was taken at 10°C higher than the initial average temperature. After the data was recorded in all three tests, the information was compared. While comparing the samples, the researcher observed that the percent of oxygen saturation was more affected by temperature at the higher sodium chloride levels and all samples had lower dissolved oxygen levels at higher temperatures.

H5 Ocean Acidification
Environmental Science
Sally Phan, C'Lannye James
John D. O'Bryant School of Mathematics and Science

We are destroying our world. We pump billions of tons of carbon dioxide into the atmosphere each year. It is to the point where the planet's natural functions can no longer keep up. One effect of this excessive burning of fossil fuels is that the oceans are absorbing too much carbon dioxide gas. The gas that it cannot absorb stays in the atmosphere, causing a host of other issues. Our group hypothesized that since the oceans are more acidic overall, organisms that have shells find that they are eroding faster. To investigate, we let the soft internal shell of the cuttlefish sit in some liquids of varying acidity. We found that more acidic liquids, as well as extremely basic ones, had a greater eroding effect than those closer to neutral. In conclusion, even though the results we got after a week weren't dramatic enough to measure properly, but observing them with the naked eye, it is obvious that acids negatively affect shell using ocean life. As a follow up experiment, we could measure dissolved oxygen in the same substances to see how it relates to acidity.

H6 Effectiveness of Specialized Microbes on Synthetic and Organic Greases

Environmental Science

Timothy Moore, Rachelle Harpin

Assabet Valley Vocational High School

The Model 37 SW-4 OzzyJuice® SmartWasher system is in the Automotive Technology shop to clean many different types of greases, mostly two main all-purpose greases which they use on cars; also organic types of greases in the culinary industry. This experiment will show the percentage of grease removal that is present from the SW-4 OzzyJuice® cleaning each different type of grease (synthetic and organic), at increasing thirty second time intervals. The Automotive Technology shop needed to know how well the SW-4 OzzyJuice® performed against the specific types of grease. Also, it was not known how well SW-4 OzzyJuice® worked against organic greases. By using the Model 37 SW-4 OzzyJuice® SmartWasher system the way it is used in the automotive industry to clean each type of grease, it was found that the model 37 SW-4 OzzyJuice® SmartWasher system sufficiently cleans both synthetic, and automotive greases. This means that the model 37 SmartWasher system can be used instead of the hazardous Safety-Kleen system, and the model 37 SmartWasher system also has potential to be used in the culinary industry as well as the automotive industry.

H10 The Dangerous Effects of Sunscreen on Freshwater Plants

Environmental Science

Tatum LeMaire

Taunton High School

In this experiment, different brands of sunscreen were tested on freshwater plants to study and observe the harmful effects that sunscreen can cause, and decide what was the worst and best sunscreen for plants. The purpose of this experiment was to show the harm sunscreen can cause and to help people realize these effects. The hypothesis for this experiment was that Neutrogena would cause the least amount of damage and Equate would cause the most. In the experiment, 1 teaspoon of each sunscreen was added to its corresponding plant, except for the control. 5 brands were tested in 3 trials, each 7 days long. At the end of the week, the worst and best for both water and plant condition was recorded. These results were averaged into the final results, which was the Neutrogena was the least effective on both the plant and water, and the CVS and Equate tied for worst. CVS had the worst water and Equate had the worst plant. In conclusion, while all sunscreens were harmful, Neutrogena is the least damaging and CVS and Equate are the most.

H16 Mealworms Biodegrading Styrofoam

Environmental Science

Abby Genova, Lily Clardy

Hudson High School

Polystyrene waste and other plastics are causing pollution at a rapid rate; 260 tons of the plastic waste is produced each year. Recent studies have shown that the gut bacteria in mealworms are capable of degrading polystyrene foam. The purpose of this experiment is to determine which type of polystyrene foam mealworms biodegrade most efficiently, and which type of single-use plastic. Two different types of this polystyrene foam was tested, expanded and extruded. Expanded has a lighter density, and the cells are filled with air. Extruded foam has a higher density, and the cells are popped. The hypothesis was that the mealworms are going to eat and degrade the expanded styrofoam better than the extruded because of its lighter density. Four trials were completed with six days each, and it can be concluded that the extruded styrofoam lost more mass compared to the expanded foam, which means the hypothesis was disproven. Next, mealworms were given a plastic bag (low-density polyethylene), a plastic bottle (polyethylene terephthalate), and a plastic spoon (polypropylene) to see which item they preferred and degraded most efficiently. The hypothesis is that the plastic bag will lose the most mass due to its flexibility. This was disproven because after another four trials of five days, the plastic bottle lost the most mass. Now with the specific types of plastic narrowed down to extruded polystyrene foam and polyethylene terephthalate the gut bacteria of mealworms can focus on these two main types in order to use their ability to receive the maximum effect.

H24 Purification of Waste Water

Environmental Science

Mahika Gupta

North Attleboro High School

Water is a gift from nature that connects every aspect of life. The use of unsafe or inadequate water can cause many diseases which can result in millions of deaths. Eutrophication in which substances are released by humans into the environment due to domestic, agricultural and industrial water activities and can lead to an immense amount of pollution. A main source of eutrophication is fertilizers which are rich with inorganic nitrogen and phosphorus causing long-term environmental problems. Microalgae can offer a source of safe and efficient treatment of wastewater. Microalgae have the ability to use nitrogen and phosphorus for their growth and remove toxic organic compounds. In the experiment different algae, Scenedesmus, Chlorella, and Chlamydomonas, were tested in the presence of fertilizer. Phosphate and nitrate concentrations and pH level data was recorded throughout the experiment. From the experiment, it can be concluded that specifically Chlamydomonas is will reduce the most amount of toxins efficient and effectively. Chlamydomonas also has the potential to be used as biomass in the future. Algae-based wastewater treatment systems can be advantageous in low land-cost areas where sunlight and warm temperatures are plentiful. It can contribute to the management of water ecosystems by providing an inexpensive and environmentally sound alternative conventional energy-intensive wastewater treatment systems. Water pollution is a global problem that needs to be reformed in order to prevent devastating outcomes. Overall, finding a way to minimize the number of toxins within wastewater is critical for the survival of mankind and will be tremendously beneficial for those who do not have access to clean water.

H25 Exploring the Presence of Microplastics in Great Pond

Environmental Science

Sarah Thieler

Falmouth Academy

The purpose of this experiment was to observe the presence of microplastics in Great Pond. Microplastics are able to act as vessels for harmful pollutants, carrying pesticides and manufactured chemicals. Although not much research has been conducted regarding the effect of microplastics on marine organisms, studies show that the small particles of plastic can cause problems when ingested, such as clogging the digestive tract of animals. It was hypothesized that microplastics would be found in Great Pond. A plankton net with an attached plastic jar was used to conduct a 30 minute tow during the tidal transition from high tide to low tide and low tide to high tide. The resulting water samples were inspected for possible plastic material using a mesh sieve. Samples were examined under a microscope to observe potential plastic fragments. When examining the possible plastic material, it was determined that none of the samples contained plastic. Although no microplastics were found in this experiment, in the future, samples could be taken from different areas in the pond, and compared with observations from around the pond to observe the types of plastics potentially entering the water source.

J8 Testing the Durability and Long Term Reliability of Solar Cells

Environmental Science

Michele Schremp

Bishop Feehan High School

As solar panels become increasingly available for consumers, it is important to ensure that they will be reliable as they are exposed to the long-term stress and strain of their environment. It was hypothesized that the power output of solar cells will gradually degrade as a result of various accelerated aging tests, bringing the solar cell to the point of complete failure. The amorphous and polycrystalline solar cells were placed through four different accelerated stress tests: thermal cycling, strain testing, freshwater humidity, and damp salt heat. For both types of solar cell, power readings were taken before each test to establish a base value for the power. A group of each type of cell was then exposed to ten trials of a test, taking power readings after each trial as well as taking pictures with a microscope at 40x power in the center of each cell to determine if there was any degradation in the physical makeup of the cell. A gradual decline in power was seen for some tests for the polycrystalline cells. The amorphous cells continued to produce the same amount of power until the exterior circuitry was physically affected, at which point, the cell would completely fail. While the initial hypothesis was proven null in the case of the amorphous cells, and generally insignificant for the polycrystalline cells, further testing explained these results by showing that any degradation to the silicon itself is generally insignificant, but damage done to the electrical system resulted in a serious decline in power production. The silicon of the cell is generally durable, but the main weakness is the electrical system.

J10 Methods That Speed Up Germination

Environmental Science

Fiona Berberi

North Quincy High School

Lima beans were planted using three different methods of germination (presoaking, scarification, and epsom salt method) and left to germinate in an area with natural light for five days in order to determine which method of germination was the most efficient. It was hypothesized that the lima beans planted using the scarification method would have the highest percentage of germination. Lima beans were soaked in warm water for (18 hours) for the presoaking method, they were rinsed in a hydrogen peroxide and water solution for the scarification method, and they were also rinsed in an epsom salt and water solution for the epsom salt method. They were then placed in plastic baggies on top of a paper towel soaked with its corresponding solution. After leaving them by a window with natural light for five days, the lima beans were taken aside and the data was recorded. Overall, it was shown that lima beans, when tested with each method, had the highest percentage of germination when planted using the scarification method, as hypothesized. The scarification method was proved to be the most efficient method of germination, as the lima beans planted using this method had a final average germination percentage of 61% , higher than that of presoaking (34%) and epsom salt (58%). This information could be useful to people like farmers, gardeners, and even climate change activists as knowing of a method that can speed up germination and be the most effective, could help farmers and gardeners plant more crops in a shorter amount of time and could help climate change activists help regulate climate change by planting a larger amount of trees in a shorter amount of time.

J11 Specific Leaf Area and Decomposition Rate, Are They Related?

Environmental Science

Pablo Flores Munoz

North Quincy High School

The hypothesis of this project proposed that "if leaves of eight broad-leaved tree species decompose simultaneously, then the leaf decomposition rate of species with smaller specific leaf area (SLA) would be higher than the leaf decomposition rate if species with larger SLA. To test this hypothesis, an experiment was conducted in order to measure and compare leaf decomposition and SLA. Three groups of 40 samples of leaf litter were sealed in litterbags. At the beginning, the experimental group was buried in containers and placed indoors to decompose at 20 degrees Celsius with constant soil humidity. After that, a control group was left exposed outdoors and another was buried outdoors. A correlation analysis was performed to evaluate the relationship between SLA and leaf decomposition rate. The correlation coefficient of the experimental group buried indoors ($r=0.578$), showed a weak positive association between both variables. Therefore the hypothesis proposed can be rejected. However, the results agree with previous studies reporting that SLA is positively correlated with leaf decomposition rate. The experimental group of the indoor buried samples displayed higher leaf decomposition (0.455) than the control groups; outdoor exposed (0.229) and out and outdoor buried (0.264) respectively. The highest leaf decomposition rate occurred in *Morus rubra* (0.814) and *Tilia chordata* (0.750). In conclusion, these findings corroborate that 1) SLA is an important trait positively associated with leaf litter decomposition, and that 2) abiotic conditions of higher and constant temperature and humidity stimulate biotic decomposition. This project can provide useful information on leaf decomposition of species in urban areas under controlled environments.

J16 Neurotoxicological Effect of Perfluorohexane Sulfonate on *Dugesia t.*

Environmental Science

Chimaa Boutarf

Pioneer Charter School of Science II

In this experiment, *Dugesia tigrina* was tested for changes in morphology and neuro related behavior when exposed to perfluorinated chemicals (known as PFC). The most common PFC's found, include Perfluorohexane sulfonate and Perfluorooctane sulfonate. A debate over the banning of these chemicals has been in place for many years since conducted experiments have proved their hazardous effects on humans and the environment. These chemicals were tested on *Dugesia tigrina* which is a type of flatworm that has regenerative powers that have been long recognized as a valuable vivo animal to study the effects of chemical exposure. These chemicals were used in my experiment to show their level of toxicity and their adverse effects on the behavioral changes of *Dugesia tigrina* (also known as planaria). These chemicals were compared in toxicity along with the control group of healthy *Dugesia tigrina*. Thus, the overall experiment supported the negative impacts of the chemicals as *Dugesia tigrina* went through neurological behavioral changes.

J17 Do You See What I Sea?

Environmental Science

Angie Chen

Hopedale Junior Senior High School

This project investigated the effects various types of plants have on the pH level of ocean water and if they can help remove carbon dioxide from saltwater over a period of time. The purpose was to come up with a solution to combat ocean acidification by investigating which plant increases the pH level of water the most. The experiment was conducted by placing a different plant in a corresponding container of saltwater and measuring the pH level of the water every day for 2 weeks to observe changes. The following data was collected, Caulerpa Mexican Fern raised the pH level the most by 0.4, and Caulerpa Peltata raised the pH level the slowest and the least by 0.1. It can be concluded that plants such as the Caulerpa Mexican Fern increase the pH level of water, and can be used to help moderate ocean acidification to create a more suitable environment for marine animals.

J26 The Parallel between Rising Shark and Seal Populations Off Cape Cod

Environmental Science

Katelyn McGauley

Newton Country Day Sch/Sacred Heart

The purpose of this literary review is to analyze the cause for the increasing shark population off the coast of Cape Cod, Massachusetts. Along with the increase in shark population, the grey seal population in the water surrounding Cape Cod has also increased. Reproduction at grey seal breeding sites, such as Muskeget Island has increased significantly from an average of 19 seals produced per year to between 3,500 to 5,000 seals produced during a breeding year. The reason for this increase in the grey seal population directly correlates with the 1972 Marine Mammal Protection Act, enacted as a US Federal Law, which protects seals from human interference, including hunting. The hypothesis of this study was as the seal population off the coast of Cape Cod rises, the population of sharks in the same location also rises due to an increase in their food source. The experimental design for this literary review consisted of research for data about the grey seal and great white shark populations in the Northwest Atlantic Ocean. The results shows a direct correlation between the rising seal and shark populations because as the seal population increased, the great white shark population also increased. Between 1990 and 2009, there were 50 confirmed shark sightings, but in 2009, 150 sharks were tagged off the coast of Cape Cod. From 1990 to 2009, in two popular breeding sites, the estimated seal population was 1,241, but in 2009 the population had increased to 1,995. Based on the data, the hypothesis was supported and the increasing great white shark population correlates with the increasing grey seal population off the coast of Cape Cod. This experiment points to potential causation for the increase in human/shark interactions between humans and shark in recent years.

J27 Soybean Futures in a Changing Climate

Environmental Science

Ruby Gaetani

Falmouth Academy

Soybeans (*Glycine max*) are one of the most economically significant crops in the United States. However, rising temperatures and CO₂ concentrations caused by fossil fuel emissions (global warming/climate change), may impact the health of soybean crops, threatening the livelihoods of those who depend on them. Therefore, it is critical to study and understand the effects of climate change on soybean growth. It was hypothesized that higher CO₂ concentrations and temperatures would have a negative effect on soybean germination and growth rate, while lower CO₂ concentrations and temperatures would have a positive effect. 60 soybean seeds were planted in 6 different CO₂ and temperature combinations. The plants were grown for 3 weeks, watered and measured daily. The hypothesis was partially supported, as plants grown under higher temperatures had a higher growth rate but took longer to germinate, with no correlation to CO₂ level. Higher temperatures also negatively affected germination success. Daily biomass gain was influenced by both temperature and CO₂, but the effects of each were opposing. These results imply that the US soybean economy could be adversely affected by climate change, due to its negative effect on germination success. Furthermore, high CO₂ concentrations negate the positive effect of temperature on crop yield.

K7 Sweet Pea Plant Growth Using Tea

Environmental Science

Andrea Ngo

North Quincy High School

During this experiment, groups of *Lathyrus odoratus* (sweet pea flowers) were grown using various liquids including H₂O and different products of *Camellia sinensis* to identify whether or not there was an interrelation between the nutrition within the Theaceae and the individual Plantae. It was hypothesized that if *Lathyrus odoratus* were to be watered every day with any type of *Camellia sinensis* product, then its growth will develop healthier and quicker than the control group that is receiving municipal water for the same duration of 2 weeks. There was a total of 3 sets of data, each one consisting of three trials; for every trial, there were four plants (one of each tea flavor and water). Foam cups were filled half-way with soil, and a single *Lathyrus odoratus* seed was placed into a 1-inch indentation. The plants were sprayed 5 times with their corresponding solution each day and observations were carried out at this time. Height measurements were also recorded every day until the time limit was up. Overall, the green tea plants had the greatest results with an average height of 39 $\frac{1}{3}$ millimeters, followed by municipal water at 19 $\frac{5}{9}$ millimeters, then the peppermint tea with 18 $\frac{4}{9}$ millimeters, and lastly, the chamomile tea group at 17 $\frac{8}{9}$ millimeters. The green tea experimental group proved to be the healthiest, displaying the greenest and fullest leaves. The hypothesis was opposed since the control group had an ultimate higher height average than the peppermint and chamomile tea plants. A possible explanation for this is because of the deficiency of specific nutrients. This research is considered to be relevant due to its significant influence to agriculture and today's society.

K18 Salinity Versus the Growth of Mung Beans

Environmental Science

Jessica Dai

Boston Latin Academy

In this experiment, I tested how different salt concentrations would affect the growth of mung beans. The effect of salt concentration on plants is relevant to our world today as sea levels rise due to climate change. Understanding how plants react to salt can influence us to develop plant varieties that are more tolerant of salt. I hypothesized that if mung beans were given different concentrations of salt water, then the average bean growth in high salinity will be lower because the salt will interfere with osmosis and cause ion toxicity. My independent variable is salt concentration. My dependent variable is the growth of the beans in centimeters. I grew the beans and watered them each day with different salt concentrations. The concentrations ranged from 0.001 Molarity to 0.1 Molarity of salt. My data supported my hypothesis since salt concentrations greater than 0.1M of salt hindered the growth of mung beans the most. There was an obvious distinction between the growth averages. Plants watered with salt concentrations were not as healthy as those watered with tap water.

K22 Bio-digester Solving Energy Problems in Developing Countries

Environmental Science

Helga Becka

Quincy High School

Statement of the Problem: In this science fair project I will create a biodigester which will produce methane gas. Methane gas is a natural biogas that can help fuel in cooking, and this would help especially poor countries and poor people to whom energy consumption is unaffordable. This is an inexpensive and an easy way to generate energy, because the methane gas will be produced by bacteria which consume organic waste.

Materials: 35 gallon sealed plastic container, 2 feet of 1 ½ PVC pipe, 8 feet of 1 inch PVC pipe for liquid run off, 90 degree 1 inch elbow PVC for liquid run off, 1 inch diameter PVC valve – liquid run off stop gap, 13 feet ¼ polypropylene tubing for methane gas flow, ¼ inch male – male gas valve 2, 1 ½ PVC caps for scrubber, ¼ inch bulk work adapters, ¼ inch male – male – male T adapter / gas flow, Large funnel, Large inner tube from a truck tire, Steel wool, Fruit pulp, Beneficial micro organisms, Green material and waste products

Experiment-Four main methods were used to do this project:

Construction of the bio-digester: I cut pipes and tubes and made all their connections to the bio-digester. It was important to make sure that all the connections were air tight; for this reason, I conducted a lot of pressure tests.

Finding optimum temperature: I had to make sure that the temperature inside the bio-digester was kept within a range of 25-35 degrees Celsius, so that the bacteria would function properly.

Small scale reaction: Doing a small scale experiment in lab helped me decide about the ratio between the amount of fruit pulp and seed material that was going inside the bio-digester.

Real biochemical reaction: I put 15 gallons of fruit pulp into the bio-digester as well as 3 gallon of methanogens. I let them sit for around two weeks.

K23 The Effect of Hydrogen Peroxide on Grass Growth

Environmental Science

Hannah Kelsey

Foxborough Regional Charter School

Much of the human race is obsessed with the terms bigger and better. They feel the need to have everything the best and believe the only way of achieving that is through a big size. This applies to pretty much everything, including plants. So, I wondered, is there a way to make plants grow taller than they normally would? Hydrogen peroxide is a known oxidizing agent. Studies have recently found that hydrogen peroxide has an impact on the growth and development of a plant. So, I decided I would test the effect of pre-rinsing seeds in hydrogen peroxide on the growth of grass. I pre-rinsed seeds for two out of four cups to be able to compare the heights. Over three weeks, I watched and compared the growth of all four plants. Based on the results, there is a way to affect the growth of plants. This experiment proved the use of hydrogen peroxide in pre-rinsing plant seeds, truly does make plants grow taller than normal seeds.

K26 A DNA Barcode Approach to Ascertain the Foraging Habits of Native Bees

Environmental Science

Francesca DiMare

Brockton High School

With increased use of insecticides, climate change, and the difficulty in maintaining domestic honeybee hives due to Colony Collapse Disorder, supporting the native bee population has become of critical importance. This study sought to determine whether single pollen grain DNA amplification can be effectively utilized to identify what local flora *Lasioglossum* forage on, and to begin composing a regionally tuned list of plants that will support the native bee population. If targeted sequences of DNA from pollen grains selected randomly from native bees can be amplified, sequenced, and identified, it can provide information that could be used to support the native bee population through companion planting. *Lasioglossum* were sampled via sweep netting in late August. Pollen grains were harvested from their bodies and stained with dye in petri dishes. 15 pollen grains, individually sampled from each petri dish, were photographed and placed into PCR tubes. PCR was then conducted using two primer sets: *psbA-trnH* and *ITS2*. Gel electrophoresis showed that of the 45 pollen grains sampled, an average of 48.89% were successfully amplified per bee following first stage PCR, 60.49% of these were successfully amplified after second stage PCR, and 38.89% of samples sent for sequencing were successfully identified. Sequenced pollen grains were identified as *Betula Kenaica*, *Pisum Sativum*, and *Veronica Arvensis*. These three successful identifications support that single pollen grain DNA amplification is a possible method for identifying flora native bees forage on. However, the high failure rate increases costs and time required to use the methodology, making it essential to increase the success rate before the method can be effectively applied on a larger scale.

K27 How Does Sodium Chloride Affect a Microbial Fuel Cell's Power Output?

Environmental Science

Grace Leopold

Calvary Chapel Academy

The purpose of this project was to investigate how changing the soil conductivity inside a microbial fuel cell affects its power output. The question was how does sodium chloride affect a microbial fuel cell's power output? The hypothesis was that the microbial fuel cell with five grams of salt would produce a higher power output than the microbial fuel cell containing one gram of salt. First, I set up the microbial fuel cell. This included preparing the soil mud, preparing the anode and cathode, then assembling the hackerboard. Next I measured the power output for twelve days by using a multimeter and different resistors. On day eight I added salt. Then I analyzed my results which showed that the five gram microbial fuel cell had a power output increase of 138.1%. The one gram microbial fuel cell had an increase of 67.8%. My hypothesis was supported because a higher change in soil conductivity resulted in a higher power output.

K28 Is Organic GMO-free?

Environmental Science

Alexandra Godfrey

Plymouth South High School

Are organic foods also GMO-free? The purpose of this experiment is to conduct research and find out if organic foods are also non-GMO. Based on previous research, there are possible ways to get around selling organic foods, due to the labeling laws. The hypothesis is that some of the organic foods tested will have the 35S marker, indicating that they contain some GMO ingredients in them. In this procedure there are four main steps that can be broken up into substeps; planting the wild-type soybeans, isolating the DNA from the wild soybeans, Roundup Ready soybeans, and organic foods, amplifying the DNA in PCR reactions, and analyzing the PCR products from gel electrophoresis. (Cold Spring Harbor Laboratory, 2015). Over half of the foods tested for GMOs showed the tubulin marker, enabling the data to be collected. there was a 40% error, meaning that 4 out of the 10 foods were unable to be used when analysing data, because they did not have the tubulin marker. All six of the foods that had the tubulin marker; miso cup, black beans, caramel milk chocolate, croutons, cocoa bunnies cereal, and spelt flour, had no 35S gene marker during transillumination. Meaning, those foods are GMO-free and organic. For these products at least, organic also means non-GMO, and the companies making these foods did not follow any of the loopholes, which companies can go through to get the organic labeling on their foods. Recently, there was a report that some foods were tested for the weed killer in Roundup. Roundup is connected to not just cancer, but also Parkinson's Disease (Reporter, 2013). A future application could involve exploring the casing on meats. Articles mention that companies producing organic meats can still put casings on the meat that can contain GMOs.

N4 The Arlington Reservoir: An Analysis of Climate Change Preparedness

Environmental Science

Sanjana Sankar, Ella Mattingly

Lexington High School

Flood prevention is becoming increasingly relevant as global warming increases and severe storms become more frequent. Many communities in Massachusetts possess small to moderate sized water bodies that can be used to minimize impacts from flooding if preparations and watershed management procedures are developed now. This study assessed the potential for using local waterbodies for flood storage. We are aware of no effort to study the use of this waterbody for flood storage before this project.

Local waterbodies can provide significant flood storage with meaningful durations to minimize the adverse impacts of more frequent and severe storms associated with global warming. This study measured the flow of water in and out of the Arlington Reservoir during and after rain storms to create a hydrology model capable of estimating its flood storage capacity during wet and dry conditions. Flow was measured by calculating the speed of water traveling through a conduit with known dimensions at the inlet and outlet of the Arlington Reservoir. The Arlington Reservoir dam maintains the water elevation at 152 ft (above mean sea level) during winter and 157 ft during the summer. Bathymetric mapping determined that raising the dam from its lowest to highest position allowed the Arlington Reservoir to store 6,710,000 ft³. Without rain, the Arlington Reservoir is fed by the Monroe Brook at a rate of 4.98 +/- 1.73 ft³/s (+/- 1sd). During two rain events (1" rain per day ~ 2yr storm), the Arlington Reservoir filled with water from the Monroe Brook, a Lexington storm sewer (Pipe L), and an Arlington storm sewer (Pipe A) at a combined rate of 12.4 +/- 5.38 ft³/s. At these rates, the Arlington Reservoir could contain all of the storm water if the dam was raised for 5.26 +/- 0.70 days.

N7 Effect of Microwave Radiation on Different Organisms

Environmental Science

Lindsey Moskal

Bishop Feehan High School

The purpose of experimenting the effect of microwave radiation on plants, yeast, and bacteria was to come to a conclusion as to whether or not it affects these organisms. If one can identify that microwaves aren't good for life, they can try to eliminate them altogether or they can try to fix the problem by reducing the amount of radiation given off by them. If seeds, yeast, and bacteria are placed in the microwave for 30 seconds, then they will not grow at all. To complete this experiment one would place each of the organisms in the microwave for a set time between 0 and 30 seconds. They would observe the growth of the seeds to see if those which were in the microwave for 5-30 seconds were as tall as the height of the control sample. The same would go for the size and the amount of bacteria and yeast bubbles in each of the experiments. The expected outcome is that the control sample will always have the most success, while the 30-second sample will have the least success in growth. The results for the plant was that the control grew the most in 14 days. The plants which were exposed to radiation for 20 and 30 seconds experienced no growth. The yeast was the same way; the control sample had the most amount of bubbles produced. The yeast that was exposed to 30 seconds of radiation did produce any bubbles. Lastly, the control sample of bacteria grew many colonies and they were large, too. Those exposed to 5-20 seconds of radiation had less colonies as the time increased. The bacteria exposed for 30 seconds did not have any colonies. In conclusion, all three of the organisms that were exposed to 30 seconds of radiation did not grow at all.

N13 Using Minerals to Combat Ocean Acidification

Environmental Science

Mary Pyrdol

Brockton High School

The ocean's pH level should normally be slightly basic, with Atlantic ocean waters having a pH of about 8.2. However, with the production of cars and factories in the past century or so, the ocean is slowly but surely increasing in acidity as pH levels start to drop, with an average Atlantic ocean pH of about 8.1. This drop in pH is due to an introduction of excess carbon dioxide as the ocean absorbs it from the atmosphere. When the ocean absorbs carbon dioxide, it dissolves into water as carbonic acid. This process occurs naturally, but with the addition of man-generated carbon dioxide being introduced into the atmosphere, the ocean absorbs the excess amounts of carbon dioxide, thus resulting in excess amounts of carbonic acid accumulating in the ocean. Carbonic acid is detrimental to various forms of marine life, including biomasses with developing exoskeletons (crabs, lobsters, shrimp, etc.) because it hinders their calcinification processes, weakening exoskeletons, and even causing population decrease or extinction of certain species sensitive to the intensifying acidity. If acidic ocean water is filtered through a magnesium-silicate olivine mineral filter, then the ocean water's pH will rise and the water will become more basic because the chemical composition of magnesium-silicate olivine will undergo a neutralization reaction with carbonic acid, neutralizing the acid, and thus helping improve the lives of marine animals by restoring the ocean's alkalinity and preventing carbonic acid from hindering the calcinification of exoskeletal biomasses.

N20 Comparing Stream Characteristics between Winchester, MA and Puerto Rico

Environmental Science

Stephanie Martinez

East Boston High School

For our project, we performed data analysis on the current levels of phosphorus, nitrogen, and suspended solids on not only our streams, but also on other streams. We saw it opportunistic to compare our sites with a few from Vermont since Vermont also contained urban stream data from the same months of 2018. We also observed if these stream sites were regulated according to state standards. Finally, we also checked saw if levels of phosphorus, nitrogen, and suspended solids were related to site observations (amount of obvious pollution).

Vermont's Department of Environmental Conservation Water Quality Standards:

Phosphorus cannot exceed 1 $\mu\text{g/L}$ at low median monthly flow for streams.

For streams below 2,500 feet altitude, which would be all of our chosen Vermont sites, nitrogen cannot exceed 2,000 $\mu\text{g/L}$ at low median monthly flow.

Surface Water Quality Standards of the Massachusetts' Department of Environmental Protection

The standard for phosphorus ranges from 11 to 45.5 $\mu\text{g/L}$.

For nitrogen, the levels range from 380 to 527 $\mu\text{g/L}$.

We hypothesized that the average suspended solids of Vermont sites will be higher than that of Massachusetts' sites.

Although both areas are exposed to human activity, there appears to be more in Vermont based off site descriptions.

We also hypothesize our MA sites to have a higher average phosphorus level than Vermont since the standard for phosphorus levels in MA is higher than that in Vermont. Finally, we hypothesize the nitrogen levels in MA to be lower than that in Vermont since the standards for nitrogen in MA is lower than the standard for Vermont.

N21 Aquaponics

Environmental Science

Joseph Mirisola

Silver Lake Regional High School

In this lab, it is expected to learn the basics of aquaponics. This lab will introduce the skills required to maintain a sustainable aquatic system dealing with plant growth and fish survival. The purpose of this lab is to observe and analyze the mutual relationship between the fish and the plants. The intent of the mutual relationship is for the fish to provide the plants with the necessary nutrients they need from fish waste. At the same time, the plants will uptake the nutrients from the waste, thus creating a clean environment for the fish. The success of this relationship can be measured by the growth of the plants and the survival of the fish, also on the turbidity, chemical concentrations, and cleanliness of the tank.

P4 Redesigning a Soil Moisture Radar for Drone Application

Environmental Science

Joseph Rotondo

Upper Cape Cod Vocational Technical High School

The project that has been completed was inspired by the need for an accurate soil moisture radar that can effectively measure the water content found in soil and the height above ground from which the radar takes its measurements. The hypothesis that was created states that using several ARENA products by Remote Sensing Solutions Incorporated, a cost-effective radar/drone solution for soil moisture can be created. The materials will be relatively inexpensive, and the product will be vetted for commercial interest. The end radar product will be similar to or better than the expected outcome, and the radar will correctly measure soil moisture and height above ground. Being interested in radar technology and possible drone implications, research was gathered on possible methods to modify the original soil moisture radar for drone application. This project was created to better analyze how soil moisture affects crops and the agriculture industry, which heavily relies on groundwater to supply nutrients to their crops. The data gathered helps to reveal the construction and testing of new radar technology to benefit industries across many different fields and society as a whole.

The hypothesis was mostly supported, a radar system was built to measure soil moisture and height above ground. The size of the radar however remains far too large to fit on recreational drones, and only industrial-sized drones can utilize the radar efficiently. The agricultural, hydrological, and climatological fields may better utilize this radar for practicality. This in turn helps society with new research and scientific findings for a better future.

Mathematics

Mathematics

- A12 The Hausdorff Dimensions of Higher Dimensional Random Walks
- B15 The Mullineux Involution and Generalized Regularization
- F20 A New Space Filling Technique Using a Domain Transformation Method
- J6 Asymptotics of k-Dimensional Visibility

A12 The Hausdorff Dimensions of Higher Dimensional Random Walks

Mathematics

Booyeon Choi

Middlesex School

A random walk is a process for determining the probable location of a point subject to random motions, given the probabilities of moving some distance in some direction. A random walk can exist in a physical dimension higher than or equal to 1. The fractal dimension of the random walk is a ratio that describes the complexity of how a fractal pattern changes as it is measured at different scales. Random walks are known for having fractal dimensions that are not integers.

This research applied a box counting method to explore the fractal dimension of the path of a random walk in various physical dimensions ranging from 2nd to 5th using different numbers of steps ranging from 1,000 to 1,000,000. The experiment was repeated 10,000 times in each number of steps and physical dimension combination with a different random seed number to explore their statistical distribution.

The result shows that the higher the number of steps, the higher the fractal dimension becomes in all physical dimensions (2nd to 5th). The fractal dimension was also higher in higher physical dimensions for a given number of points. The standard deviation was higher as both the number of steps and the number of physical dimensions increased. With limited computing power, it was impossible to determine whether the fractal dimensions of these random walks would converge to a value in the long run or keep on increasing without bound. In the 5th physical dimension with 1,000,000 steps, which was the highest dimension and the highest number of steps used in this experiment, the result was relatively wide normal distribution where $\mu = 2.03574$ and $\sigma = 0.105024$.

B15 The Mullineux Involution and Generalized Regularization

Mathematics

Allen Wang

Acton-Boxborough Regional High School

The Mullineux transpose map is an operator on partitions that arises from modular representation theory. Due to its importance in representation theory, quantum algebras, and combinatorics, alternative descriptions of the operator are desired. Fayers, Bessenrodt, Olsson, and Xu used regularization to prove an equivalent definition of Mullineux transpose. In this paper, we study the Mullineux transpose map and the generalized regularization on partitions on partitions and prove a condition under which the two maps are exactly the same. We conclude with several conjectures regarding additional properties of the global crystal basis for the basic $U_q(\mathfrak{sl}_b)$ -module.

F20 A New Space Filling Technique Using a Domain Transformation Method

Mathematics

Jung Won Baek

Northfield-Mt. Hermon School

The basic building block of the curves is an open square formed by connected lines. A complex process made by the mathematicians needs to be analyzed to simplify the procedure recursively converting each point on the 1-dimensional domain to coordinate values on the 2-dimensional domain. Thereafter, a recursive smaller version of the original open square on the 2-dimensional domain can fill out the whole square. The relationship between points on a line segment and points in a square is displayed by the SFCs, which shows the mapping between those points. Based on the studies of the SFCs, a new efficient alignment or algorithm can be formed so that one quadrant's end of the curve lines up with the next quadrant's beginning of the curve. If this can come true, we can reduce operational counts that cost calculating the complex mathematical and computational calculations on matrix manipulations. Compared to the building blocks by the existing SFC method, such as Peano and Hilbert curve, present research illustrated histogram analysis and graphical data showing that filling open square using present method can be efficient during a computer running time. Using simplified mathematical notations, fewer operations such as fewer matrix multiplications were observed. Using an algorithm studied in this paper, we tried to reduce operational counts that cost calculating the complex mathematical and computational calculations when creating artistic and geometrical patterns which can be applied to the image compression and combinatorial optimization in an efficient manner.

J6 Asymptotics of k-Dimensional Visibility

Mathematics

Ezra Erives, Srinivasan Sathiamurthy

Lexington High School

We focus on \mathbb{N}^3 , imagined as a three dimensional, axis-aligned grid world partitioned into $1 \times 1 \times 1$ unit cubes, each of which is considered to be empty, in which case a line of sight can pass through it, or obstructing, in which case no line of sight can pass through it. From a given position, some of these obstructing cubes block one's view of other obstructing cubes, motivating the following question: What is the largest number of obstructing cubes that can be simultaneously visible from the surface of an observer cube, given that all of the obstructing cubes lie within a cube of fixed size? We present a model through which the problem of visibility is turned into one of partially ordered sets, yielding an $\Omega(n^{\frac{8}{3}})$ lower bound, where n is the side length of the cube. Through the analysis of lattices corresponding to the elements of partially ordered sets modelling visibility in higher dimensions, the aforementioned lower bound is generalized to $\Omega(n^{\frac{d-1}{d}})$ for dimension $d > 3$. The previous work along with additional analytic techniques are used to prove an $O(n^{\frac{d-1}{d}} \log n)$ upper bound in a reduced visibility setting. Finally, an $O(n^{\frac{d-1}{d}} \log n)$ upper bound considering the bottom faces of cubes and their higher dimensional analogues is presented.

Physics & Electronics

Physics & Electronics

- A21 SafeSound: A Novel Method NIHL Prevention via Sound Attenuation
- A24 Concentrated Sound Waves and the Extinguishing of Flame
- B9 Relativity: The Secrets of the Octonions
- B12 Computer Vision-Based Characterization of Nanoscale Lamina
- C6 The Mystery Behind Aerial Warfare
- C10 Piezoelectricity
- C20 Archery Techniques: Determining the Best Arrow to Penetrate a Target
- C25 Visualization of Sound Waves in 3D
- D13 Quantum Catalyzation of a Portable, High Energy Nuclear "ARC" Reactor
- D24 A Correlation between Telescope Lens Diameter and Image Resolution
- F5 Blood Spatter Analysis
- F7 A Simple Low-Cost Device To Measure Fluid Viscosity
- G21 Designing the Most Effective Pulley System
- G26 Wifi-Signal Strength, Obstructed and Measured
- G28 Magnetic Force Variations with Temperature
- H3 The Effects of Using App Functions on a Cellular Electromagnetic Field
- K11 Exploring the Diffractive Bending of Light Through Apertures
- K13 Phony Radiation: The Effect of EMFs on Plants
- N28 Cell Phone Microscope

A21 SafeSound: A Novel Method NIHL Prevention via Sound Attenuation

Physics & Electronics

Andrew Youssef

Mass. Academy of Math & Science

Over 20 million adolescents are at risk of developing noise-induced hearing loss (NIHL) due to unsafe use of personal audio devices (PADs). PADs can produce sound intensities of 120 dB, 46% higher than the 75-dB LEQ WHO threshold. The objective of the project was to engineer a sound-attenuating solution for all PADs that maintains the original sound quality. SafeSound is an application that reduces unsafe audio outputted from a PC by limiting (1.6% sound distortion) or compressing (0% distortion) the audio. SafeSound-PC allows users to safely listen to streamed or pre-recorded audio, graph audio intensity, and record compressed audio to a WAV file. SafeSound-Pi runs continuously on a Raspberry Pi, which processes and sends audio from a player to the PAD. When tested on various types of audio, the limiter maintained an intensity of 74.7 dB LEQ, and the compressor an intensity of 74.9 dB LEQ. SafeSound is compatible with all audio players and PADs that capture or output audio information through 3.5 mm jack cables or Bluetooth. Both versions of the solution run on any operating system that supports Python. By reducing exposure to unsafe sound, SafeSound may prevent NIHL development.

A24 Concentrated Sound Waves and the Extinguishing of Flame

Physics & Electronics

Justin Millette, Aaren Abrams-Greenberg

Somerville High School

It is known that fire is a chemical reaction that requires heat, where fuel is consumed and reacts with oxygen. Fire often generates enough heat for it to chain react. One way that fire can be extinguished is by depriving it of oxygen. The oxygen in the air can be displaced from some force moving the air enough to extinguish the flame. By focusing sound waves and directing them at the fire we were able to create such a force, and extinguish the flame. Certain sound waves push the air, moving the oxygen away from the fire. These sound waves tend to be lower frequency, which means the waves created are larger when graphed, and push more air when moving. Only some frequencies can extinguish fire, those being from 25Hz to 60Hz. We hypothesized that 30Hz was the optimal frequency for extinguishment. We conducted trials by aiming a modified subwoofer at a tea light and timing how long between the start of the tone being played and the fire extinguishing to measure the efficiency of each frequency. We conducted trials on frequencies between 25Hz and 100Hz at 5Hz intervals. We determined that 30Hz was the most efficient frequency, so our data confirmed our hypothesis. We also noticed that past 60Hz, the sound had little to no effect on the flame whatsoever, which was very interesting to us.

B9 Relativity: The Secrets of the Octonions

Physics & Electronics

Ella Berger

Home School

Einstein has shown in his theory of relativity that it is impossible to go faster than the speed of light. Einstein's theories have been proven again and again, but this doesn't mean that they might not be incomplete. It may, in fact, be possible to travel faster than light using extra dimensions.

Einstein only used the four familiar dimensions in his theory: three dimensions of space and one dimension of time. What if there are one or more additional dimensions that would allow one to travel faster than light? According to my theory, there is the possibility of not just one, but four extra dimensions: three extra dimensions of space and one extra dimension of time.

To incorporate all eight dimensions, I will use eight different kinds of numbers. Two of them, the real numbers and the imaginary numbers, are very well known. Together, these make the complex numbers, C . The full set of numbers that I will use to explain the dimensions we are familiar with is a set of four-dimensional hypercomplex numbers: the quaternions, H . What about the other four? To represent all these dimensions, I will use the octonions, O . Octonions are non-commutative, like the quaternions, but they are also non-associative.

B12 Computer Vision-Based Characterization of Nanoscale Lamina

Physics & Electronics

Daniel Cui

Deerfield Academy

The main objective of this study was to develop a method of characterizing nanomaterials by optical microscopy. The work for this study strived to automate the image contrast-based characterization of the layer numbers using computer vision algorithms. After acquiring the necessary data points using graphene and MoTe₂ samples through an experimental method consisted of using both ImageJ and Gwyddion, curve fitting in RStudio was used to create regression models that were incorporated in a computer vision method composed of 3 algorithms. In total, 12 MoTe₂ samples and 16 graphene samples were used in 28 test trials in order to determine the algorithms' efficiency in layer number characterization.

Ultimately, a success rate of 90% was obtained with an average overall run time of 15 seconds for the computer vision method. As a consequence, this computational method may be faster, more effective, and more cost-effective than current widely used electron, atomic force, and optical microscopy techniques like multiple beam interferometry.

C6 The Mystery Behind Aerial Warfare

Physics & Electronics

Simran Kaur

Hopkinton High School

The purpose of this project is to make a model aircraft that is invisible to radar. It is based on stealth technology, in which the aircraft cannot be detected by enemy radar for military purposes. Stealth technology is used to destroy an enemy's air defense. The principle behind my project is the more light that is absorbed or scattered, it makes it hard for the radar to identify the object. To make an aircraft stealthier, or invisible to radar, the factors that affect the stealthy properties of the aircraft include: metals, shapes, paints, colors, fibers, and type of wings. To do so, I tested 39 combinations of metals, shapes, paints, colors, and fibers that best reflect the least amount of light. Upon reviewing the data, I tested the least combination with different wings on the aircraft model. Thus, I created the aircraft model that reflected the least amount of light, making it stealthier.

C10 Piezoelectricity

Physics & Electronics

Yana Chumakova

Westfield High School

Piezoelectricity is the electric polarization in a substance, especially in certain crystals, resulting from the application of mechanical stress. Some recent experiments have used piezoelectrics in pavement as a renewable energy source; it can be used to produce energy from cars driving on a road.

The purpose of this project was to find out if the size of potassium sodium tartrate crystals affects the piezoelectric output voltage when mechanical pressure is applied. It was predicted that the larger the crystal, the greater the output voltage will be. Different frequencies were applied to different sized crystals, and the output voltage was recorded. The results show that the voltage output seems to be independent of the crystal dimensions and the driving frequencies tested in this experiment within the variations in the average voltages. The peak average voltage appears more stable for the smaller crystal than the larger crystal at both frequencies. The larger crystal shows significant fluctuation in the voltage at the higher frequencies. It is likely that the stability of the output voltage depends on the size and possibly the orientation of the crystal, which would require further study.

The output voltage is not affected by the size of the material which means that even small areas of the material in the road would produce significant amounts of electricity. However, the voltage depends on frequency, which means roads on which cars travel at a higher speed will produce greater voltage.

C20 Archery Techniques: Determining the Best Arrow to Penetrate a Target

Physics & Electronics

Grace Krzanik

Berkshire Arts & Technology Charter Public School

Carbon and aluminum arrows are widely used in the archery world, and each contains its own strengths and weaknesses in varying activities; this project focuses on the penetration depth of each type of arrow. It is predicted that the carbon arrows will penetrate the target deeper than the aluminum arrows because they are lighter during flight, and they are less likely to bend on impact due to their level of durability. This was tested by firing two sets of arrows- one carbon and the other aluminum -at a foam target, then measuring the penetration depth of each individual arrow and taking the averages. The results showed the average penetration depth of a carbon arrow was 9.45 inches, and the average for an aluminum arrow was 10.43 inches. The data refuted the hypothesis because the aluminum arrows exceeded the average penetration depth of the carbon arrows. Other experiments that could be performed on this topic would be changing arrow length, seeing how arrows perform over varying distances, and determining which types of arrows are proficient in penetrating certain materials, depending on the situation.

C25 Visualization of Sound Waves in 3D

Physics & Electronics

Amrita Thirumalai

Worcester Academy

Malignant tissue is removed surgically, using chemotherapy or through drug treatment. Sound waves can destroy tissue through ablation. Kidney stones are routinely pulverized using ultrasound. Multiple sound sources converging in-phase on unwanted tumors can provide effective treatment while preventing healthy tissue damage. Being able to see sound waves in 3D would help immensely, just as a CT scan helps a surgeon plan her minimally invasive surgery that also heals rapidly.

By constructing a Kundt's tube, using two speakers and a tube with Styrofoam beads inside, I visualized different frequencies, which were produced by a signal generator app on my phone. I observed which harmonics I saw when the speakers were in phase and 180° out of phase. Even harmonics were produced when the speakers were in phase and odd harmonics were produced when out of phase. This showed me that I can control the position of maximum amplitude of the standing wave by adjusting the phase. By using a phase shifter this can be finely adjusted to target the malignant tumor. I applied the information I gained from visualizing subsonic frequencies to focusing transducers, producing ultrasonic frequencies, to levitate particles. Ultimately, this helped me understand how to focus ultrasound on specific cancerous cells in the body.

D13 Quantum Catalyzation of a Portable, High Energy Nuclear "ARC" Reactor

Physics & Electronics

Aakash Sunkari

North Attleboro High School

Nuclear reactors are an excellent source of energy due to their high power output - enough to power large cities. Atoms hold tremendous amounts of binding energy within their nucleons; this energy is released via nuclear reactions. Current nuclear reactors harness this power via fission and fusion, but are rather scientifically primitive: their size, cost, and complexity supersedes their function.

As a continuation of my previous work, which concerned the development of a portable, high energy nuclear reactor based on direct high energy neutrinoless-double beta energetics, the goal of this year's research is to optimize the electron generation and electron capture phases of the reactor geometry. The current work focused on achieving the Quantum Anti-Zeno Effect, a quantum mechanical system in which a decaying system (such as neutrinoless double beta decay) can increase its decay rate through repeated observations via an chirped ultrashort pulse amplification laser system, thus producing more high energy electrons. Subsequently, a Superconducting Magnetic Energy Storage System (SMES) was designed using geometrically optimized carbon nanotubes to create an outer core that captures and maintains high amounts of current from the reactor indefinitely. Quantum Catalyzation was tested in the monte-carlo simulator Geant4 and the SMES system was tested in Radia. In order to optimize these systems, a generative-adversarial artificial neural network was created using the GeantV framework.

The specific decay rate of the decaying quantum system shows a significant increase in the decay rate of ^{48}Ca as a result of the QAZE. The current density and magnetic field distribution show that the SMES is able to perform as a stable electron capture core.

D24 A Correlation between Telescope Lens Diameter and Image Resolution

Physics & Electronics

Siobhan Morris

Falmouth High School

When observing celestial bodies using a telescope, sometimes the resolution of the image makes it hard to see the observed object and its finite details. When we want to observe an object more clearly, the closer we get, the clearer it becomes. Unfortunately, astronomers observing images delivered from telescopes can not get closer to the object. So how do they fix the resolution? It is known (Morris, 2018) that when observing an object from a farther baseline, you will get a more accurate measurement of how far away the object is. Error in judgement of distance decreases in the axial dimension of the distance away (Z dimension) as the baseline increases. Based on the same optical principles that govern parallax, the error when testing in the lateral dimension will decrease as well. Establishing a relationship between lens diameter and image resolution will allow one to predict what celestial body can be observed.

F5 Blood Spatter Analysis

Physics & Electronics

Kayla Berry

Berkshire Arts & Technology Charter Public School

The topic of this experiment is a blood spatter analysis, the purpose of a blood spatter analysis is to identify what caused the blood or the spatter by how the diameter changes each time. My experiment was designed to test the height and diameter of blood spatters and how it is affected. I designed this experiment in a safe way that did not involve any real blood, and in just a really safe hazard free way. The card board was a really efficient way to catch and dry the spatters in my opinion, because of how deep and durable it is.

My hypothesis was actually proven to be correct in this experiment, the hypothesis was if the height is increased each time by 30 cm, then the diameter will increase each time because of the impact in the blood drop. My blood drops increased as you can see in each graph for each one of my trials. I believe the most important piece from all of the collected data from the experiment is definitely my first trial. As you can see the line goes up about a half of a centimeter for the diameter on each of the 30 cm increasing's.

F7 A Simple Low-Cost Device To Measure Fluid Viscosity

Physics & Electronics

Barut Ural

Southeastern Regional Vocational Technical High School

A prototype apparatus has been designed and built to test fluid viscosities using pendulum motion. Test fluids included water, olive oil, mineral oil, glycerin, Karo syrup, and honey. A new data analysis methodology has been developed and used to determine the viscosity from the details of the pendulum motion in the fluid.

Tested fluid viscosities spanned four orders of magnitude ranging from 1 cPs to 10,000 cPs. The agreement between measured versus reported viscosities is remarkable.

This work provides a big improvement over the methods presented by several papers published in the American Journal of Physics, European Journal of Physics, and the Physics teacher. Those methods work only in highly restricted conditions.

For example, Leme and Oliveira (2017) used a theoretical approximation to account for the effects of bob velocity and acceleration on the drag force. Then, they used this equation and linear theory of damped harmonic oscillations to calculate amplitude decay as a function of test parameters including fluid viscosity. Therefore, Leme and Oliveira's methodology is valid for only highly restricted conditions. Furthermore, it requires estimation of the experimental amplitude decay rate from data, which can be subjective. The small peak amplitude requirement forced Leme and Oliveira to an extremely low-resolution image acquisition (typically 25 pixels for peak amplitude), which casts doubts on the precision of their results.

The derivation and use of my method are based purely on algebra. I used the steady state drag force equation, but included the acceleration effect in an ad hoc fashion via a measured viscosity correction correlation. My method accounts for the non-linear effects that arise in high Reynolds number motion, and at large bob angles.

G21 Designing the Most Effective Pulley System

Physics & Electronics

Mary Woods

Bishop Feehan High School

Simple machines were some of the first engineering feats in the world, with them a task could be performed with less effort. Moreover, simple machines achieve what most fields of science do not, they are used by large numbers of people regardless of their scientific know how. By improving these devices, specifically pulleys for this experiment, it benefits the large amount of people who use them daily. The variable in this experiment was the distance between the pulleys. Four systems were tested: one with equal distance between the pulleys, one with a longer equal distance between the pulleys, another with more distance between the first and second pulleys than the second and third pulleys, and one with more distance between the second and third pulleys than the first and second pulleys. The systems were compared based on their efficiency, efficiency being a reliable way to test the usefulness of the system. All systems were tasked to lift the same weight that was measured to take 1 newton of force to lift. The hypothesis was that the pulley system with a large equal distance between the pulleys would be most efficient, as the weight would be spread more evenly over a larger distance. However, this did not occur. The pulley system with more distance between the second and third pulleys than the first and second did the best with an efficiency of 69.99%. The system that was expected to do the best came in third with an efficiency of 47.17%.

G26 Wifi-Signal Strength, Obstructed and Measured

Physics & Electronics

Zachariah Gravel-Blaney

Westfield High School

Wifi signals are present almost everywhere, and is becoming a more and more important part of our lives. It is important to understand how WiFi works, hence the the reasoning behind this project. This project tested the strength of a wireless radio signal as it travels through, air, water, saltwater and a faraday cage. This specific faraday cage is made up of a shoe box and aluminum foil, it acts as a constant and even disruption of the electromagnetic waves. The hypothesis the experimenter made presumes that the signal passing through salt water and the faraday cage would be the weakest due to electromagnetic interference that the properties the salt and aluminum have. This was achieved by putting the router, along with any obstruction used, inside the faraday cage, measuring the signal strength in dbm, and turning off and on the power to get ready for another measurement. After 10 measurements were taken for each of the different scenarios, averages were found and compared. Scenarios consisting of a the signal through the faraday cage were weakened exponentially when compared to the control scenario with no obstructions. The weakest signal of all was the saltwater/faraday combination which was predicted by the hypothesis. In conclusion the electromagnetic properties of the salt and aluminum did interfere substantially with the radio waves that were emitted from the router. Experiments similar to this one may be able to help people and companies use radio waves and signals more efficiently by understanding the properties of said waves. Data like this could also be used in larger scale important technological projects and advancements that use radio signals in the future.

G28 Magnetic Force Variations with Temperature

Physics & Electronics

Brianna Muller

Taunton High School

Magnets are a commonly used item in everyday life. In this experiment, the magnetism of a magnet was put through different temperature changes. The purpose of this was to see how strong a magnet can be when put through the various extreme conditions. At first the hypothesis was if the magnetism of a magnet is being tested in various temperatures then the strongest magnetism will be shown when the magnet is in room temperature because magnets are primarily used to being in room temperature which means that the magnetism must be strong. This was proven wrong. The procedure was to put a magnet in various temperatures (freezer, ice bath, room temperature, and boiling water) and placing it into a pile of paper clips. After performing that the mass of the paper clips were measured. Going by the averages of each test, the freezer test picked up an average of 48.23 g., the ice bath picked up an average of 28.04 g., the room temperature test picked up an average of 26.04 g., and the boiling water test picked up an average of 20.76 g. Furthermore, the freezer test was more successful than the room temperature test, which was hypothesized.

H3 The Effects of Using App Functions on a Cellular Electromagnetic Field

Physics & Electronics

Mackenzie Rae, Emilie Pease

Westfield High School

In today's society, it has become a rarity to find someone who does not have a wireless cell phone. Though these devices have advanced our everyday lifestyles, they emit a serious hazard, radiation. We designed this experiment to discover if Apple's iPhones emit enough radiation to be potentially harmful to humans. In order to avoid interference from cell towers and other electromagnetic devices, we performed our experiment in an open area. Once there, we set the iPhone on the ground and placed 3 cones 10 cm, 50 cm, and 1m from the phone. We then turned on our app function and at every 5 minute interval leading up to 15 minutes (5,10,15), we measured the radiation at every cone with our EMF Reader. The app functions we used were Phone Call, Social Media (Instagram), and Game (BitLife). In order to get a comparable reading, our control group was when the iPhone was completely powered off. We also repeated this procedure with 3 models of iPhones; 5c, 7, and 8+.

In the trials regarding Social Media and Games, the emissions succeed 170.32 Hz when detected from 10 cm away. When making a phone call, the emissions only reached 170.32 Hz after 10 minutes from 10 cm away. From 50 cm away, the emissions were typically 93.676 Hz and from 1 m all emissions were less than 17.032 Hz. The Control group was all under 17.032 Hz.

After analyzing our data, we were able to conclude that cell phones are potentially harmful to the cellular tissue of the human body. This is because 50-60 Hz is required to cause potential cellular degeneration. Many of our readings succeeded this limit by more than 120 Hz.

K11 Exploring the Diffractive Bending of Light Through Apertures

Physics & Electronics

Supriti Karki

Quincy High School

Quantum mechanics and physics work hand-in-hand to explain the phenomenon known as diffraction. Diffraction is the bending of light (monochromatic) through apertures. Huygen's principle and Thomas Young's Double Slit experiment proves that diffraction is created through an alternating pattern of dark and light bands (diffraction pattern) when secondary waves interfere constructively and destructively with each other. My purpose of this study is to examine central maxima, in both degrees and meters, of a 532nm laser beam as it passes through multiple single slits with different size widths to answer the question. I also want to explore any limitations or thresholds within the mathematical model itself.

I mounted my laser beam on a miniature stand that I replicated on AUTODESK FUSION. All of the slides with the apertures were held on an adjustable slider positioned 10 feet (3.048 m) directly away from the stand. There was also a screen further away from the adjustable slider to examine the diffraction patterns. The sizes of the apertures varied significantly (from 0.007m to 0.00001m to give context). I used a formula to find the central maxima because relying on my eyesight for results was too indefinite.

When I examined and calculate the diffraction pattern of each aperture, I found that the greater the ratio was between lambda and the slit width (a:b where b=1), meaning when the slit width was small enough to match lambda, the central maxima increased. I also went a step further and found there was a certain point where mathematically, the maxima could not be found because its inverse value of sine was greater than 1. From this, I developed a formula that calculates the threshold for the diffraction pattern of different sizes of slits.

K13 Phony Radiation: The Effect of EMFs on Plants

Physics & Electronics

Susan Takang, Taina Rico, Nelly Silva

Brockton High School

The purpose of the experiment is to determine whether the EMP-RP coming from a wifi router could affect the growth of green beans. Beans were exposed for different periods of times throughout the 15 days of our experiment. If a green bean is exposed to EMFs then the exposed green bean will have a slower growth rate compared to a bean not exposed. This reaction will take place because EMFs promote the accumulation of H₂O₂ within plants, which will hinder the bean's water circulation system. As well as increased H₂O₂, the EMFs will also trigger lipid peroxidation which will disrupt homeostasis within the bean cells. The independent variable is the various days of exposure that different plants had which determined how much the green bean would grow. The experiment will be constructed by using a wifi router as our EMF-RF device and connecting the router to a cell phone. Plants were planted into plastic containers, observed each day while watering them. Green bean plants were surrounded by the wifi router on a flat surface. Each plant had three trials. However, Plant A's had 3 days of exposure, Plant B's had 8 days of exposure, Plant C's had 15 days of exposure and Control Plants with no exposure.

N28 Cell Phone Microscope

Physics & Electronics

Sam Trumble

John D. O'Bryant School of Mathematics and Science

By conducting this experiment, I proved that my initial hypothesis was correct. The data that I collected (aka – my photographs) supports my hypothesis because I was able to examine enlarged specimens using my cell phone and the microscope that I built. The image quality that I was able to capture using the cell phone microscope is better in the sense that I can see details in the specimens that I was unable to see before; however, the picture quality is a little lower than my regular cell phone camera due to slight blurriness in the enlarged images. Some mistakes that I could have made during the building process of this cell phone microscope were blurring or scratching the lens and having the camera stage at a slight angle due to imprecise measurements.

In the future, I think that I could be a little more careful with the handling of the lens and more precise with the drilling to ensure that I have the clearest picture possible. I also could try different sizes of lenses and lenses with different magnification levels to further enhance the pictures that can be captured with this cell phone microscope. In real life, microscopes are expensive, bulky and fragile. This cell phone microscope cost less than \$10.00 to build. It was fairly easy to construct if you have access to the proper tools. In addition, it is portable and lightweight and would be a great addition to my camping backpack. As a First Class Boy Scout and Troop Guide, I can envision myself using this cell phone microscope to educate the younger Scouts in my troop and to help them take a closer look at the world around them.

Computers

Computers

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A22 Using Deep Learning for Noise Reduction and Artifact Suppression in CT Computers

Pratik Bharadwaj

Acton-Boxborough Regional High School

X-ray computed tomography (CT) has been widely utilized in clinical, industrial and other applications. Due to the increasing use of medical CT, concerns have been expressed on the effects of heavy radiation dosage to patients. By lowering the X-ray flux, however, Low Dosage CT (LDCT) images are noisier and suffer from amplification of artifacts, which degrades the signal-to-noise ratio and could compromise the diagnostic utility of these images. With the advent of deep learning to address medical problems, autoencoders have shown promise in reducing noise due to their unique compressing and decompressing capability. In this study, a convolutional autoencoder was designed to reconstruct artificially corrupted CT images, utilizing algorithms that simulate both the presence of noise and artifacts in CT images. After mapping over five thousand noisy images to their denoised counterparts, experimental results show that the proposed model is capable of suppressing noise while maintaining structural details. Specifically, from a test set of 2000 images, PSNR and SSIM of the autoencoder averaged at 30.9456 and 0.8396 respectively, whereas reproductions of other common denoising methods, including dictionary learning and block-matching 3D (BM3D), averaged a PSNR and SSIM of 28.5228 and 0.7324, respectively. Furthermore, the processing speed for target images is 47 percent faster than the aforementioned methods. This work can be used for more accurate radiotherapy diagnosis by providing realistic CT values for affected images.

A25 Privacy Vulnerabilities within IoT Device Traffic

Computers

Luc Coté

St. Mark's School

A smart home IoT device is any single purpose internet connected device designed for consumer use. Analysis of content, metadata, and patterns of a user's traffic can reveal information about their activities. IoT devices connect events in the physical world to the digital world, and thus any information leaked from an IoT device's traffic patterns would give information on a user's physical state, making IoT traffic serious privacy concern. The use of a traffic shaper with a VPN is a possible remedy for such information leaks as it could disguise the patterns and endpoints of the device traffic. In this experiment, the traffic patterns of three major smart-home devices (Amazon Echo, Nest Home Camera, and Withings Sleep Monitor) are analyzed for information-leaks then re-analyzed with traffic shaper/VPN security solution. Following examination and data collection, the preliminary results from this study show the combination of a VPN and traffic shaper to be an effective remedy to the privacy vulnerabilities found in the patterns of smart home IoT device traffic.

A28 A Study In The Traveling Salesman Problem

Computers

Andrew Adiletta

Worcester Academy

The traveling salesman problem is a very interesting problem because on the surface it appears incredibly easy to solve, but when you dig deeper it becomes evident that it is a very difficult problem to solve. It involves a salesman who is trying to get to all the cities in his region in the shortest distance possible. As it turns out it's not so easy, because the more cities that are added for the salesman to pass through, the more difficult it is to compute which path is the shortest. If you have 3 cities, for example, there is a total of 3 factorial possible paths that the traveling salesman can choose from. Effectively, when the salesman starts off, he has 3 cities to choose from, after that he has 2 cities to choose from because he's already traveled to one of the cities, and then lastly, he has one single city to go to which leaves $3 * 2 * 1$ or 3 factorial possible paths. Factorial is a funny thing in mathematics because it grows so massively fast. In fact, if you look at the growth of a factorial graph, versus an exponential graph, you will find that the factorial grows at a much faster rate. How fast? Well, if you have 5 cities, there is a total of 5 factorial paths or 120 possible. After examining many of the approaches to TSP. An Artificial Intelligence approach was intriguing, using pattern recognition techniques. However, after more work, a new approach seemed very intriguing: A Genetic Algorithm approach. Simply stated, a Genetic Algorithm solves a problem by employing natural selection, just as humans evolved, could the Traveling Salesperson evolve?

B8 Calling 911 When Detecting an Irregular Heart Rate Using Arduino

Computers

Tanisha Rajgor , Archita Nemalikanti

Hopkinton High School

About 610,000 people die every year in the United States due to heart-related diseases. Many of those cases occur because of a lack of proper medical attention in time. Paramedics do not arrive in time when a person is struck immediately with cardiovascular disease. There are many devices on the market that can measure one's heart rate, such as the Apple Watch and Fitbit. However, when a person has an irregular heart rate these devices can only inform the victim of it. The victim must call for medical on their own. But what if the person cannot physically call, and there is no one to help them?

When heart rate drastically drops or raises, a device created should be able to call 911. There are four modules to the project: the signal (pulse) generator, the Arduino board, the Bluetooth module, and the app in the phone. A signal generator simulates a heart rate through electronic signals or beats. The signal generator is an analog device that sends out a pulse to the Arduino. The Arduino, a digital device, allows the circuit to flow, and is the 'brain' of the circuit. The Arduino is supposed to receive the heart rate from the signal generator and display the heart rate on the display (which is located on the breadboard). If the heart rate is over 80 bpm or less than 50 bpm, then the Arduino should begin a countdown of thirty seconds on the display. When the countdown hits zero, the Arduino should recognize it, and send a signal to the Bluetooth module located on the breadboard. The Bluetooth Module should then send a message to the app in the phone, and then the phone should be able to call 911 (or any other number; in this project, 911 should not actually be called, so it was replaced with a different number) the Arduino will also inform the user by using an alarm.

B10 Mobile Application of A Deep Convolutional Neural Network for Produce Computers

Lucas Lanzendorf

Mass. Academy of Math & Science

Price Look Up (PLU) Codes assigned to every type of produce are essential to cashiering. It is difficult for cashiers to memorize enough PLU Codes to best serve customers, and the additional time taken to manually identify item PLU Codes slows the flow of customers through a checkout line. The purpose of this project was to develop a more time-efficient alternative to memorizing PLU Codes. This goal was achieved by integrating a convolutional neural network (CNN) in a mobile application. The dataset used to train the CNN uses thousands of images of produce captured from every angle through the use of a rotating platform. The network was then implemented in an Android application in Android Studio. The application was validated using a series of new images of produce and achieved a training accuracy of 97.7% in under 6 seconds of response time. Compared to the average accuracy of similar neural networks (85.3%), the application demonstrated 14.5% improvement. This application has the potential to greatly improve the efficiency of cashiers at supermarkets and consequentially benefit individual consumers.

B21 R-View

Computers

Srivishnu Piratla

Advanced Math and Science Academy

The first school shooting I remember was the Sandy Hook shooting in Connecticut, I was just one year older than the kids that were killed. I still remember our third-grade class sitting around in a circle and talking about the shooting. More school shootings nowadays happen in high school. As a current freshman in high school, there is always that fear inside me that my school could be infiltrated by a perpetrator. I thought my town was safe from all the shootings since I hadn't heard of any shootings near me but one day I was reading through my news feed and a person got shot at a gas station, five minutes away from my house. That really scared me - because we go by that gas station on my way to school every day. This prompted me to develop a system that could quickly detect firearms carried by potential attackers in public areas and schools. The system should be inexpensive, leverage existing infrastructure, and be easy to install. The system should alert the authorities and provide nearby civilians with the safest escape path through a mobile app. This prompted me to create the R-View system, The R-View system uses a deep convolutional neural network trained in Tensorflow, specifically the Single Shot Detector Mobilenet, to identify perpetrators. It uses PHP scripts to bridge the client and the program running on the phone. With this solution, action will be taken proactively whenever a shooter enters into a place with the system installed.

B22 Is It a Plane? Is It a Dragonfly? Ask the Machine

Computers

Akash Kumar

Shrewsbury High School

This project demonstrates the application of deep learning techniques for image/object recognition. The last few layers of the a pretrained resnet34 convolutional neural network is trained with images of dragonflies and planes to create a new neural network this is then used for detecting images that contain dragonflies or planes. This same model can be trained with a different set of images to detect arbitrary objects. This project uses the fastai library to achieve the above goal. In this project the effect of learning rate on the final was studied and the results showed that allowing the model to calculate its own learning was most optimal. The objects chosen for training were arbitrary which implies that this technique can utilized for the identification of different diseases like anaplasmosis or lyme. Diseases like these are diagnosed by looking at infected cells by trained pathologists. However, a trained computer program like the one in this project, when presented with pictures of the diseased cells, can efficiently identify the disease.

B26 A Sound-Based Mobile Application for People with Sleep Disorders

Computers

Nazif Vardar

St. Peter-Marian Jr. Sr. CCHS

INTRODUCTION: People spend more than 25% of their life sleeping. Poor sleep quality is associated with an increased risk for a number of chronic diseases and conditions like diabetes, cardiovascular disease, stroke, obesity, depression. Besides its medical harms, sleep deprivation can negatively affect an individual's cognition, concentration, productivity and performance over the day. How can we measure and improve the sleep quality of people with sleep disorders?

PROBLEM STATEMENT: Music has powerful and diverse effects on both body and mind, influencing breathing and heart rate, triggering the release of hormones, stimulating the immune system, and boosting the brain's cognitive and emotional centers.

HYPOTHESIS: Music can improve the sleep quality of people with sleep disorders.

PROCEDURES:

Implement a sound-based mobile application to integrate into a sleep-analyzer application's (Sleep as Android, Urbandroid).

Enable database access to the mobile application to track daily preferences of participants. (e.g. listen or don't listen to music, music genre)

Link the app with other mobile applications (Youtube, Sleep as Android, Firebase) by using their APIs.

Search relaxing music for 6 different genres and create a playlist each containing 4 different songs.

Select participants by a questionnaire and make them use the app for 2 weeks.

Observe Participants' activities in Firebase console and take notes.

Analyze the participants' sleep pattern and create graphs.

RESULTS AND CONCLUSION: Sleep length does not necessarily improve sleep quality. Deep sleep proportion is inversely related to sleep length independent of listening to music. Each participant's sleep quality has improved when they have listened to music.

C9 An Application of Machine Learning for Insulin Injections

Computers

Adiva Daniar

Pioneer Charter School of Science

The purpose of this project was to create an efficient calculator for patients with Type 2 Diabetes to determine how much insulin they should take. The goal was to make it as tailored as possible to each person. The prototype needed to be quick and simple to use while not generalizing patient statistics. The prototype met the criteria and the constraints. The code was first panned using java, then converted to a user interface.

C24 A Problem-Agnostic Black Box Metaoptimization Strategy

Computers

Aedan Cullen

Hopkins Academy

Current machine-learning solutions focus on the ability of fixed algorithms to optimize numerical models, such as neural networks. Both the optimization algorithm, which adjusts the parameters of the numerical model, and the structure of the model itself are traditionally fixed. This project investigates the possibility for a general-purpose "black box" optimization method to be implemented, which adjusts an arrangement of discrete computational elements rather than a typical numerical model. This structure allows both the optimization algorithm itself and a trainable model to be represented using the same basic set of elements, and as a result it is practical to create a "metaoptimization" flow where one optimizer is able to train a second, improved version of itself. This project introduces a new statistical method for evaluating performance of meta-trained optimizers. As a result, it is easier to automatically generate efficient, application-specific optimizers even without the system having any prior knowledge.

C27 Effects of Different Training Sets on Image Classification

Computers

Yuxuan Bao

Northfield-Mt. Hermon School

There is often great difficulty in model training when using multiple available datasets with different characteristics for the desired categories for a given application. To solve the problem, this research developed a training method for convolutional neural network models with multiple datasets to achieve good performance on both datasets. Two different methods of training with two characteristically different datasets with identical categories, one with very clean images and one with real-world data, were proposed and studied. The model used for the study was a neural network modified from ResNet, optimized for performance. Mixed training was shown to produce the best accuracies for each dataset when the dataset is mixed into the training set at the highest proportion, and the best combined performance when the real-world dataset was mixed in at a ratio of around 70%. This ratio produced a top-1 combined performance of 63.8% (no mixing produced 30.8%) and a top-3 combined performance of 83.0% (no mixing produced 55.3%). This research also showed that iterative training has a worse combined performance than mixed training due to the issue of fast forgetting. Rehearsing the previous dataset during the second training alleviated this issue, but iterative training with rehearsal still did not surpass mixed training in either combined or dataset-specific performance.

C28 Multi-Scale GPA Conversion Calculator

Computers

Stephen Hinck, Nicholas Duncan

Westfield High School

When applying for college, filling in information for a scholarship, or attempting to gauge your acceptance chances into a certain school, your high school GPA is a requirement. However, the manner in which GPAs are calculated in high schools across the country, vary from school to school. The common 3 forms of receiving your high school GPA are in the form of $x/100$, $x/4.0$, and $x/5.0$ (x being your score out of the given number). Westfield High School calculates their GPA on an $x/100$ scale with a slim potential to have a maximum GPA of $110/100$ due to weighted classes. The problem lies in the fact that Westfield High School does not convert your GPA into a 4.0 or 5.0 scale, and without any knowledge of converting your GPA to these scales, a student could report an incorrect GPA on an application, or be unable to enter their GPA at all. By creating a multiscale GPA conversion calculator, we will be solving an issue that not only would greatly help ourselves, but also be a useful tool for our community, and even nationwide. By using C++ programming we will create a calculator that automatically converts your $x/100$ GPA into a final, accurate $x/4.0$ GPA after entering your grades. This calculator will ease the stress students will have in applying to colleges or for scholarships in an already rushed and daunting process. During research, many issues were encountered and overcome. Initially, the sum variables were not initialized to be zero, so incorrect numbers were output. Another issue was in C++ $/2$ doesn't work the same as $*.5$. These issues were both fixed and the calculator was able to work and meet the design criteria: faster than by hand and 100% accurate. The researchers will pursue making the calculator more user friendly by implementing a GUI given more time.

D6 Defenses Against Adversarial Examples Using Signal Processing Tech.

Computers

Neel Bhalla

Lexington High School

Deep or machine learning (ML) models are being widely applied to various fields with applications to computer vision, speech recognition, natural language processing, audio recognition and can perform classifications tasks with high accuracy. Some examples of systems using ML models are biometric systems (fingerprint or face recognition to log on to your bank account or phone), self-driving cars making driving decisions, our interaction with Siri or Alexa systems. These ML or "smart" systems are so prevalent that we interact with them every day without realizing how they are making critical decisions for us. One key question to consider is - can these ML models be "hacked"?. Can we trick the ML models to make false decisions.?

One way to hack a closed ML model that you don't have access to the internal system except to interact with it is to perturb the input data going into the model and force it make a decision on the perturbed input. The ML model will not have a way of knowing that the input has been perturbed and would make an erroneous decision. The perturbed input data is called adversarial examples.

In this project we propose to develop a defense against adversarial attacks using signal processing techniques. The input to the ML models are signals that can be described in the time or image domain. By using signal processing based filtering techniques, we can filter out the input perturbations in the data and the "filtered" data would be more robust to model classification errors. We experiment with various signal processing filtering approaches and conduct experiments on the MNIST, CIFAR-10 and ImageNet datasets, and show that ML models with Fourier or Wavelet preprocessing on inputs have higher accuracy on adversarial examples.

D9 Teletherapy Platform with Integrated Eye Tracking Technology

Computers

Ashwin Sukthankar

St. John's High School

This project involved the development of two prototypes meant to simulate a teletherapy session to teach children with autism how to make eye contact. Teletherapy is the use of telecommunications technology to delivery of professional services at a distance by linking clinician to client, or clinician to clinician. Both prototypes made use of a conventionally available eye tracker, Visual C# for the code, and Unity for the GUI.

This project seeks to teach children with autism how to make eye contact, as they often shy away from direct eye contact and social contact.

D10 The Evolution of Buses: Optimizing Bus Routes Using Genetic Algorithms

Computers

Brayden Goldstein-Gelb, Henry Ayanna

Somerville High School

In an attempt to fix some of the flaws present in the Massachusetts bus system, a genetic algorithm was created to create new bus routes. The required materials were a computer, access to MBTA data, a code editor, the P5.js library and the HERE API to calculate the distances between bus stops. An algorithm was then created using the same principles as evolution in nature. The algorithm was given a set of points, each containing data such as the average entrances and exits on a weekday and the coordinates of the bus stop.

Genetic algorithms have three main steps: selection within a population, reproduction and mutation. First, all changeable parameters were first randomized. Then, a fitness function determines the “best” performing members of the population and the population is replaced with a new one. In the mutation step, each member of the population has a small chance of being changed slightly. This new population was then put through the same process until improvement levels off or the user sees fit.

The highest fitness score achieved by the algorithm, when initialized randomly, was 93.31% of the original bus system. However, when the algorithm was initialized as the original map of the MBTA, it was able to attain scores of over 116.12% of the original bus system.

D11 Quality Printing, A How To!

Computers

Alberto Flores

Southeastern Regional Vocational Technical High School

My project was made in order to create a more streamlined process for engineers to follow when 3D printing and modeling. This new standard that I have created will allow engineers to 3D print at the highest quality possible. When an engineer is able to print at these standards their models will be much better when working on any projects that may be at hand. Comparatively, if your model is brittle and broken your project may fall apart or worse may not work at all.

D12 Which Sorting Algorithm is the Fastest on Average for Sorting Lists?

Computers

Samuel Schumacher

Taunton High School

This project's goal was to determine whether the merge sort, insertion sort, or quicksort sorting algorithm would be the fastest on average when sorting numerical lists in ascending order. It was hypothesized that the quicksort algorithm would be the fastest. The independent variable was the sorting algorithm used; the dependent variable was the time needed to sort the lists. Sorting algorithms are relevant because they are often used unknowingly in everyday life. These algorithms have a number of uses, such as sorting products in an online store by price or reducing the time needed to search a database, making them very relevant in today's technology-centered society. It is important to know the relative speed of sorting algorithms so that the time needed to perform these operations can be minimized. In the experiment, the programming language Python was used to write a program that could use merge sort, insertion sort, and quicksort to sort numerical lists. Each of these algorithms sorted ten different lists across five trials, producing the following results: Merge sort was the fastest, averaging 0.132 seconds; quicksort was the second-fastest, averaging 0.261 seconds; and insertion sort was the slowest, averaging 8.367 seconds. However, once an outlier was removed from the data of all three algorithms—the ninth list performed extremely poorly when sorted using quicksort, skewing the results—these new results were found: Quicksort was the fastest, averaging 0.056 seconds; merge sort was the second-fastest, averaging 0.092 seconds; and insertion sort was the slowest, averaging 5.457 seconds.

D25 Toxic or Not: Using Machine Learning to Predict Toxicity

Computers

Andrea Danila

Sharon High School

My project focuses on predicting activity in the Aryl Hydrocarbon Receptor (AhR), a protein in Chromosome 7. The responses that certain chemicals elicit on the AhR indicate the chemical's toxicity. I thus utilized the Tox21 AhR dataset for my project, which I then split into a training set and a validation set. The data consisted of the name of a chemical, an activation marker, and then different features of chemical structure with information corresponding to each chemical. I researched the features to better understand how they may affect the toxicity of a chemical and used a Decision Tree Classifier to further determine which features were most important. After training and optimizing to lower losses, the model, which implemented the Keras library, ran on the validation set and achieved an accuracy of 97%. I conclude that deep learning can successfully be used to help predict the toxicity of new drugs, reducing animal testing and getting drugs to market more quickly.

D26 Using Machine Learning to Predict Flu Outbreaks

Computers

Neil Malur, Benjamin Chen

Weston High School

Influenza is a common disease that breaks across the world every year. It is constantly evolving past medical treatments in new strains, making combating it a challenge, and lack of knowledge about when it will break limits how well communities can be prepared. Current methods often mispredict levels of the outbreak, leading to either over-preparation or under-preparation. Over-preparation wastes resources and time while under-preparation limits how well care can be given to those affected, causing the epidemic to hit even harder and affect more. The flu virus is difficult to predict as it changes every year and affects the population differently. In 2017, models underpredicted levels of the crisis, leading to severe under-preparation that inhibited the ability of those affected to receive appropriate and timely care. A serious flu season can end the lives of 50,000 people in the United States alone, so the flu is a major issue.

The intensities of flu outbreaks and gross under-preparation due to model inaccuracies provided motivation to improve existing techniques in order to prevent similar situations in the future. In this paper a method is examined to predict the number of flu outbreaks per year so that we may be better able to respond to outbreaks of the virus in the future. A machine learning model was developed using a type of Recurrent Neural Network (RNN) called an LSTM (Long Short-Term Memory) to predict the frequency of flu outbreaks in any given week. It uses the frequency of past flu outbreaks as well as various socioeconomic factors to predict the number of outbreaks in any given week. The most major result is this methodology and its successful flu predictions, helping medical professionals prepare for future outbreaks and save lives in need.

F8 How Does Tree Depth Effect the Performance and Efficiency of Chess AI

Computers

Sam Honor

Bishop Feehan High School

This project explores how a game tree can be used to programmatically play the game of chess. In a world dominated by machine learning and neural network based artificial intelligence systems, it is important to remember that there are other solutions to intelligent computing problems. A common issue with using neural networks is the availability of training data. Without adequate training data, a neural network is completely ineffective at a given task. Player vs player games are notoriously hard to teach a neural network how to play, as it is very hard to collect a wide enough variety of training examples that includes various strategies and positions. A game tree however, requires no training data, and in theory will have a 100% win rate (in practice this is not the case). This experiment tests game trees of depths 1 (control), 2, and 3 to show how the depth of a game tree affects the performance of chess AI. The experimental AI is tested against Stockfish Chess AI playing at level 1. Stockfish is a competitor in the World Computer Chess Championship. The hypothesis is that the tree with depth 3 will perform the best, as it searches the furthest and therefore has the most information to work with. The significant results of the experiment were that the depth three AI performed the best, winning 50% of the time. The reason it could not win all the games was that Stockfish utilized an endgame algorithm that gave it a distinct advantage. Adding this to the experimental algorithm would not fit in this experiment, as it was not game tree based. The purpose of this experiment is to explore the performance of game tree based chess AI.

F11 KnowBias: A Novel AI Method to Detect Political Bias in Text

Computers

Aditya Saligrama

Weston High School

We introduce a system for detecting the degree of political bias in textual content such as social media posts and news articles. In the space of scalable text classification, a common problem is domain mismatch, where easily accessible training data (i.e., tweets) does not correspond in format to the desired testing domain (i.e., longer form article content). In our approach, we address this challenge by demonstrating a two-step classification system that can reduce any given content at evaluation time to be similar to the training domain. First, we show that a naive system suffers from accuracy degradation when attempting to classify content outside its training domain of tweets. We then profile each of the optimizations that help our novel two-step system perform well on all types of polarized content. We finally evaluate our improvements using a variety of test suites, including a set of tweets and long-form articles where annotations were crowd-sourced to decrease label noise, measuring accuracy and Spearman-rho rank correlation. In practice, our solution achieves a high accuracy of 86% ($\rho = 0.65$) on these tweets and 75% ($\rho = 0.69$) on long-form articles.

F13 Using Machine Learning Techniques to Categorize the Seafloor

Computers

Lawrence Tang

Falmouth High School

Most of the ocean is unexplored, and currently there is a push towards using autonomous robots to assist with the exploration of the seafloor and increase efficiency. For the robots to be able to adaptively plan their path to collect relevant information, they need to be able to categorize their environment. This project developed image categorization techniques that a robot can use to explore the unknown ocean. Using transfer learning with a Mask R-CNN network trained on the COCO dataset, I was able to train the network on a few hundred seafloor images annotated for coral, terrain, and fish. I used zero-shot learning by applying k-NN on feature vectors extracted from images using the Mask R-CNN network. I used the output of ROI pooling on the bounding box proposals as feature vectors. I was able to successfully create a model that could distinguish between different seafloor objects and could be applied in an automated underwater vehicle.

J7 Antimicrobial Resistance Prediction Using Convolutional Neural Network

Computers

Andrew Zhang

Roxbury Latin School

Antimicrobial resistance (AMR) threatens the effectiveness of antibiotics against bacteria worldwide, causing hundreds of thousands of deaths each year. Unsure of which antibiotics will be effective against a particular strain, clinicians are in the dark for prescriptions. Traditional culture-based testing takes at least two days, in which time the patient's condition could significantly worsen. Thus, there arises a need for faster identification of a bacteria's resistances. I propose a method to determine if a bacteria is resistant to an antibiotic based on its whole genome sequence (WGS) data using deep convolutional neural networks (DCNN). DCNN can quickly and accurately classify data by learning features from large data sets, as shown in other areas of research like image classification. An encoding scheme is designed to convert WGS data, which are strings, to genomic images, and AMR phenotypes to labels, so AMR diagnosis problem can be tackled as an image classification problem. A DCNN model is developed to work with the unique characteristics of genomic images, is shown to learn resistance genes, and achieves an average AMR prediction accuracy of 98%. The model is verified with *Acinetobacter Baumannii* resistance to Carbapenem and *Klebsiella Pneumoniae* resistance to Ampicillin. The model takes less than a second to predict AMR phenotypes. This model, if used together with the real-time genome sequencing machines, now already available, could make rapid AMR predictions, allowing for critical time to ensure good patient outcomes, and preventing outbreaks of the deadly AMR infections.

K16 Direct Anonymous Attestation with Subverted Platforms

Computers

Ethan Mendes, Patrick Zhang

Westford Academy

More than ever, users today wish to keep their identity and other personal information hidden from identity thieves and hackers. This idea of remaining anonymous is especially applicable to demonstrate that a device isn't malicious or that it is part of a specific group, such as in the case of Digital Rights Management. Existing processes utilize a Trusted Platform Module (TPM) to perform these attestations. However, all existing anonymous attestation protocols allow the operating system (a difficult body of code to verify due to its large size) to control the process of the attestation, which can lead to leaked credentials. We have built on preceding work to present an attestation protocol which reduces the reliance on the host operating system by using both a secure execution environment provided by Intel Software Guard Extensions (SGX) and a secure means of sending the attestation through the operating system using The Onion Router (TOR). This protocol has a more realistic threat model than any past work, from which a strong notion of anonymity can be achieved with the same functionality provided by all previous methods.

P17 Rehabilitation System for Limb Movement Evaluation

Computers

Yutian Fan

Milton Academy

A cerebral infarction is a brain illness caused by a blockage in or narrowing of the arteries that supply blood and oxygen to the brain. The restricted amount of oxygen to the brain results in varying levels of disorder in the limb function of patients, severely affecting their normal lives. For cerebral infarction patients, physical rehabilitation is crucial in the early stage of their illness. The correct instruction of rehabilitation exercises can effectively restore the patient's limb function, reduce the chance of reoccurrence and improve the patient's daily life.

In order to provide cerebral infarction patients effective early treatment, this project strives to develop a motion evaluation model based on deep learning. In order to enhance the instruction of rehabilitation exercises, the project's model defines 6 standard exercises as training input. It then employs the python Openpose framework to extract the coordinates of 18 joints of the human body, and traces the trajectory of these 18 joints when a person carries out one of the standard exercises. The trajectory of the joints during the exercise is used to train the LSTM network. The final model can be used as a guiding model for rehabilitation training.

Chemistry

Chemistry

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B5 Using Superhydrophobic Coatings to Prevent Corrosion

Chemistry

Maxwell Onffroy

Bancroft School

Superhydrophobic coatings are relatively new and have many applications such as increased corrosion resistance, water repellency, and increased sterilization; however, these coatings have not been seen to be durable or long lasting. The purpose of this experiment was to test two commercial and one laboratory made superhydrophobic coating for their effectiveness and determine the best layer to prevent corrosion. In phase 2, a new coating will be made and tested with the commercial coatings

Steel sheets, 2.5cm x 2.5cm squares with the corners cut, were coated with Rust-Oleum Neverwet, RainGuard liquid repellent, and a zinc oxide/epoxy coating, originally created by a group headed by Xin Zhang. The coatings sliding angle and contact angles, measurements of superhydrophobicity, were determined through the application ImageJ. The organic compound 1,10-phenanthroline was used to determine the amount of iron corroded into solution using a spectrophotometer.

The experiment tested 3 different layers of each of the 3 coatings: one below the Recommended layer, one at the Recommended layer, and one over the Recommended layer. The experiment additionally consisted of a 3.5% NaCl solution (the percentage of salt in the ocean) corrosion run and a deionized solution run to determine the effectiveness of each coating. When immersed in the NaCl all of the coatings degraded quickly and the large standard deviation showed the coatings varied in effectiveness for each coating layer. When the sheets were immersed in distilled water 3 layers of Rust Oleum was seen to work the best with very little corrosion in 3 days, while 2 layers of ZnO/Epoxy allowed for less corrosion than the Rainguard coating and controlled sheets.

B23 Finding an Efficient Method to Remove Phosphate from Water

Chemistry

Sarah Liu

Lexington High School

Eutrophication is a process caused by the presence of excessive nutrients in bodies of water, which results in the formation of a dead zone. Phosphate is the primary cause of eutrophication in freshwater systems. Although methods of removing phosphate from water exist, they involve complex biological processes, or treating water with chemical precipitation in a lengthy process that produces excessive sludge. Thus, the goal of this project is to identify a polymer that can be used in a filter to efficiently remove phosphate, and prevent the onset of eutrophication in bodies of water. Ion exchange is a process achieved between polymers and ions in a surrounding solution, that allows the ions to retain their precipitation properties. An ion exchange reaction was performed between sodium-supported water hardness reducing resin and saturated aluminum sulfate, ferrous sulfate, and calcium chloride solutions, which are metals that form precipitates with phosphate. Then, this resin was left in water containing phosphate to precipitate the phosphate. Using this resin in a mesh filter removed 800 ppb of phosphate from 10 times its weight of water when left in the solution for 1 hour. All the variables were tested through experimentation, and a control experiment was also performed, with resin that did not complete ion exchange with metals. The resin I produced can be reused indefinitely after performing ion exchange with sodium chloride, then repeating the experiment. The optimal resin can remove 800 ppb of phosphate from solutions with phosphate concentrations of over 800, and can remove up to 800 ppb of phosphate from solutions with lower concentrations. The experiment can also be successfully. The resin was also tested on samples of water from local water systems.

B25 Analysis of Mfg. Process of D-Glucose-Based Thermoformed-Polymers

Chemistry

Suvin Sundararajan

Westfield High School

This project analyzes the manufacturing and polymerization process in creating a stable polymer based upon the monomer D-Glucose. The purpose was to assess whether changes to the materials and the polymerization procedure would increase the overall tensile strength in series of recycling through heat reformations.

Polymer samples were created by changing ingredient proportions of starch, hydrochloric acid, and polyethylene – oxide and dried for seven days in a lab. Each sample was examined to mark polymer orientation and cut into dumbbell shapes parallel to striations, which conform to ASTM standards. Tensile strength tests were conducted to measure stress as a function of strain over a set period of time.

Using force probes, increases to proportions showed an increase in overall strength that could be maintained and improved after re-melting through heat. Some polymers were able to be thermoformed properly, while ones with little or no HCl failed to be thoroughly recycled without caramelizing. The inclusion of PEO composite increased the overall strength further. Variations in tensile strength tests suggested that as materials reform due to heat, bonds within become less stable and less durable.

Higher proportions of hydrochloric acid and PEO resulted in greater overall tensile strength after six periods of recycling. Properties of this polymer can be benchmarked with other commonly used plastics to establish real world applications. This includes the majority of consumer goods produced with plastic but also durable building materials.

C15 Table Salt. Surprisingly Complex

Chemistry

Conroy Casey

Berkshire Arts & Technology Charter Public School

In the experiment Table Salt. Surprisingly Complex., we will be growing basic table salt crystals on different angles. More specifically, we will be looking how salt grows on three different angles. We will be using three different 3D printed models of triangles with their main angles being thirty, sixty and ninety degrees to test this out. We will heat up three identical beakers with the necessary amount of water and salt in each, suspend the shapes in the water, and finally weigh the shapes to get the mass of the salt that grew on them and compare them. We believe that the triangle with the ninety degree angle will have the most salt grow onto it because salt crystals generally grow in cubic formations. The data that we collected shows that each triangle did indeed grow salt on it. The sixty degree triangle had a total mass of 2.6 grams of salt, and the ninety degree angle had 0.2 grams of salt on it, disproving our hypothesis.

C16 Effect of pH and Concentration on Antioxidants in Berries and Dementia

Chemistry

Sanjana Krishna

Acton-Boxborough Regional High School

For people at a high risk of dementia, blueberries provide a good way to lower that risk. Given a certain quantity of blueberries, I wanted to see in what conditions the antioxidant concentration would be the highest and the lowest. Determining how much the blueberries were affected by different pH ranges and concentration of Fe and H₂O₂ for the Fenton reaction would help provide insight on preventing the occurrence of the reaction in the brain of people with risk of dementia. The effect of these factors on the reaction, which produces gaseous free radicals (hydroxyl) that stabilize with the antioxidants in blueberries, can be determined qualitatively and quantitatively through concentration of antioxidants using Folin Reagent/ DPPH and mass change. Furthermore, from the findings, an ideal supplement that maximizes antioxidant concentration can be made.

D7 Quantifying Effect of a Rapid Temperature Increase on Coral Bleaching

Chemistry

Elizabeth Regnier, Catherine Morrissey

Westfield High School

This project is to help our population understand how a rapid increase in temperature would affect coral bleaching, and how to quantify it. With our sea waters rising, due to global climate change, there has been a 50 percent decrease in the coral population. Due to this, we wanted to see if a rapid increase of temperature would affect the amount of coral bleaching. Two fragments of *Caulastrea furcata* (coral species) were placed in Tank A, and another two fragments were placed in Tank B, with proper nutrients, water conditions and lighting. Over the course of 21 days, water temperatures were gradually raised from 78°F/26°C to 89°F/31.6°C and images were taken from the left, right, and front view, to see if temperature (independent variable) affects the area of bleaching (total bleaching (dependent variable)). Our hypothesis was, if temperature is increased beyond optimal temperature, then the coral bleaching will increase. The data collected and analyzed from this experiment supported our hypothesis because it showed there was a significant difference in our data between Counts 1 and 7. Using our image analysis system; ImageJ, we discovered a non-invasive way to quantify the extent of bleaching.

D17 Concentration of Red Dye 40 in Sports Drinks

Chemistry

Abby Goyette

Westfield High School

This project was an analysis of how much Red Dye 40 various sports drinks contain. The negative effects of Red Dye, as well as the increasing popularity of sports drinks were the motivation in conducting this project. Concentration was determined by creating a set of standards with a known stock solution. The concentration of the stock solution was calculated using Beer's Law. Using a spectrophotometer the absorbances of each standard were measured and a graph was formed of concentration versus absorbance. The absorbance of each sports drink was found and then the concentration was calculated using the equation from the graph. The hypothesis was disproved, as darker drinks didn't consistently correlate with a greater concentration. Powerade and Gatorade Fruit Punch both contained the same amount of Red 40. Contributions of this project include: public awareness on the negative effects of Red Dye 40 and a method for determining the dye concentration in sports drinks. In the future this could be used to help the FDA set limits on how much Red 40 food and drink products can contain.

D28 Using a Watch for Chemical Analysis: A Wearable Diagnostic Platform

Chemistry

Timothy Pinkhassik

Boston University Academy

This work tested the feasibility of creating a cheap and easy to use platform for measuring the amounts of different analytes, or molecules and ions of interest. Versatile wearable devices for monitoring the levels of metabolites, signaling molecules, and pathogens are critical for the shift of medical practice toward personalized and preventive medicine.

The hypothesis tested in this project is that a wearable device built from inexpensive components can be adapted for the analysis of different analytes using RGB values measured from the surface. The work was divided into two sub-hypotheses and four engineering goals. Specifically, I tested the sub-hypotheses that RGB values can be used to measure the concentration of model analyte and that the platform can be adapted to different chemosensors. In addition, I pursued engineering goals of creating imitation skin for testing the platform, assembling the device from inexpensive components, programming the device to give the response based on the analysis of color, and 3D printing a wearable prototype.

Experimental data supported the main idea of this project and showed that the main hypothesis was valid.

Concentration of a model analyte was readily measured from RGB values of colored solutions; entrapment of indicator dyes in nanocapsules allowed expansion of a platform; a hydrogel and a gelatin gel with embedded dye-loaded nanocapsules was created as imitation skin, and a wearable prototype device was built using a PJRC Teensy 3.2 microcontroller and programmed to give response based on color recognition.

F21 Don't Use Carmex, Use FeMe

Chemistry

Melanie Roman, Fernanda Castaneda

Edward M. Kennedy Academy for Health Careers

Lip balm is an important skin care product that heals, prevents and moisturizes cracked lips. It is especially important in dry and cold winter months. This experiment examined the difference in primary ingredients used in most lip balms. In this experiment beeswax and coconut oil was melted and cooled down. Once it was hardened each product was tested on its texture. The coconut component resulted in being the smoothest, beeswax concluded to be to dry and the coconut oil with beeswax was also dry.

F28 Hidden Sugar

Chemistry

Anyeli Arias, Maicoll Ferreira

Edward M. Kennedy Academy for Health Careers

Most of us should be getting more fruit, not less, says Maxine Siegel, R.D., who heads Consumer Reports' food lab. Adults should be eating at least 1½ cups of fruit each day, but according to a 2015 report from the Centers for Disease Control and Prevention, 76 percent of Americans don't consume that much. Studies show that depending on the type of fruit you eat the effect will be different. Drying, for instance, rises the sugars content in the fruit to a higher level, while eating it raw could lead to obtaining unnecessary calories and sugar. The FDA's added sugar label misses a key point – it doesn't cover sugars from natural sources that have been heavily processed during production.

Hidden sugars are types of sugar added to processed foods that most people do not recognize as sugar. They are "hidden" by packaging that markets products as "healthy" and "wholesome." There are no website or research found that is exactly about this project. If we contract the natural sugar from the fruit then we will find out that fruit has a lot of natural sugar. We will also find out that a banana contains more sugar than a strawberry.

In this experiment, a sugar metabolism kit can determine the average amount of natural sugars in baby food. After testing various types of baby food, the flavor that contained the most natural sugar was the banana. The hypothesis stated that if natural sugar could be extracted from baby food, it would show that fruit contains a lot of natural sugar, particularly the banana. We found that our hypothesis was correct.

G25 How To Get Away With Murder

Chemistry

Jasmani Rivas, Nayeli Ortiz

Edward M. Kennedy Academy for Health Careers

I am conducting this experiment because it can determine how someone is murdered. It gives information that leads me to what happened and based on the evidence collected, I can infer what weapon was used. I conduct this experiment based off of the question of which weapon (hammer, a fist, and a knife) results in a larger blood spatter? I took an educational guess that if I test what weapon results in a larger blood spatter, then a hammer would result in a larger blood spatter because a hammer contains more mass and will deliver more force which would cause the blood spatter to be larger. I will soak a sponge in fake blood and use a sheet of paper to then measure the width and length of the blood spatter. This will be done three times for each individual weapon. I will then compare the results and determine if our hypothesis was correct. Place the trash bag onto the floor.

H8 Anatomy of A Kidney

Chemistry

Thajhea Desir

Foxborough Regional Charter School

Transplantation has been one of the most greatest breakthroughs in medicine, allowing doctors to use the organs the was once in one body and effectively transfer it to another. But transplantation has also posed a growing problem in society. There is currently a large discrepancy between the people on the waiting list and the organ donors. There are more people on the waiting list than there are organ donors. This project explores the hardships scientists and engineers face in the field of bio-printing, a newly developing practice of using 3D printers to create effective organs that would have the ability to replace real human organs. All this is done at an attempt to solve the problem of the need for organs that is currently plaguing society. With the use of the Engineering Design process, through experimentation that ultimately failed, would go on to prove that it would take years to create a synthetic kidney.

H19 DMS Produced by Phytoplankton as a Solution to Ocean Acidification

Chemistry

Emma Kelly, Yashvi Gupta, Himasri Shapally

Grafton Memorial Senior High School

By replicating an ocean environment and reversing the effects of one of the most contributing causes of ocean acidification, we will be able to observe the changes and discover a small scale solution that will make a minimal negative effect on the living organism of the ocean for this large issue. Our goal is to find a solution to the problem of ocean acidification by finding something that will bond more easily with H^+ than calcium to increase calcium carbonate production rather than bicarbonate production.

Based on the chemistry of ocean acidification, we proposed dimethyl sulfide produced by Phytoplankton as a solution to counter the effects of ocean acidification. We then tested this proposed solution in a marine environment including live organisms. With the ocean covering more than 70% of the Earth, introducing any type of solution oceanwide is unrealistic. Our supporting data with more research and testing could potentially be used for small scale solutions, like in coastal regions or bays. By doing this project we hope to educate ourselves and others on ocean acidification and how we can contribute to positive change in our environments.

H27 Alternatives For Chemical Ice Melt

Chemistry

Molly Elkerton

Bishop Feehan High School

This project focuses on finding substitutes for ice melt that uses chemicals. Chemicals can be dangerous so it would be beneficial to find a natural ingredient that melts ice that can be used in place of chemicals. The scientist will be testing salt, beet juice, and pickle brine to see which one melts the ice the best. She believes that pickle brine will melt the ice better than salt or beet juice because the pickle brine can prevent the ice from sticking to the road in the first place. Previous research supports this hypothesis, saying that pickle brine is a salty solution that has properties to melt ice. The scientist will test both the freezing and melting of ice using these ingredients. She will see which ingredient melts the ice the quickest and which ingredient prevents the ice from freezing. There will be three trials of each substance as well as three trials of tap water as a control group. Data will be measured and then organized into charts and graphs. The scientist expects all of the ingredients to cause the ice to melt faster, but pickle brine will be the best option to use as ice melt. The data did not reflect this expected outcome. The melting data showed that all of the added ingredients cased the tap water to melt slower, which was not expected.

H28 Electrolyte Challenge: Tropicana Orange Juice vs. Gatorade

Chemistry

Joandy Tejada

Edward M. Kennedy Academy for Health Careers

What drink helps replenish electrolytes more efficiently? Orange Juice replenishes electrolytes more efficiently due to the high amount of Potassium ions. In my experiment I created a conductance measuring circuit in order to find the conductance of the drinks. It was discovered that my hypothesis was backed up, as orange juice did prove to be more conducive. It was concluded that Orange Juice has more electrolytes which means it is able to replenish more electrolytes more efficiently than Gatorade can.

J25 Impact of Additives on Surface Tension

Chemistry

Song Yu Chen

North Quincy High School

The effect of different additions of substances including NaCl, C₁₂H₂₂O₁₁ and C₁₇H₃₅COONa to H₂O was tested to explore the interaction between them and the surface tension of water. The estimated results were that salt (NaCl) and sugar (C₁₂H₂₂O₁₁) would increase the surface tension while dish soap (C₁₇H₃₅COONa) would weaken it. In the experiment, a lever system was built so that one side could have a needle suspended at the surface of the water while a container on the other side received weight. The amount of mass received was recorded and further analyzed for an in depth understanding of the experiment. The results from the experiment show that C₁₂H₂₂O₁₁ was able to increase surface tension, C₁₇H₃₅COONa was able to weaken it and CaCl₂ did not make a change that was able to be captured in the experiment. These results can be later used to manipulate water's adhesion and cohesion which could play a role in saving energy during the use of water in various power plants. This could also be used to change the substance that comes in contact with water in hydraulic power plants to change how water is able to flow through the system.

J28 What Effect Does Low pH Acid Rain Have on Different Coatings?

Chemistry

Era Haxhimali, Ramon Rossi

Somerville High School

As it is well known, acid rain is so strong and powerful that it can slowly deteriorate any object or living thing until it consumes it all. Building materials are some of the main objects humanity uses to shield itself from harm, but even though they are not 100% foolproof, there are preferable materials that are more resistant to damage than others. As well as building materials, many coverings are made to protect structures such as buildings. So with that information, we created our question: What effect does acid rain have on different coatings? For this experiment, rather than testing the building material alone, we would also test which covering would be best in the case of an acid rain occurring. In order to best understand the test subject and fully complete the experiment, we researched many topics, including pH, acid rain, building materials, and protective coverings. Based on a thorough research, we made the hypothesis that silicone will be the best protective covering against acid rain. The denser the object the more resistant it becomes to acid, yet the less dense, the less resistant it is. Given this information we can say that this also applies to the density of coverings, and that it is the main point to keep an object more resistant. We had to decide what materials to use, as well as what protective coatings to use, and how to soak them in an acid of a pH level of two, which is the substance acid rain is composed of. We decided to use granite, iron, concrete, and wood. We chose these materials because they are some of the most used materials in building today. We also had to buy all the materials and had to get beakers to hold the acid rain. We made the acid rain by diluting the nitric acid to a pH of one, with the ratio of 1:10.

K1 Determining the Specific Heat Capacity of Different Substances

Chemistry

Advika Sonti

Tahanto Regional High School

The specific heat capacity of a substance is the amount of heat energy, in Joules, that is required to change the temperature of 1 gram of a substance by 1 degree Celsius. It is a physical property that relates energy change to temperature change and provides a correlation between the two. Materials with a low specific heat capacity require less energy to increase or decrease their temperature, whereas materials with a high specific heat capacity require more energy to change their temperature. Every substance has its own specific heat capacity and since that value has been established for all the metals on the periodic table, the purpose of this project was to determine that value for some other materials. Four different substances were experimented with three trials for each. The materials that were used were a glass cup, a plastic lid, a steel spoon, and a ceramic bowl. First, the mass of the substance was measured, then it was dropped into boiling water until the substance reached the temperature of that boiling water. A separate mass of water was measured and its temperature was recorded as well. The substance was then dropped into a calorimeter, containing the documented sample of water, and closed immediately. Once the substance and the water had reached an equilibrium, the final temperature was recorded. This was repeated for all three trials and for all four materials. With this data, the specific heat was calculated for each trial using the equation $q=mc\Delta T$. The results for each trial were averaged out to conclude with one final answer for each of the substances. It was found that the glass cup had the lowest specific heat (0.253 J/g°C), followed by the steel spoon (0.370 J/g°C), then the ceramic bowl (0.793 J/g°C), and lastly the plastic lid (1.435 J/g°C).

K9 Which Dilutions of Gatorade Are Safe to Drink?

Chemistry

Nolan Tavares

Taunton High School

Gatorade is a common sports drink used by countless people to hydrate and replenish electrolytes. However, there are some concerns about whether Gatorade is safe to drink, since it contains high amounts of sugar, as well as color additives, such as Red 40. During this experiment, dilutions of a 7×10^{-5} Red 40 stock solution were created, and then were put into a spectrophotometer to help make a Beer's Law calibration curve. Then, the concentrations of the ADI standards for Red 40 were calculated. Afterwards, 5 mL of each type of Gatorade, except the Fruit Punch + Berry, were placed into sample tubes and were also sent through a spectrophotometer to figure out the concentration (mol/L) of dye that is added to different types of Gatorade. In the end, the G2 Raspberry Lemonade had the lowest concentration, while the Fruit Punch + Berry had the highest concentration. The Fruit Punch + Berry had the highest concentration because it has the darkest shade of red out of all the samples. Similarly, the G2 Raspberry Lemonade had the lowest concentration because it has a light pink color. However, the hypothesis was proven incorrect, as the Gatorade samples had lower concentrations than all the ADI standards for one, two, and three bottles. All in all, after comparing the ADI concentrations and Gatorade concentrations, it was calculated that no water needs to be added to each type of Gatorade. However, this project was not perfect, and questions and recommendations were left as a result.

K17 Impact of Increasing Liquids on Diluting Digestion

Chemistry

Allison Tribendis, Madeline Tribendis

Swampscott High School

This experiment aimed to discover how much liquid can be consumed with food until negatively impacting digestion, and if different liquids have different effects. It was hypothesized that digestion would stall when combined with increasing amounts of water or soda. Due to the fact that soda has complex sugars, it was also hypothesized that soda would take longer to digest than water. Increasing increments of water added to the simulated stomach acid clearly showed a breaking point of 50%. When 50% (25mL) water was added to the stomach acid, it took double the amount of time that the lower percentages of water took to dissolve the Tum. Increasing increments of soda in the simulated stomach acid clearly displayed a breaking point of 60% (30mL). All the soda trials took longer than water to digest the Tum, proving that the complex sugars found in soda prolong digestion. Typically, the human stomach contains 20-100mL of stomach acid. If these percentages were applied to the human stomach, the average person could drink half of the amount (50%, or 25 mL, more) of stomach acid in water, and a little more than half of the amount (60%, or 30mL, more) of stomach acid in soda before negatively impacting digestion.

K19 Effects of Food Additives on Maillard Reaction and Water Loss

Chemistry

Justin Booth

Somerville High School

Various food additives applied before cooking (sugar, baking soda, salt) and during cooking (oil, water, honey) were examined to determine which pair of additives produced the fastest reaction speed of the Maillard reaction, and the highest percentage of retained water content after cooking in chicken breast samples. It was hypothesized that if 3 different food additives (salt, baking soda, and sugar) were applied to 1 cm³ samples of chicken, and those samples were applied with 3 different food additives (oil, water, honey) on the cooking surface, then the samples treated with baking powder and honey will produce the fastest reaction and greatest retained water content because since the Maillard reaction involves reducing sugars—which can be found in honey—it could be opportune for a more efficient reaction and because the Maillard reaction has been shown to accelerate in an alkaline environment. Samples were treated with additives, weighed and heated on a 200° C hotplate for 30 - 300 seconds, then weighed again to determine how much water was lost. The samples were placed in a lightbox and a picture was taken of each, the photos were cropped, color averaged, and HSV value was taken. The results showed that honey was the most effective food additive during cooking in accelerating the Maillard reaction, with baking soda being the most effective additive before cooking within the samples cooked in honey. Salt was shown to be the most effective additive in aiding water retention, with water being the most effective additive during cooking.

K20 Creating Bioplastic from Starch

Chemistry

Emily Bone

Westfield High School

In this project, four different types of starches (potato starch, rice starch, tapioca, and corn starch) were used in creating sheets of bioplastic. The bioplastic sheets were put under two tests to determine which of the starches created the strongest and most water resistant plastic.

The plastic was created by heating the starch with water, vinegar, and glycerin. The vinegar breaks down the amylopectin bonds in the starch into amylose and glycerin makes the plastic pliable. Water resistance was tested by measuring the amount of time it took water to soak through a sheet of the bioplastic in a three hour period. Strength was measured through a tensile strength test where weight was added to a strip of bioplastic until the plastic tore under the pressure.

In the strength test, potato starch was able to hold the highest amount of weight before breaking on average at 367g. Rice starch held the smallest amount of weight on average at 197g. In the water resistance test, all bioplastics except the one made from rice starch were able to hold the water for three hours without the water penetrating through. Due to these findings, potato starch was deemed the best starch to use when making a water resistant and strong bioplastic. In these two tests, rice starch was the least water resistant and supported the lowest amount of weight. Although potato starch made the most water resistant and strong plastic, it does not necessarily make it the “best” all around bioplastic. There are many different types of plastics with different properties needed to perform different tasks, and in future research I may experiment with these different properties in bioplastic.

N1 How Do CO₂ Levels in Sea Water Affect Algae Growth?

Chemistry

Mariel Fulghum

Swampscott High School

This experiment aims to discover the effect of raised carbon dioxide levels in sea water on algae growth. The hypothesis states that the growth of algae will increase as CO₂ is added. This considers the factors of algae being a plant that undergoes photosynthesis and the fact that plants generally thrive in a more acidic environment. Through molar calculations and the bubbling of CO₂ into the salt water, the conditions of an ocean are replicated in a controlled way. The experiment's data shows that an increase in CO₂ in sea water does increase the growth of algae, with two exceptions. The hypothesis is proved partially correct by the experiment.

N15 Water vs. Electrolytes

Chemistry

Michaela Brulport

Edward M. Kennedy Academy for Health Careers

Conducting this experiment will show the different qualities of water that us people drink on a daily basis. Water that was tested was tap, bottled, and bottled water with electrolytes. The question is, which type of water is better to drink. If I test bottled water without electrolytes, bottled water with electrolytes, and tap water, then I will find which type of water is the best suitable for drinking and what brand of water is the best.

N26 The Hidden Secret of Science

Chemistry

Claweens Quetant

West Roxbury High School

Many people think that oil cannot dissolve or will never be able to dissolve in water. People say water easily dissolves other polar substances (like sodium chloride, salt) but does not dissolve non-polar molecules such as oil. From my research I found out that oil can actually dissolve in water if we degassed the water first. Water boils at 100 degree Celsius gas goes out and we can mix it with the oil. The purpose of this experience is to get people to know that, Water can be mix with oil.

I tried to boiled water to degassed it. Then I conduct my experiment by taking the degassed water and shook it with oil and also by taking not degassed water and shook it with oil. I found that these two had some differences, which was not easy to tell. Having these differences is basically saying that something did happened to oil in the water. Then I used conductivity to check the clarity of them. I checked the conductivity and it shows me that oil is able to mix with water. Whether a material is a strong electrolyte, a weak electrolyte, or a nonelectrolyte will affect the conductivity of water because of the concentration of ions case.

To conclude this was a great experienced and I learned so many things in it, which could help scientist. I think everyone should get a chance to see this project and to learn about it.

P6 How Does pH Level Impact Enzyme Activity in Lactaid Pills

Chemistry

Gianfranco Yee

Urban Science Academy

Individuals who suffer from lactose intolerance are deficient in the digestive enzyme lactase, which breaks down lactose (sugar in dairy milk). So, they take the lactase enzyme supplement Lactaid in order to consume dairy products. However, this product's overwhelming number of negative customer reviews lead me to question its true effectiveness, thus I formulated an experiment gauging its effectiveness. My approach dealt with the pills' special coating, called an enteric coating, which is designed to remain stable in acidic environments (such as the stomach) but break down in relatively basic environments (such as the intestines). Its purpose is to protect pills' contents from stomach acid, which could denature the contents. My goal is to determine how well this coating does its job in low pH levels. In my experiment, pills were exposed to a pH 4 solution for varying times, and then combined with lactose milk to measure enzyme activity (in terms of glucose production). I hypothesized that the pills had a strong coating rather than a weaker one that would deteriorate producing a thinner coating more easily broken down. However, the evidence refuted my hypothesis by showing that the longer the pills remained submerged in the buffer, the greater the enzyme activity when placed in a lactose solution for a set time. These results indicated that the coatings were not completely effective.

P8 Fiji vs. Poland Springs

Chemistry

Kerry Ferdinand, Isabella Amador

Edward M. Kennedy Academy for Health Careers

We are conducting this experiment to test if all water is the same by measuring the pH level of both drinks of water. The difference between their levels on the pH scale will tell which water is the healthiest and have a better taste. This experiment will be focused on how can we prove that Fiji is truly better than Poland springs by testing the chemical quality of the water? So far, we believe that Fiji would be better quality water compared to Poland Springs, not only can that be inferred based on how it tastes but it might also be proved by its pH level. The procedure is as follows. First, we must get all the materials together. Then we must put the Fiji and Poland springs into different cups. Next, we must test the pH of Poland Springs and write the results. After we will do the same with Fiji. Finally, we must compare results to determine which is better.

P9 Does the Temperature Affect the Growth of Crystals?

Chemistry

Ashley Julmiste

West Roxbury High School

The purpose of this project was to figure out whether the crystals growth in the warm or cold temperature will increase in size the most, in terms of mass and circumference. The process of growing crystals takes 12 hours. In order to determine which temperature has increased in size the most, I will measure each crystals mass and circumference. My experimental results indicated that the circumference of crystals grew more in a room temperature than a cold temperature. And a mass of crystals that was involved in a cold temperature weighed more than in a room temperature. For example, the circumference of crystals in a room temperature has a high average of 18.4 cm and the cold temperature with an average of 16.8 cm. However the mass of crystals in a cold temperature has a higher average of 91.2 g in a room temperature with an average of 69.2 g. Due to the process of crystallization different temperatures form different amount of crystals, when molecules can be arranging unique shapes and sizes. For instance, crystals being involved in a warm temperature grows faster than cold temperature because a higher temperature increases the rate of growth that produce more pressure upon the pipe cleaner. And makes the distance between the molecules greater, which gives the process access to form larger amount crystals. On the other hand crystals been involved with a cold temperature forces the molecules close together that creates a bond to form a large amount of smaller crystals.



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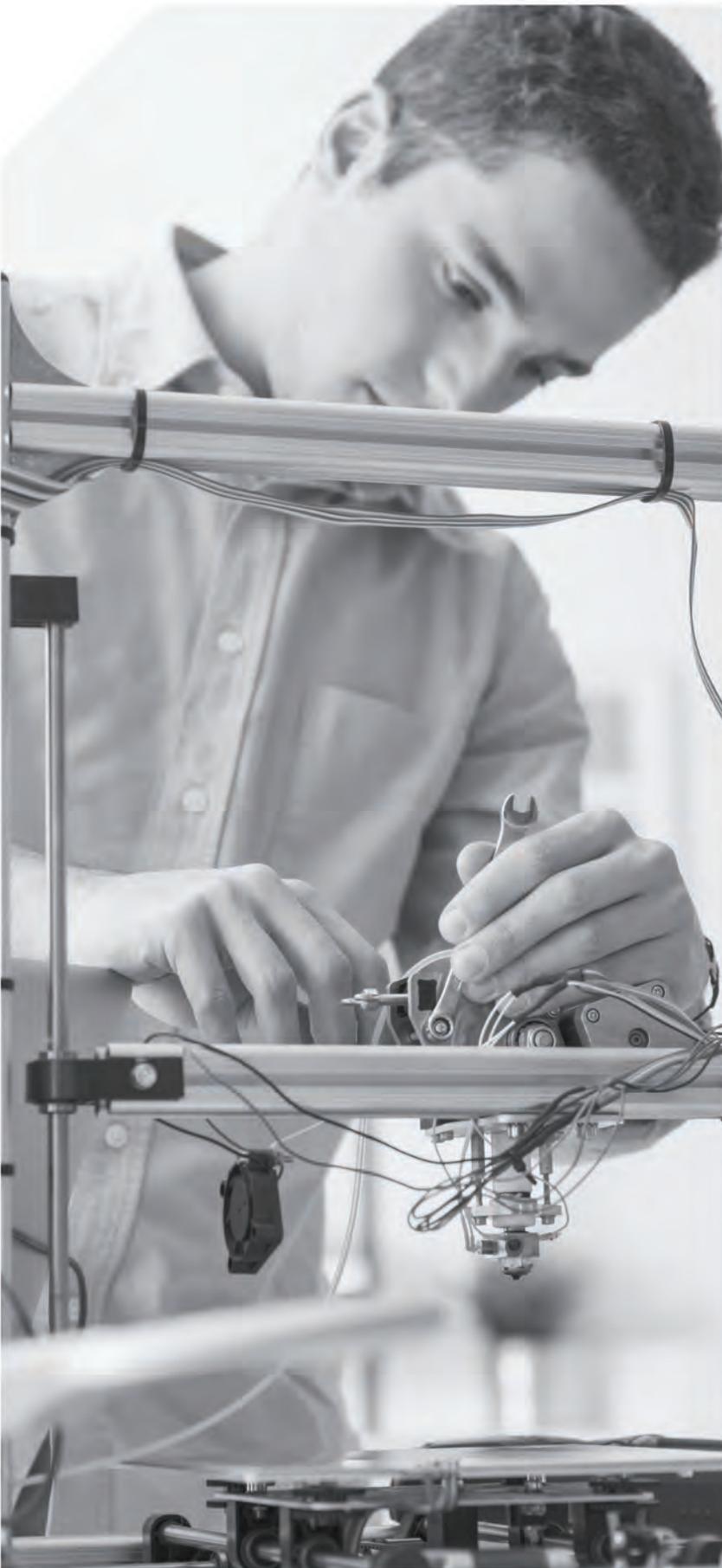
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