MSSEF

HIGH SCHOOL DIVISION

THE 68TH ANNUAL **MASSACHUSETTS STATE**

Science & Engineering Fair

May 5-6, 2017

OFFICIAL PROGRAM
AND ABSTRACT BOOK

Anisa, MPS1 Disease, Canada

FOCUSED ON DEVELOPING SPECIALTY TREATMENTS
for debilitating diseases that are often difficult to diagnose and treat, providing hope to patients and their families.

Congratulations to all of this year's MSSEF participants!

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2017
MASSACHUSETTS STATE SCIENCE & ENGINEERING FAIR

Official Program & Abstract Book

May 4-6, 2017

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MSSEF • • • Massachusetts State **Science & Engineering** Fair

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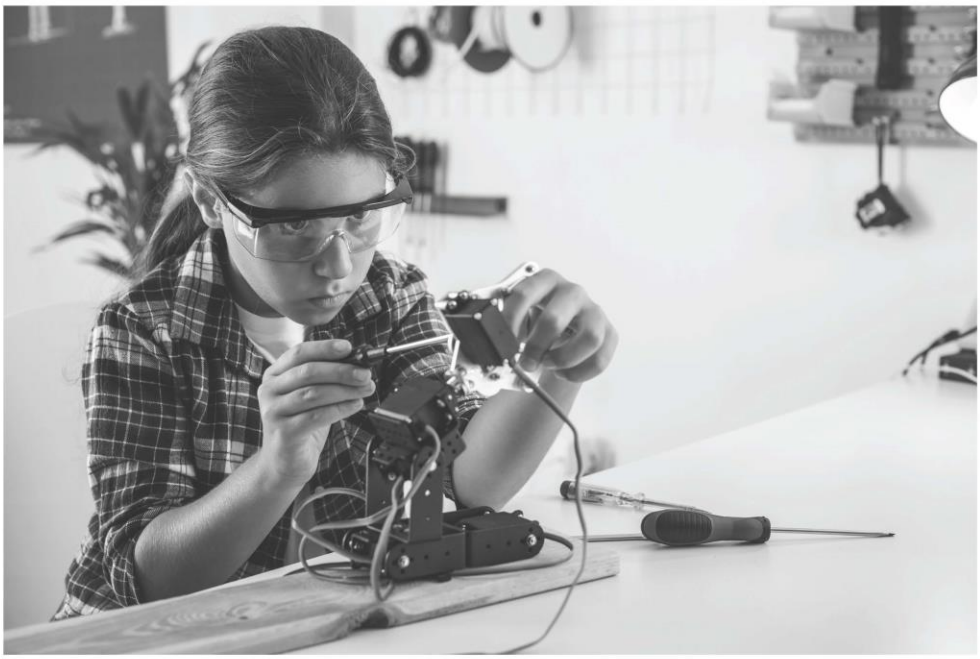
YOU INSPIRE US!

Fish & Richardson is proud to support the **Massachusetts State Science & Engineering Fair** in its work to promote education and achievement for students in STEM.



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MSSEF • • • Massachusetts State **Science & Engineering** Fair

2017 SCHEDULE OF EVENTS

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 4, 2017

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

Friday, May 5, 2017

General Student Registration, Project Set-Up, Safety Inspections/Final Approval, Exhibitor Photos — 7:30 – 11:00 am
Johnson Athletics Center

MSSEF Educator Day — 8:30 – 1:30 pm
Open to all STEM teachers
Stratton Student Center/Twenty Chimneys Room

Judge Orientation Program & Project Assignments — 10:30 – 1:30 pm
Kresge Auditorium
Judge Access to Student Exhibits begins after 11:30 am

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

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

Judging of Exhibits — 11:30 – 6:00 pm
STUDENTS MUST REMAIN UNTIL 6PM – See MasterMind Challenge & Reception Below
Judges' lunch provided 12:45-2:30 pm

For Parents of Science Fair Students*
"Financing College Education in Today's Economy" — 11:45 – 1:30 pm
Stratton Student Center/Mezzanine Lounge; Lunch Served

MasterMind Challenge & Reception — 4:00 - 6:00 pm
MANDATORY: STUDENTS MUST REMAIN UNTIL 6 PM WHEN JUDGING ENDS
Led by a team of Symantec engineers!
Student Challenge, fascinating activities/displays, food and social
Stratton Student Center/Lobdell Dining Area

Saturday, May 6, 2017

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

2017 SCIENCE FAIR STEM EXPO

Featuring Major MSSEF Sponsors & Partners
Sat, May 6 12:30 – 3 pm
Johnson Athletics Center

MERRIMACK
COLLEGE

EXPERIENCE SOMETHING GREATER.

One of only two Augustinian colleges in the United States, Merrimack is committed to providing students with opportunities to develop intellectually, spiritually, socially, and ethically.

At Merrimack, you'll find your footing... and your fit, from academics to clubs to sports to social activities to internships.

Along the way, **you'll be empowered** to try new things and explore new directions.

Sure, making friends and having fun will be part of the experience. But you'll also have opportunities to get involved and give back. Because **something greater** isn't a thing we say, it's what we aspire to every day.

Greater Boston, MA • merrimack.edu/visit

MSSEF • • • Massachusetts State **Science & Engineering** Fair

Welcome to the 2017 Massachusetts State Science & Engineering Fair!

Celebrating 68 Years of Inspiring Students in Research & Innovation

Seeing a future where every student is empowered through learning in science and engineering practices.

MSSEF is helping that future happen today!

Today's science fair program is about tomorrow's innovators. MSSEF partners annually with over 200 Massachusetts schools to give their students the rare opportunity to be researchers and problem-solvers – the chance to make our world and future a better place. Each year, when we walk through the showcase of projects created by the 400 most outstanding MA high school student researchers, we are awed and grateful. The future looks bright in the hands of these talented and public-minded young scientists and engineers.

MSSEF alumni often refer to their research and presentation as "life-forming" experiences. Consider the experience of this individual who participated in science fairs from a very young age:

> *"From the third grade through high school, MSSEF and science fairs had a profound impact on my life…[giving me the chance and tools for] 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."*

The bottom line about MSSEF programs! They enable students to "do" science and engineering the way it is done professionally. Students become highly motivated by the potential of discovery and learning something new. Creating independent research projects, guided by a mentor or teacher, students investigate a topic in depth, raise questions and explore solutions to challenges in all fields, from curing disease to cleaning the planet to fixing common "everyday problems." This "learning through doing and discovery" process is what supports our mission – to develop future thought leaders through experiences in science and engineering practices that empower students and educators to learn in and beyond the classroom. This type of learning helps students to acquire essential life and career skills, including competencies in STEM (Science, Technology, Engineering & Math) that are now in high demand in every job sector. MSSEF has been promoting this type of learning for 68 years, and it is now an essential part of the Massachusetts revised science, technology & engineering standards.

MSSEF programs reach over 50,000 students each year, the majority in high-needs districts. MSSEF's Curious Minds Initiative supports independent research investigations by thousands of students statewide (79% of CMI schools are in high-needs districts, 98% are public schools), with the goal to bring this opportunity to every high school and middle school student in the state.

To our donors and sponsors, thank you! Our success is a credit to your generosity. On behalf of the MSSEF Board of Directors and High School Fair Committee, we gratefully thank MIT for hosting the statewide MSSEF High School Fair through every one of our 68 years. We also offer our sincere appreciation to the hundreds of volunteers and supporters who make this program possible.

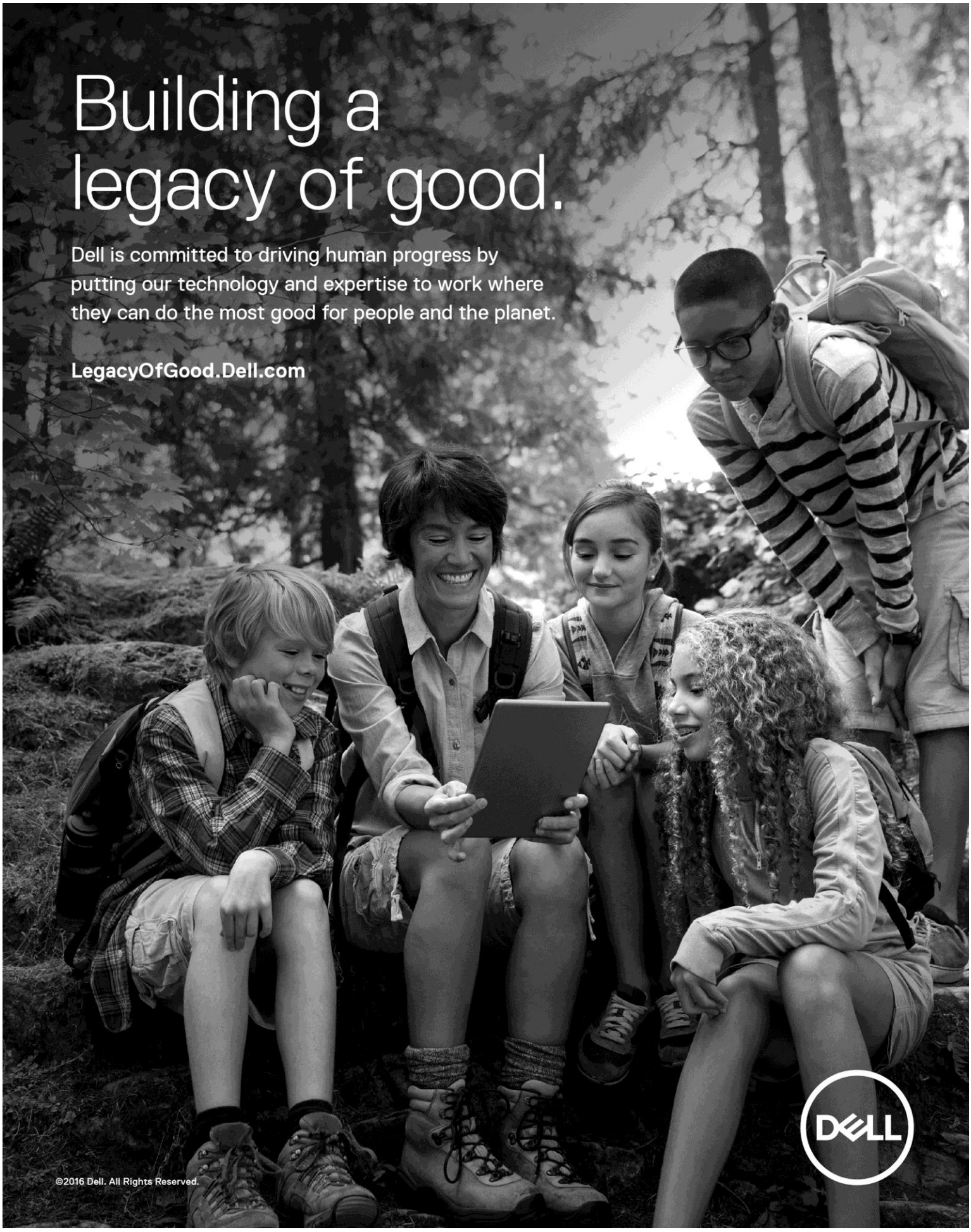
To all, we extend a warm welcome to the 2017 Massachusetts State Science & Engineering Fair – an experience that lasts a lifetime!

Sincerely,

Timothy A. French
Chairman of the Board

Cora Beth Abel
President & CEO

William F. Rigney
Chair, High School Committee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(617) 725-4000

CHARLES D. BAKER
GOVERNOR

KARYN E. POLITO
LIEUTENANT GOVERNOR

May 2017

Dear 2017 Science Fair Students,

On behalf of the Commonwealth of Massachusetts, Karyn and I congratulate all of the high school students who earned a place in the 2017 Massachusetts State Science & Engineering Fair (MSSEF). We commend you for your innovative ideas, your diligence and your passion for science and technology.

Now in its 68th year as a national thought and practice leader, MSSEF 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 MSSEF will be a critical partner in helping us reach this goal.

We extend our congratulations to MSSEF and its 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.

Best of luck to all of the 2017 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,

CHARLES D. BAKER
GOVERNOR

KARYN E. POLITO
LIEUTENANT GOVERNOR

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The Patent Award Winners – 2002-2016

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 MSSEF 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 Aiylam
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.

Saluting Our 2017

Sponsors, Donors & Contributors

MSSEF
HIGH SCHOOL DIVISION

THE 68TH ANNUAL **MASSACHUSETTS STATE**

Science & Engineering Fair

April 14, 2017

• SUPPORTING •

CABOT

At Cabot, our commitment to sustainability extends beyond our manufacturing facilities. We want to make a positive and lasting difference in the communities where we operate. A vital part of this commitment is evidenced through our philanthropic activities, which give priority to programs that educate young people in the fields of science and technology. As one of the world's leading chemical companies, we are continually working on solving complicated problems in transportation, infrastructure, consumer products and the environment. We are passionate about providing opportunities to young people who will join us in solving the challenges put before us today and in the future.

FISH.
FISH & RICHARDSON

Founded in 1878, Fish & Richardson is a leading global law firm unlike any other law firm in the world. With over 400 attorneys and technology specialists, the firm is one of the largest practicing IP strategy and counseling, IP litigation, and business litigation. 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.

GFCT
Gelfand Family Charitable Trust

Gelfand Family Charity Trust strives to provide hands-on STEM enrichment for middle- and high-school students. One of the most effective ways to accomplish that mission is through the support of the Massachusetts State Science & Engineering Fair. www.gfct.us

LINDE FAMILY FOUNDATION

MERRIMACK COLLEGE

Founded in 1947 in North Andover, MA, Merrimack College is a private Augustinian Catholic college home to over 3,200 undergraduate and 575 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.

Northeastern University

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.

SANOFI GENZYME

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.

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Be the first to live in the new residence complex coming to the University of Massachusetts Boston in fall 2018! Study science or engineering in our College of Science and Mathematics, School for the Environment, or College of Nursing and Health Sciences. Join our Honors College for access to many interdisciplinary courses. Our beautiful waterfront campus, just minutes from downtown Boston, gives you prime access to research, internships, clinicals and employment opportunities. Win a UMass Boston Chancellor's Scholarship as a MA State Science & Engineering Fair prize winner. www.umb.edu

WPI

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.

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PRESIDENT

Cora Beth Abel
Tel: 617-491-1508
abel@scifair.com

VICE PRESIDENT OF CORPORATE DEVELOPMENT

Eleanor A. Tishler
Tel: 888-437-3247
etishler@scifair.com

• IN APPRECIATION •

We are grateful to our supporters – companies, universities, foundations, individuals and professional organizations, for their help over the past 68 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 State Science & Engineering Fair, Inc. (MSSEF) 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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INTERNATIONAL SCIENCE & ENGINEERING FAIR

Hats off to the 2017 Massachusetts Delegates!

The 2017 Massachusetts delegates to the Intel International Science and Engineering Fair (ISEF) will be introduced at the Award Recognition Ceremony on May 6. The International Fair will be held in Los Angeles from May 14-19.

The MSSEF delegates include the first-place winners at each of the six regional fairs held in March. In addition, each regional fair selected additional delegates based on their placement at each respective fair. A total of 21 students and four 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 1,700 high school students from over 70 countries to showcase their independent research. Todays, 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 $5 million in prizes and scholarships.

We wish to thank the INTEL Foundation and our other generous sponsors for their support of our Massachusetts/ISEF delegates. We salute our full delegation, including the chaperones, and extend our best wishes to all for much success and pleasure at the 201 "International".

MSSEF Massachusetts State Science & Engineering Fair

CONGRATULATIONS
& Best Wishes

intel ISEF — a program of — SOCIETY FOR SCIENCE & THE PUBLIC

To the Massachusetts Delegates to the 2017 Intel International Science & Engineering Fair.

GOOD LUCK in Los Angeles

GEMS Mini-Grants — Up to $4,000

This Could Be **YOUR** School!

MSSEF Massachusetts State Science & Engineering Fair

GEMS GELFAND ENDEAVOR in Massachusetts Schools

Mini-grants from GEMS aim to enable schools and teachers to inspire students through direct engagement in research and invention, and the excitement of science fair competition.

GEMS grants include professional development opportunities for STEM teachers to bring the professional science and engineering practices right into their classrooms in alignment 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** wish to expand their annual Science and/or Engineering Fair program.
Get the Application: https://form.jotform.com/62245971165964

Goal: Schools develop or expand a sustainable Science Fair program, and teachers bring science & engineering practices into their classrooms.

Benefits:

- Grants up to $1,000 for the first year, and renewable up to $4,000 for a 3-year program.
- Tuition Scholarships for CMI Courses for up to 5 STEM teachers enroll in http://scifair.com/curious-minds/
- Science Fair consultant to visit your school upon request
- Invitations for Teachers & School Leaders to:
  - ✓ Join meetings of the MSSEF High School Committee that helps to shape policy and organize the statewide science fair programs.
  - ✓ Attend MSSEF Educator Day (free) at MIT – a look behind-the-scenes at the statewide Science & Engineering Fair for high school students held annually in May. http://scifair.com/educator-day/

For more information: gems@scifair.com

MSSEF • • • Massachusetts State **Science & Engineering** Fair

Be our guest at a Special Luncheon & Seminar for Science Fair Parents

FINANCING YOUR CHILD'S COLLEGE EDUCATION

Learn about financial aid and resources available to today's college students

Friday, May 5, 2017
11:30 am – 1:30 pm
Stratton Student Center – Mezzanine Lounge

Panel Members

Wendy Lindsay
Director
Regional Student Program
New England Board of Higher Education

Katie Holland
Associate Director
Financial Aid
UMASS Boston

Stephanie Wells
Director, Community Outreach
Massachusetts Educational
Finance Authority

mefa
Massachusetts Educational Financing Authority

NEW ENGLAND BOARD OF HIGHER EDUCATION · 1955 ·

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The "Curious Minds" Initiative (CMI)

Learning through Science/Engineering Practices & Student Independent Research
An MSSEF Program with special funding for underserved students & high-needs schools

The three CMI programs work together to support schools and empower teachers so they integrate exciting project-based experiences into *existing* curricula, and to run exciting competitions (science fair events) that showcase student research and innovation projects.

1. **Professional Development for Teachers**: CMI offers three graduate-credit courses plus workshops. Teachers completing all three courses for credit earn the "STEM Certificate in Science & Engineering Practices" in partnership with Framingham State University. CMI courses have helped 300+ STEM educators to dramatically increase their teaching effectiveness—and they are impacting over 16,000 students each year.
2. **Mentoring for Students:** CMI pairs young students (grades 6-12) with STEM mentors as they work on independent research projects, exploring a topic that interests them. MSSEF recruits professional scientists and engineers, and college STEM majors, who provide resources and challenge their students' critical and innovative thinking about their research. An MSSEF at- school STEM Facilitator guides the program.
3. **Mini-Grants for Schools: IMAGINE** a school in a any community that could offer guidance and funding for its students to investigate a question about the world that truly interests them. CMI "Mini-Grants" enable schools and teachers to do just that: to inspire students to pursue STEM learning through direct engagement in research and innovation, and through the excitement of science fair competition.

Interested in CMI at your School? Contact us today! cmi@scifair.com

OUR SINCERE CONGRATULATIONS

To all participants in 2017 Massachusetts State Science & Engineering Fair.

Thank you for your dedication and hard work in increasing the advancement of science and engineering.

UMASS LOWELL

"Next Generation" and New MA STE Standards!

cmi Curious Minds Initiative

Are you prepared for the new Standards?

Take CMI Courses in 2017!

1

TSIP: "Teaching Science through the Inquiry Process"

6 days • 3 credits

Practical strategies to infuse more science practices into your teaching

August 14-18 & November 4
WPI-Worcester

2

PCS: "Project-based Classroom Science"

4 days • 2 credits

Project-based units for science concepts and tools to guide student research

August 7-10 & November 4
WPI-Worcester

3

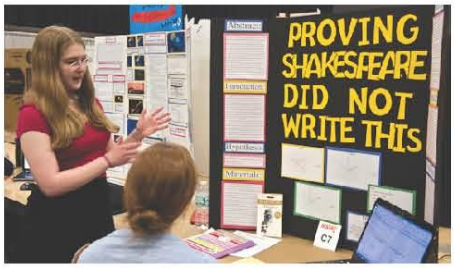
OSEF: "Organizing a Science & Engineering Fair"

2 days • 1 credit

Manage your "Science Fair Program" and gain district-wide support.

August 10-11
WPI-Worcester

Complete all three CMI Courses for graduate credit and earn the
STEM Certificate in Science & Engineering Practices
from Framingham State University!



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

MSSEF
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For more Information: **cmi@scifair.com**

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

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MSSEF EDUCATOR DAY @ MIT

Friday May 5, 2017 8:30am – 1:30pm

Held during the 2017 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 2017 MA team @ 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 MSSEF 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.jotformpro.com/70787985795988

1:30 **Adjourn**

2017 Educator Day is hosted by MSSEF's Curious Minds Initiative (CMI)
Many thanks for the generosity of our major CMI funders & sponsors who make this day possible!
Gelfand Family Charitable Trust, Linde Family Foundation & MathWorks

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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 -- **S**cience, **T**echnology, **E**ngineering and **M**ath.

2017 COP Panel

Moderator
Barnas G. Monteith, MSSEF Alumnus and Vice Chair
Massachusetts State Science & Engineering Fair, Inc.

Dr. Estefi Alvarez
Hologic, Inc.

Joseph Damigella
Kuerig Green Mountain, Inc.

Held on Saturday morning, May 7 @ 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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MSSEF REGIONAL FAIR NETWORK

Congratulations for a Stellar Year!

Each year during February and March, thousands of high school students across the Commonwealth participate in their school district and regional science fairs. MSSEF would like to recognize the regional fair directors, coordinating committees, sponsors, host sites, science educators, judges, mentors and the hundreds of volunteers who help to promote the awareness and advancement of science and technology to these students who are members of tomorrow's workforce.

Region I: Western Massachusetts
Western Massachusetts Region I Science Fair
Massachusetts College of Liberal Arts
Chair: Barbara Kotelnicki

Region II: Central Massachusetts
Worcester Regional Science & Engineering Fair
Worcester Polytechnic Institute, Worcester
Chair: Nancy G. Degon

Region III: Southwestern Massachusetts
Rensselaer - BCC Region III Science & Engineering Fair
Bristol Community College, Fall River
Chair: Dr. James Pelletier

Region IV: Northeastern Massachusetts
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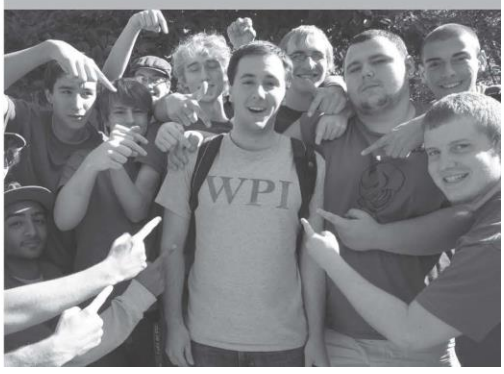

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Judges Listing by Last Name

Judge	Affiliation
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Adams, Will	Riparian Pharmaceuticals
Adler, Michael	INTEL Massachusetts
Ajlouni, Burouj	Thermo Fisher Scientific
Akinjiyan, Favour	Novartis
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Arran, Lokman	MA Dept. of Transportation DOT
Arumugam, Arun	Consultant
Ataca, Sila	Boston University
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Atkinson, Kristine	A/A Patent Investigations
Atti, Ali	Toshiba America
Atwood, VMD, MD, MPH, MRCVS, FRSPH, Steven W.	Animal Health Care Associates, Ltd.
Austin, Eric	MIT Lincoln Laboratory
Awrach, James	SeaFire Micros, Inc.
Babani, Mahesh	Dell EMC
Babcock, Katharine	Boston University School of Medicine
Bailey, Phillip	MIT Lincoln Laboratory
Banker, Yigal	Dell EMC
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Keep, Stephanie	National Center for Science Education
Kelliher, Peter	National Oceanic and Atmospheric Administration
Kernan, Gabriela	MA Dept. of Public Health
Khan, Liaquat	Community College System of New Hampshire
Khan, Amber	Destination Imagination
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Kyratzoglou, Ioannis	The MITRE Corporation
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Lamb, Caroline	MIT Lincoln Laboratory

Last, Adam	Corporate Environmental Advisors
Lawrence, Trey	Aramco - Research Lab
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Majer, Christina	Ribon Therapeutics
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Malin, Gennady	Sanofi Genzyme
Malkoski, Vincent	MA Div. of Marine Fisheries
Maloney, Erin	ImmunoGen, Inc.
Maloney, Tom	EMD Millipore
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McKneally, Ranida	Consultant
McManus, Catherine	Nitsch Engineering
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Miller, Eric	Massachusetts Institute of Technology
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Mills, Joslyn	Tufts University
Mills, Gordon	GE Healthcare
Minassian, Saro	Self-employed

Minassian, Elizabeth	Self-employed
Moore, Richard	US Air Force - Hanscom AFB
Moore, Karen	Novartis
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Noori, Azam	Merrimack College
Nowak, Michael	Massachusetts Institute of Technology
O'Melia, Sean	MIT Lincoln Laboratory
O'Neill, Sharon	Pfizer Neuroscience Research Unit
Okun, Alyssa	Boston Medical Center
Olsen, Rich	Retired
Orlando, Ralph	Veterans Administration: VA Boston HealthCare System
Osinski, Anthony	MA Dept. of Public Health
Otter, Marshall	Marine Biological Laboratory
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Prentice, Magdalena	Millennium Pharmaceuticals, Inc.
Prevost, Tina	Analog Devices, Inc.
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Psencik, Jeffrey	Massachusetts Institute of Technology

Purohit, Prakash	Raya Technologies
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Quiñones, Rebecca	MA Div. of Fisheries & Wildlife
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Sheridan, Rob	Massachusetts General Hospital
Shirley, Matthew	Novartis
Shomer, Nirah	Merck Research Laboratories
Silby, Mark	UMASS Dartmouth
Simpson, Keith	UTC Aerospace Systems
Singh, Vipender	Novartis
Sivakumaran, Sudhir	Boston University School of Medicine
Slein, Liam	MOSES
Song, Jenny (Jiahui)	Wentworth Institute of Technology
Sopka, John R	High Performance Systems Software
Stephan, Mark	Dell EMC
Stephen, Ralph	WHOI
Stephen, Emily	Massachusetts Institute of Technology
Stevens, Chrissy	ImmunoGen, Inc.
Stier, Caitlin	WGBH
Talkowski, Matthew	Massachusetts General Hospital
Strattman, Wayne	Consultant
Strizhak, Elliott	UTC Aerospace Systems

Stroman, Michael	MA Dept. of Environmental Protection
Suh, Minny	Boston University School of Medicine
Sullivan, Susan	Verik Bio
Sun, Lucy	Pfizer Global Research & Development
Sun, George	Massachusetts Institute of Technology
Sutcu, Yagiz	InfoScope Research
Szewczak, Lara	Cell Press/Elsevier
Tang, Rueyjing	Commonwealth of Massachusetts
Tanna, Nikunj	Waters Corp.
Tarselli, Mike	Novartis
Tartaglia, Lawrence	Beth Israel Deaconess Medical Center
Tengtrakool, Jennifer	Sanofi Genzyme
Thomas, Suzanne	Marine Biological Laboratory
Thompson, Zach	Takeda Pharmaceuticals
Thompson, Joe	Sanofi Genzyme
Thrasher, Daniel	Ocular Therapeutix
Tracey, Ross	Novartis
Tweedie, John	Boston Environmental & Engineering Associates, Inc.
Uppiliappan, Badhri	Analog Devices, Inc.
Velázquez, Francisco	Tufts University
Verma, Rashi	Boston University
Vetere, Stephen	Nobis Engineering, Inc.
Vlass, Tyler	Moderna Therapeutics
Wadhwa, Navish	Harvard University
Wagner, Jeff	Harvard School of Public Health
Walton, Thomas	Aeroplas Corp. Intl.
Weber, J.C.	Marine Biological Laboratory
Webster, Christopher	Retired
Wei, Linna	Sanofi Genzyme
Wijnja, Hotze	Commonwealth of Massachusetts
Wilgo, Matthew	New England Cord Blood Bank
Williams, Eric	Novartis
Wink, Alexandra	Boston University
Winkler, Devon	Commonwealth of Massachusetts
Wittels, Norman	Dexter Southfield School
Wolshin, Ernest	Retired
Wong, Connie	Novartis
Woskov, Paul	Massachusetts Institute of Technology
Wu, Katherine	Harvard University Science Center
Wuest, Diane	GNS Healthcare
Xiao, Alan	Novartis
Yadon, Adam	Harvard School of Public Health
Yegnanarayanan, Siva	MIT Lincoln Laboratory

Yen, Allen	Boston University
Zee, Jade	Northeastern University
Zhang, Ximo	Waters Corp.
Zurawski, Jonathan	Brigham & Women's Hospital

Section 2 - Page 9 of 9

2017 Exhibitors

Apr 13, 2017

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
Abdi, Saida	C14	Madison Park Tech Voc HS
Abrams, Max	F27	Falmouth High School
Adams, Courtney	P14	Westfield High School
Addanki, Anvitha	F17	Canton High School
Adiletta, Matthew	C9	Worcester Academy
Aguilar, Gerardo	N4	Berkshire Arts & Technology Charter Public School
Agyei, Amma	A25	Assabet Valley Voc. H. S.
Aiello, Vito	G17	Martha's Vineyard Regional H. S.
Ali, Halimo	K12	Madison Park Tech Voc HS
Ali, Ardo	C14	Madison Park Tech Voc HS
Allaparthi, Snigdha	J26	Lexington High School
Alves, Ineida	F25	Excel High
Amico, Anthony	D10	Everett High School
Amiji, Salima	B4	Bishop Feehan High School
Anderson, Henning	G18	Joseph Case High School
Arace, Anthony	A26	Taconic High School
Aragon-Robbins, Michael	N13	Madison Park Tech Voc HS
Arona, Adrianna	C4	Westfield High School
AuDuong, Kevin	H27	Plymouth North High School
August, Colby	B25	St. John Paul ll High School

Aybar Estrella, Emmanuel	D13	Everett High School
Babiy, Marcus	J8	Northbridge Jr.-Sr. H. S.
Bagdasian, Brianna	H20	Taunton High School
Baker, Mairead	H21	Boston Latin Academy
Baptiste, Kathryn	D23	Taunton High School
Bartolomeo, Alexia	P23	Everett High School
Bass, Rhedise	J25	Somerville High School
Bazile, Vanessa	K5	John D. O'Bryant School of Mathematics and Science
Beadle, Katherine	F1	Bishop Feehan High School
Beale, Emma	K6	Hopkinton High School
Beausoleil, Chase	F7	Bishop Feehan High School
Beke, Abike	P12	Somerville High School
Benouannane, Rania	G25	East Boston High School
Best, Brian	N19	Hopkinton High School
Bharadwaj, Pratik	B23	Acton-Boxboro Reg. H.S.
Bhupatiraju, Vivek	J9	Lexington High School
Blaise, Meredith	F4	Bishop Feehan High School
Blanco, Rina	N21	East Boston High School
Bocage, Portia	C14	Madison Park Tech Voc HS
Bogle, Conner	B13	Marlborough High School
Bonito, Michael	J21	Bourne High School
Bontemps, Stevens	D14	Stoughton High School
Botelho, Jocelyn	J28	Taunton High School
Boucher, Christopher	C22	Everett High School
Bourzgui, Driss	J5	Berkshire Arts & Technology Charter Public School
Bouzit, Imane	K16	Pioneer Charter School of Science II
Bower, Allison	H18	Westfield High School
Bower, Jordan	H18	Westfield High School
Brea, Daniela	G22	Edward M. Kennedy Academy for Health Careers
Brote, Tiana	A15	Bancroft School
Bui, Michelle	N21	East Boston High School
Bulovic, Katarina	H13	Lexington High School
Burke, Chloe	H15	Bishop Feehan High School
Burns, Grace	K4	John D. O'Bryant School of Mathematics and Science
Byrne, Chloe	J2	Ursuline Academy
Cameron, Amanda	J4	Marlborough High School
Cao, Siyi	G20	St. Mark's School
Cardinale, Jason	D10	Everett High School
Carmichael, Janelle	J6	St. Mark's School
Carter, Dominic	B13	Marlborough High School
Casey, Connor	J15	Leominster High School
Caufield, Hayley	B14	Berkshire Arts & Technology Charter Public School
Chan, Patricia	J19	Braintree High School
Chen, Eileen	P9	Boston Latin Academy

Chen, Alexander	G6	Algonquin Regional H.S.
Chin, Dashiell	F10	Quincy High School
Chisholm, Aiden	B1	Westfield High School
Choi, Si Young	N22	Brooks School
Choi, Joshua	D24	Shrewsbury High School
Chopra, Rohit	K13	Community Charter School of Cambridge
Chug, Isha	P20	Shrewsbury High School
Churchill, Andrew	K22	Somerville High School
Clark, Martha	B10	Falmouth Academy
Coffey, Liam	A17	Westfield High School
Cohen, Mya	J14	Bourne High School
Cohen, Sam	K25	Natick High School
Cole, Hannah	P21	Newton South High School
Cole, Grace	G8	Boston Latin Academy
Collins, Mei	C28	Somerville High School
Correia, Matt	F19	Bishop Feehan High School
Coty, Will	H19	St. John Paul ll High School
Cox, Rebecca	G15	Falmouth Academy
Cremin, Rebecca	J20	Edward M. Kennedy Academy for Health Careers
Cullen, Aedan		Hopkins Academy
Curry, Tim	C19	Taconic High School
Daignault, MaiLee	N17	Berkshire Arts & Technology Charter Public School
Dalal, Aneeha	K19	Grafton Memorial Senior H. S.
Danko, Julia	D6	Wachusett Regional High School
Daraphet, Alina	F22	Northbridge Jr.-Sr. H. S.
Das, Sanjna	D21	Lexington High School
David, Jason	N13	Madison Park Tech Voc HS
Davignon, Cameron	A18	Westfield High School
De, Sumit	K20	Foxborough Regional Charter School
Defay, Benjamin	B28	Lexington High School
Defay, John	B28	Lexington High School
Delaney, Kate	B21	Newton Country Day School
Dello Russo, Michael	J22	Revere High School
DeSota, Elianna	N18	Mass. Academy of Math & Science
Devalla, Kumudini	H3	Quincy High School
Deveaux, Genevieve	A4	St. Mark's School
Deveney, Chloë	K19	Grafton Memorial Senior H. S.
DiCerbo, Lucas	H26	Lexington High School
Diltz, Jackson	F3	Westfield High School
DiPietro, Alexa	N10	Revere High School
Dogar, Numaan	A23	Mass. Academy of Math & Science
Dominguez, Manuel	D13	Everett High School
Downs, Karenna	P14	Westfield High School
Dubuisson, Nessie	J17	Brockton High School

Duong, Kevin	F26	Excel High
Dwyer, Christopher	D20	Wachusett Regional High School
Egan, Abby	G28	Plymouth North High School
EL-Saudi, Saja	C28	Somerville High School
Eldredge, Allison	G1	Falmouth Academy
Engler, Rose	H16	Martha's Vineyard Regional H. S.
Etienne, Jared	K15	Foxborough Regional Charter School
Falcao, Michael	K9	Pioneer Charter School of Science II
Farah, Albert	N6	Medford High School
Farah, Saiida	H7	Edward M. Kennedy Academy for Health Careers
Farah, Joseph	D8	Medford High School
Farnham, Johnna	G5	Westfield High School
Feilhauer, Alisa	C5	Joseph Case High School
Fenske, Charlie	B7	Falmouth Academy
Ferretti, Isabella	P5	Plymouth South High School
Figueroa, Cristian	P1	East Boston High School
Fisher, Curtis	C25	Martha's Vineyard Regional H. S.
Fitzgerald, Catherine	N23	Southeastern Reg. Voc-Tech. H S
Foster, Abigale	D5	Wachusett Regional High School
Fuller, Janelle	N11	Mary Lyon Pilot High School
Gaines, Daniel	N16	Martha's Vineyard Regional H. S.
Garcia-Chope, Jose	A2	Bancroft School
Garhwal, Saatvik	C12	Foxborough Regional Charter School
Gay, Rayana	F28	Edward M. Kennedy Academy for Health Careers
Gedeon, Brittney	C28	Somerville High School
Geraghty, Rory	F9	Bishop Feehan High School
Gillette, Apollo Elizabeth	A20	Taconic High School
Golowich, Louis	K11	Lexington High School
Gomez, Karla	J12	Edward M. Kennedy Academy for Health Careers
Gopalakrishnan, Vivek	F23	Lexington High School
Green, Mitchell	B15	Foxborough Regional Charter School
Griffin, Bryce	G22	Edward M. Kennedy Academy for Health Careers
Grobe, Sarah	F6	Westfield High School
Guerin, Theo	B7	Falmouth Academy
Guerriero, Benjamin	H6	Marian High School
Gupta, Mahika	B18	North Attleboro High School
Halak, Dania	J24	Revere High School
Haluch, Trisha	C16	Westfield High School
Hamzallari, Klei	F10	Quincy High School
Han, Ryan	K10	Winchester High School
Harrington, Lauren	C1	Bishop Feehan High School
Hartigan, Katherine	A3	St. Mark's School
Hartung, Haylee	J18	Taunton High School
Hea, Hurryra	G10	John D. O'Bryant School of Mathematics and Science

Herlong, Amelia	D19	West Boylston High School
Hewson, Madilynn	P15	St. John Paul ll High School
Holmgren, Erin	K24	Brockton High School
Hoque, Aditya	B19	Mass. Academy of Math & Science
Hu, Kevin	A7	Mass. Academy of Math & Science
Huang, Katherine	F12	Lowell High School
Hunter, Derek	F11	North Quincy High School
Ingmanson, Margaret	G13	Silver Lake Reg. H. S.
Iqbal, Hasna	H28	Boston Latin Academy
Ireland, Alexander	J16	Quincy High School
Isakov, Michael	N2	Lincoln-Sudbury Reg. H. S.
Jenkins, Genia	P6	John D. O'Bryant School of Mathematics and Science
Jiang, Lauren	G23	Boston Latin School
Johansen, Lida	B24	Assabet Valley Voc. H. S.
Jones, Tyler	A28	Wachusett Regional High School
Joseph, Daisha	K17	Bishop Feehan High School
Joyner, Ky-Auna	K5	John D. O'Bryant School of Mathematics and Science
Jude, Sadie	P2	West Boylston High School
Kafka-Gibbons, Charlotte	G14	Somerville High School
Kania, Nick	P10	Falmouth Academy
Karim, Asiya	D9	Lexington High School
Kariuki, Judy	D22	Foxborough Regional Charter School
Karnik, Sathwik	A9	Mass. Academy of Math & Science
Kavanagh, Conor	D14	Stoughton High School
Keeler, Emma	H11	Falmouth Academy
Kelliher, Grace	P17	North Quincy High School
Kelly, Emma	G3	Newton Country Day Sch/Sacred Heart
Khandekar, Nikhil	G24	Acton-Boxboro Reg. H.S.
Kim, James	H24	Phillips Academy
Kitsock, Emily	J23	Nantucket High School
Knudsen, Anders	J27	Cambridge Rindge & Latin High School
Konar, Kimberly	J4	Marlborough High School
Koran, Isabel	N7	Foxborough Regional Charter School
Koul, Akash	A19	Bancroft School
Krishna, Krithi	B11	Westborough High School
Kundu, Piyusha	G16	Lincoln-Sudbury Reg. H. S.
Kuperstein, Harry	A16	St. Mark's School
Kwon, Grace	D28	Falmouth High School
LaCourse, Cameron	B6	Taunton High School
Landry, Christopher	H5	Calvary Chapel Academy
Lazo, Jairo	F24	Edward M. Kennedy Academy for Health Careers
Le, Ngoc	F25	Excel High
Lederman, Juliana	N9	Marblehead High School
Lee, Christine	G7	Lexington High School

Legkodukh, Evelyna	F18	Westfield High School
Lemberger, Derek	D12	Shepherd Hill Reg. H. S.
Lemus, Anny	G25	East Boston High School
Leopold, Grace	F15	Calvary Chapel Academy
LeSage, Jordan	K21	Berkshire Arts & Technology Charter Public School
Li, Austin	G4	Quincy High School
Li, Lorna	B3	Taunton High School
Li, Kamryn	N1	Taunton High School
Liang, Zifeng	G2	Miss Hall's School
Liang, Tamara	F8	North Quincy High School
Lim, Cheaheon	B20	Northfield-Mt.Hermon School
Lim, Katherine	K14	Lexington High School
Lipscomb, Rayne	K4	John D. O'Bryant School of Mathematics and Science
Little-Gill, Sierra	P22	Hanover High School
Louaddi, Oulaya	N10	Revere High School
Loven, Michelle	A8	Mass. Academy of Math & Science
Lyons, Grace	A2	Bancroft School
Machado, Luana	K7	Methuen High School
Madhukar, Anshuman	D27	Shrewsbury High School
Maduanusi, Precious	J20	Edward M. Kennedy Academy for Health Careers
Maheswaran, Shivi	G12	Lexington High School
Mai, Do	P7	John D. O'Bryant School of Mathematics and Science
Mannion, Fiona	J11	Boston Latin Academy
Marangoni, Mansel	H10	Taconic High School
Marcosa, Bradley	H8	Upper Cape Cod Voc-Tec. H. S.
Marcuse, Julien	K26	Mary Lyon Pilot High School
Marks, Mei	J23	Nantucket High School
Mathers, Annabelle	D3	Wachusett Regional High School
Matis, Natalie	D17	Wachusett Regional High School
McAloon, Madison	P16	Taunton High School
McCormick, Kristen	N28	Newton Country Day School
Medeiros, Madyson	K1	Joseph Case High School
Medeiros, Zachary	A17	Westfield High School
Mehta, Karan	A6	Bancroft School
Menzel, Lauren	J3	Westfield High School
Metri, Anna	N20	Falmouth Academy
Minocha, Himanshu	C23	Hopkinton High School
Mitchell, Sean	P13	Westfield High School
Mizerak, Evan	A10	Wachusett Regional High School
Moran Sanchez, Carlos	N27	East Boston High School
Morgan, Alyssa	C27	Matignon High School
Morgan, Keerah	B9	Taconic High School
Moriarty, Brigid	B12	Westfield High School
Morrissey, Brendan	B1	Westfield High School

Muhameiti, Aoguzi	K9	Pioneer Charter School of Science II
Mullaly, Grace	P23	Everett High School
Murphy, Skylar	C16	Westfield High School
Murray, Ryan	P13	Westfield High School
Nair, Ambika	P8	Newton Country Day Sch/Sacred Heart
Najah, Nadine	G11	Pioneer Charter School of Science II
Najah, Aiman	P19	Pioneer Charter School of Science II
Nance, Bailey	H8	Upper Cape Cod Voc-Tec. H. S.
Nandan, Deepa	P18	Westborough High School
Nandi, Shurobhi	A24	North Attleboro High School
Nathan, Krish	K18	Westborough High School
Neary, Caitlin	K27	Bishop Feehan High School
Nene, Advait	A21	Hopkinton High School
Nguyen, Peter	K2	Taunton High School
Nguyen, Ngoc Tram	C17	Miss Hall's School
Nguyen, Tam	P9	Boston Latin Academy
Nouri, Meriam	N14	Pioneer Charter School of Science II
Nur, Rukia	H4	Excel High
OBryant, John Richard	F24	Edward M. Kennedy Academy for Health Careers
Ofei, Joseph	F20	Taconic High School
Oli, Bishakha	K8	Falmouth Academy
Oliva, Leslie	N27	East Boston High School
Onffroy, Philip	C20	Bancroft School
Otter, Troy	C11	Falmouth High School
Packer, Nathaniel	H25	Martha's Vineyard Regional H. S.
Padela, Umar	J19	Braintree High School
Palmer, Dylan	P3	St. John Paul ll High School
Pannu, Arashleen	A11	Shrewsbury High School
Pappas-Byers, Bronwyn	A5	Hopkinton High School
Paradis, Andrew	N8	Excel High
Park, Sang Yoon	G21	Deerfield Academy
Parkinson, Elizabeth	N3	Bishop Feehan High School
Patel, Deep	D12	Shepherd Hill Reg. H. S.
Patel, Priti	N15	Foxborough Regional Charter School
Pathalam, Vikram	C7	Shrewsbury High School
Patta, Anoop	K18	Westborough High School
Pendergast, Sam	A1	Mass. Academy of Math & Science
Penubarthi, Vishnu	C8	Shrewsbury High School
Pereira, Juliana	G27	Edward M. Kennedy Academy for Health Careers
Pereira, Aidan	B17	Bishop Feehan High School
Perkins, Heather	K3	Berkshire Arts & Technology Charter Public School
Pham, Khanh	F26	Excel High
Phan, Huy	P9	Boston Latin Academy
Piard, Madge	G26	Edward M. Kennedy Academy for Health Careers

Pires, Luis	G19	Excel High
Plaza, Illiani	G25	East Boston High School
Podesta, Jonathan	J7	Stoughton High School
Pol Tejeda, Kiana	N26	East Boston High School
Portelli, Alec	K22	Somerville High School
Prakash, Indumathi	F16	Sharon High School
Pralat, Jenna	B16	Mass. Academy of Math & Science
Puri, Sanjana	C24	Lexington High School
Qian, Jason	A22	St. Mark's School
Qian, Amy	C17	Miss Hall's School
Qin, Felix	A19	Bancroft School
Qutab, Ali	D7	St. Peter-Marian Jr. Sr. CCHS
Raj, Yashasvi	D11	Lexington High School
Ram, Janani	D25	Westborough High School
Reid, Jayden	P6	John D. O'Bryant School of Mathematics and Science
Roberts, Katharine	H16	Martha's Vineyard Regional H. S.
Roca, Francisco	D13	Everett High School
Rosen, Elan	D18	Hopkinton High School
Rosenzweig, Noah	B13	Marlborough High School
Rotondo, Joseph	K28	Upper Cape Cod Voc-Tec. H. S.
Rowley, Peter	K25	Lexington High School
Rubinstein, Foster	J21	Bourne High School
Saiju, Aman	H26	Lexington High School
Sane, Eshan	K18	Westborough High School
Sanon, Eunnindy	G27	Edward M. Kennedy Academy for Health Careers
Santangelo, Julia	F3	Westfield High School
Santos, Michael	N27	East Boston High School
Sarafin, Samantha	A4	St. Mark's School
Schmidt, Annika	C25	Martha's Vineyard Regional H. S.
Schmitt, Mary	J14	Bourne High School
Schremp, Christine	B5	Bishop Feehan High School
Sears, Olivia	H9	Revere High School
Serre, Ryan	A20	Taconic High School
Sharif, Ekran	J20	Edward M. Kennedy Academy for Health Careers
Sharma, Parima	A5	Hopkinton High School
Shaw, Rashawn	N8	Excel High
Shen, Rachel	F5	Quincy High School
Sigel, Jonathan	B22	Mass. Academy of Math & Science
Singh, Shefali	H22	Falmouth High School
Sinha, Varnika	A12	Mass. Academy of Math & Science
Skogstrom, Ava	B26	St. John Paul ll High School
Slein, Margaret	C26	Archbishop Williams H.S.
Smith, Lenahnia	K4	John D. O'Bryant School of Mathematics and Science
Song, Daniel	C10	Lexington High School

Soriano, Manyeuiris	P7	John D. O'Bryant School of Mathematics and Science
Sotir, Dylan	C18	St. Mark's School
Spice, Abigael	C16	Westfield High School
St.Louis-Severe, Christine	H7	Edward M. Kennedy Academy for Health Careers
Stark, Nicole	D2	Wachusett Regional High School
Stawasz, Kristen	B8	Westfield High School
Stewart, Isabelle	H23	Falmouth Academy
Stinehart, Madison	B2	Westfield High School
Su, Anna	C2	Miss Hall's School
Sussman, Rachel	H13	Lexington High School
Swamy, Varun	C7	Shrewsbury High School
Szymanowski, Bartek	J8	Northbridge Jr.-Sr. H. S.
Ta, John	C15	Mass. Academy of Math & Science
Tanenbaum, Nicole	H17	Taunton High School
Tang, Sophia	F21	Boston Latin School
Tatten, David	C21	John D. O'Bryant School of Mathematics and Science
Taylor, Emily	J1	Berkshire Arts & Technology Charter Public School
Taylor, Nature	F14	Madison Park Tech Voc HS
Taylor, Jillian	H12	Upper Cape Cod Voc-Tec. H. S.
Terpak, Caitlin	J13	Berkshire Arts & Technology Charter Public School
Thomas, Heidi	P4	Edward M. Kennedy Academy for Health Careers
Thompson, Brian	N12	Mary Lyon Pilot High School
Thongphala, Benjamin	D12	Shepherd Hill Reg. H. S.
Thou, Starleene	K24	Brockton High School
Tillman, Benjamin	F2	Martha's Vineyard Regional H. S.
Todorov, Teodor	H14	Pioneer Charter School of Science II
Torra, Celeste	P12	Somerville High School
Tran, Jacqueline	G9	John D. O'Bryant School of Mathematics and Science
Trattel, Samantha	J23	Nantucket High School
Turcios, Kevin	P1	East Boston High School
Valencius, Ilan	N25	North Quincy High School
Van Liew, Christopher	D16	Wachusett Regional High School
Vazquez, Juliana	J10	East Boston High School
Veinbachs, Alessandra	D1	Bancroft School
Weare, Helena	H23	Falmouth Academy
Weiss, Elizabeth	P11	Newton Country Day Sch/Sacred Heart
Whitehead, Caylah	A14	Taconic High School
Wilfong, Kim	K19	Grafton Memorial Senior H. S.
Williams, Kaylie	H1	Westfield High School
Woelflein, Kate	K6	Hopkinton High School
Wong, Alice	A13	Taunton High School
Wong, Kathleen	K7	Methuen High School
Wong, Sara	N24	North Quincy High School
Xiao, Violet	H2	Falmouth Academy

Xu, Charles	D26	Falmouth High School
Xu, John	C13	Deerfield Academy
Yan, Mingze	F13	Worcester Academy
Yin, Qiuyi	B27	St. Mark's School
Yoo, Seo-Hyun	K23	Lexington High School
Yuan, Andrew	D15	Wachusett Regional High School
Zgurzynski, Mary	D4	Wachusett Regional High School
Zhi, Sally	C6	Mass. Academy of Math & Science
Zhou, Richard	K11	Lexington High School
Zhuge, Jamiee	A27	Wachusett Regional High School
Znakharchuk, Ilona	B2	Westfield High School
Zorrilla Santana, Baleriet M.	N26	East Boston High School

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Exhibitors by School City/Town, School, Student

Acton	Acton-Boxboro Reg. H.S.	Region: 4
Khandekar, Nikhil	Discipline : Biology	Exhibit: G24
	The Effect of Heat Indices on Dermestid Beetle's Decaying of Carcasses	
Acton	Acton-Boxboro Reg. H.S.	Region: 4
Bharadwaj, Pratik	Discipline : Computers	Exhibit: B23
	Monitoring, Predicting, and Detecting Muscle Fatigue using a WBAN	
Adams	Berkshire Arts & Technology Charter Public School	Region: 1
Bourzgui , Driss	Discipline : Environmental Science	Exhibit: J5
	Lichen: Bio-Indicators of Air Quality	
Adams	Berkshire Arts & Technology Charter Public School	Region: 1
Daignault , MaiLee	Discipline : Biology	Exhibit: N17
	Solar Powered Water Desalination Device	
Adams	Berkshire Arts & Technology Charter Public School	Region: 1
Terpak, Caitlin	Discipline : Biology	Exhibit: J13
	Yeast Lab: Antifungals	
Adams	Berkshire Arts & Technology Charter Public School	Region: 1
Caufield, Hayley	Discipline : Physics & Electronics	Exhibit: B14
	Lighter Than A Feather?	
Adams	Berkshire Arts & Technology Charter Public School	Region: 1
Aguilar, Gerardo	Discipline : Chemistry	Exhibit: N4
	Salt Bridge (Not an Engineering Project)	
Adams	Berkshire Arts & Technology Charter Public School	Region: 1
Perkins, Heather	Discipline : Chemistry	Exhibit: K3
	Purifying Salt-Water	
Adams	Berkshire Arts & Technology Charter Public School	Region: 1
Taylor, Emily	Discipline : Physics & Electronics	Exhibit: J1
	Finding a Noninvasive Device to Help Reduce Hand Tremors	
Adams	Berkshire Arts & Technology Charter Public School	Region: 1
LeSage, Jordan	Discipline : Biochemistry	Exhibit: K21
	Natural Antiseptic Remedies	
Andover	Phillips Academy	Region: 4
Kim, James	Discipline : Biochemistry	Exhibit: H24
	The Effect of Meso-tetra Porphyrin on Alzheimer's Disease	
Attleboro	Bishop Feehan High School	Region: 3
Burke, Chloe	Discipline : Biochemistry	Exhibit: H15
	The Effects of Mouthwash on Oral Bacteria	

Attleboro	Bishop Feehan High School	Region: 3
Parkinson , Elizabeth	Discipline : Environmental Science	Exhibit: N3
	The Effect of Antacids on Soil Damaged by Acid Rain	
Attleboro	Bishop Feehan High School	Region: 3
Neary , Caitlin	Discipline : Biology	Exhibit: K27
	The Effect of Microwave Radiation on Living Organisms	
Attleboro	Bishop Feehan High School	Region: 3
Harrington, Lauren	Discipline : Chemistry	Exhibit: C1
	Which Drinks Contain the Most Blue Food Dye?	
Attleboro	Bishop Feehan High School	Region: 3
Joseph, Daisha	Discipline : Biology	Exhibit: K17
	Battle of the Bandages	
Attleboro	Bishop Feehan High School	Region: 3
Beadle, Katherine	Discipline : Biochemistry	Exhibit: F1
	Varying Lipid Production Efficiencies among Microalgae	
Attleboro	Bishop Feehan High School	Region: 3
Amiji, Salima	Discipline : Biology	Exhibit: B4
	DNA Mutations and Drug Resistance in Cancer	
Attleboro	Bishop Feehan High School	Region: 3
Beausoleil, Chase	Discipline : Engineering	Exhibit: F7
	Taming the Tsunami	
Attleboro	Bishop Feehan High School	Region: 3
Schremp, Christine	Discipline : Environmental Science	Exhibit: B5
	Toxicity of Titanium Dioxide and Zinc Oxide Nanoparticles	
Attleboro	Bishop Feehan High School	Region: 3
Blaise, Meredith	Discipline : Behavioral Science	Exhibit: F4
	Psychosocial Turmoil	
Attleboro	Bishop Feehan High School	Region: 3
Geraghty , Rory	Discipline : Behavioral Science	Exhibit: F9
	Does Listening to Music Help to Do Homework?	
Attleboro	Bishop Feehan High School	Region: 3
Correia, Matt	Discipline : Engineering	Exhibit: F19
	London Bridge is Eroding Down	
Attleboro	Bishop Feehan High School	Region: 3
Pereira, Aidan	Discipline : Physics & Electronics	Exhibit: B17
	The Effect of Electromagnetic Forces on Metal Rings	

Barnstable	St. John Paul ll High School	Region: 5
Palmer, Dylan	Discipline : Engineering	Exhibit: P3
	Theoretical Spacecraft Propulsion	
Boston	Excel High	Region: 6
Duong, Kevin	Discipline : Biology	TEAM Exhibit: F26
	Improving T-cell Engineering to Treat Leukemia by Identifying Cancer	
Boston	Madison Park Tech Voc HS	Region: 6
Aragon-Robbins, Michael	Discipline : Engineering	TEAM Exhibit: N13
	Air Driven Engine	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Piard, Madge	Discipline : Biochemistry	Exhibit: G26
	Which Fruit or Vegetable Produces the Most DNA Extraction?	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Sharif, Ekran	Discipline : Engineering	TEAM Exhibit: J20
	Curing Cystic Fibrosis with CRISPR/CAS 9	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
St.Louis-Severe, Christine	Discipline : Chemistry	TEAM Exhibit: H7
	Does Less Dense Fruits Contain More Vitiamn C?	
Boston	Excel High	Region: 6
Pires, Luis	Discipline : Environmental Science	Exhibit: G19
	Are These Plants GMO?	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Brea, Daniela	Discipline : Engineering	TEAM Exhibit: G22
	DNA Extraction & Molecular Engineering	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Thomas, Heidi	Discipline : Chemistry	Exhibit: P4
	Electrolyte Challenge: Orange Juice Vs. Sports Drinks	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Cremin, Rebecca	Discipline : Engineering	TEAM Exhibit: J20
	Curing Cystic Fibrosis with CRISPR/CAS 9	
Boston	East Boston High School	Region: 6
Santos, Michael	Discipline : Biology	TEAM Exhibit: N27
	pH in Algae Balls	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Gay, Rayana	Discipline : Biochemistry	Exhibit: F28
	Does Bar Soap Damage Your Skin ?	

Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Griffin, Bryce	Discipline : Engineering	TEAM Exhibit: G22
	DNA Extraction & Molecular Engineering	
Boston	East Boston High School	Region: 6
Oliva, Leslie	Discipline : Biology	TEAM Exhibit: N27
	pH in Algae Balls	
Boston	Excel High	Region: 6
Alves, Ineida	Discipline : Biochemistry	TEAM Exhibit: F25
	Do Natural Compounds Have Antibiotic Properties?	
Boston	Boston Latin Academy	Region: 6
Baker, Mairead	Discipline : Biochemistry	Exhibit: H21
	pH's Effect on the Oxidation of Apples	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Pereira, Juliana	Discipline : Biochemistry	TEAM Exhibit: G27
	Generating Electricity Using Biowaste	
Boston	Boston Latin Academy	Region: 6
Cole, Grace	Discipline : Chemistry	Exhibit: G8
	Chemically Curly Hair	
Boston	Excel High	Region: 6
Paradis, Andrew	Discipline : Environmental Science	TEAM Exhibit: N8
	The Effect of Mycorrhizal Fungi on the Growth of Tomatoes	
Boston	Madison Park Tech Voc HS	Region: 6
Bocage, Portia	Discipline : Behavioral Science	TEAM Exhibit: C14
	Light Based Emotions	
Boston	Excel High	Region: 6
Shaw, Rashawn	Discipline : Environmental Science	TEAM Exhibit: N8
	The Effect of Mycorrhizal Fungi on the Growth of Tomatoes	
Boston	East Boston High School	Region: 6
Turcios, Kevin	Discipline : Biology	TEAM Exhibit: P1
	How Effective is Your Virtual Reality Experience?	
Boston	John D. O'Bryant School of Mathematics and Science	Region: 6
Tran, Jacqueline	Discipline : Behavioral Science	Exhibit: G9
	Music on Plant Growth	
Boston	Boston Latin School	Region: 6
Jiang, Lauren	Discipline : Biology	Exhibit: G23
	Analysis of the Ebola Glycoprotein from the 2014 Outbreak	

Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Farah, Saiida	Discipline : Chemistry	TEAM Exhibit: H7
	Does Less Dense Fruits Contain More Vitiamn C?	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Maduanusi, Precious	Discipline : Engineering	TEAM Exhibit: J20
	Curing Cystic Fibrosis with CRISPR/CAS 9	
Boston	East Boston High School	Region: 6
Figueroa, Cristian	Discipline : Biology	TEAM Exhibit: P1
	How Effective is Your Virtual Reality Experience?	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
OBryant, John Richard	Discipline : Physics & Electronics	TEAM Exhibit: F24
	What Material Blocks the Sound the Best?	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Sanon , Eunnindy	Discipline : Biochemistry	TEAM Exhibit: G27
	Generating Electricity Using Biowaste	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Lazo, Jairo	Discipline : Physics & Electronics	TEAM Exhibit: F24
	What Material Blocks the Sound the Best?	
Boston	Excel High	Region: 6
Nur, Rukia	Discipline : Chemistry	Exhibit: H4
	Radiating Devices	
Boston	Boston Latin Academy	Region: 6
Mannion, Fiona	Discipline : Physics & Electronics	Exhibit: J11
	Electromagnets	
Boston	Excel High	Region: 6
Le, Ngoc	Discipline : Biochemistry	TEAM Exhibit: F25
	Do Natural Compounds Have Antibiotic Properties?	
Boston	John D. O'Bryant School of Mathematics and Science	Region: 6
Mai, Do	Discipline : Biochemistry	TEAM Exhibit: P7
	Investigating Photosynthesis with Algae Balls	
Boston	Boston Latin School	Region: 6
Tang, Sophia	Discipline : Biology	Exhibit: F21
	Development of an Antigen-Detection Diagnostic Assay for Lyme Disease	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Gomez, Karla	Discipline : Environmental Science	Exhibit: J12
	Using Calcium to Protect Forest Plants from Nitric Acid Rain.	

Boston	Madison Park Tech Voc HS	Region: 6
David, Jason	Discipline : Engineering	TEAM Exhibit: N13
	Air Driven Engine	
Bourne	Bourne High School	Region: 5
Cohen, Mya	Discipline : Biology	TEAM Exhibit: J14
	Automated Plant Monitoring System	
Bourne	Upper Cape Cod Voc-Tec. H. S.	Region: 5
Marcosa, Bradley	Discipline : Environmental Science	TEAM Exhibit: H8
	The Food For Our Food	
Bourne	Bourne High School	Region: 5
Schmitt, Mary	Discipline : Biology	TEAM Exhibit: J14
	Automated Plant Monitoring System	
Bourne	Upper Cape Cod Voc-Tec. H. S.	Region: 5
Nance, Bailey	Discipline : Environmental Science	TEAM Exhibit: H8
	The Food For Our Food	
Bourne	Bourne High School	Region: 5
Bonito, Michael	Discipline : Biology	TEAM Exhibit: J21
	The Effects of Global Warming on the Bourne Community Sea Level	
Bourne	Bourne High School	Region: 5
Rubinstein, Foster	Discipline : Biology	TEAM Exhibit: J21
	The Effects of Global Warming on the Bourne Community Sea Level	
Bourne	Upper Cape Cod Voc-Tec. H. S.	Region: 5
Taylor, Jillian	Discipline : Environmental Science	Exhibit: H12
	The Growth of Plants In a Hydroponic System	
Braintree	Braintree High School	Region: 5
Padela, Umar	Discipline : Biochemistry	TEAM Exhibit: J19
	Building a Better Microbial Fuel Cell	
Braintree	Braintree High School	Region: 5
Chan, Patricia	Discipline : Biochemistry	TEAM Exhibit: J19
	Building a Better Microbial Fuel Cell	
Braintree	Archbishop Williams H.S.	Region: 5
Slein, Margaret	Discipline : Environmental Science	Exhibit: C26
	The Study of H. sanguineus Population Density and Genetic Variation	
Brighton	Mary Lyon Pilot High School	Region: 6
Marcuse, Julien	Discipline : Computers	Exhibit: K26
	Learning Runner AI	

Brighton	Mary Lyon Pilot High School	Region: 6
Fuller, Janelle	Discipline : Chemistry	Exhibit: N11
	What Makes a Good Quality Lip Balm?	
Brighton	Mary Lyon Pilot High School	Region: 6
Thompson, Brian	Discipline : Environmental Science	Exhibit: N12
	Reducing Ocean Acidification	
Brockton	Brockton High School	Region: 5
Thou, Starleene	Discipline : Environmental Science	TEAM Exhibit: K24
	Filtering with Titanium Dioxide	
Brockton	Brockton High School	Region: 5
Dubuisson, Nessie	Discipline : Engineering	Exhibit: J17
	Combating Global Warming through A New Air Conditioner Design	
Brockton	Brockton High School	Region: 5
Holmgren, Erin	Discipline : Environmental Science	TEAM Exhibit: K24
	Filtering with Titanium Dioxide	
Cambridge	Cambridge Rindge & Latin High School	Region: 4
Knudsen, Anders	Discipline : Biology	Exhibit: J27
	Quantitatively Comparing cECM Protein in Different Scenarios	
Cambridge	Matignon High School	Region: 4
Morgan, Alyssa	Discipline : Biology	Exhibit: C27
	Cell Phone Microscope Vs. Compound Light Microscope	
Cambridge	Community Charter School of Cambridge	Region: 4
Chopra, Rohit	Discipline : Biology	Exhibit: K13
	Capping Cancer: Cancer Prognosis through Telomere Length	
Canton	Canton High School	Region: 5
Addanki, Anvitha	Discipline : Behavioral Science	Exhibit: F17
	Long Term Impacts on War Affected Population: Study Using Planaria	
Chelsea	Pioneer Charter School of Science II	Region: 4
Muhameiti, Aoguzi	Discipline : Environmental Science	TEAM Exhibit: K9
	The Effects of Caffeine on the Environment	
Dedham	Ursuline Academy	Region: 5
Byrne, Chloe	Discipline : Biochemistry	Exhibit: J2
	The Hemagglutinating Effect of Lectins on Blood of People with PCOS	
Deerfield	Deerfield Academy	Region: 1
Park, Sang Yoon	Discipline : Environmental Science	Exhibit: G21
	Effect of S. pasteurii and Calcium Alginate on Increasing Soil Cohesion	

Deerfield.	Deerfield Academy	Region: 1
Xu, John	Discipline : Behavioral Science	Exhibit: C13
	Mitigating Congestion through Map Design: A Case Study of DC Subway	
Dudley	Shepherd Hill Reg. H. S.	Region: 2
Patel, Deep	Discipline : Engineering	TEAM Exhibit: D12
	Solar Powered Go-Kart	
Dudley	Shepherd Hill Reg. H. S.	Region: 2
Lemberger, Derek	Discipline : Engineering	TEAM Exhibit: D12
	Solar Powered Go-Kart	
Dudley	Shepherd Hill Reg. H. S.	Region: 2
Thongphala, Benjamin	Discipline : Engineering	TEAM Exhibit: D12
	Solar Powered Go-Kart	
East Boston	East Boston High School	Region: 6
Lemus, Anny	Discipline : Biology	TEAM Exhibit: G25
	How Sweet It Is!	
East Boston	East Boston High School	Region: 6
Zorrilla Santana, Baleriet M.	Discipline : Biology	TEAM Exhibit: N26
	Wild Type Vs. GMO Plants	
East Boston	East Boston High School	Region: 6
Blanco, Rina	Discipline : Chemistry	TEAM Exhibit: N21
	Borax Recrystallization	
East Boston	East Boston High School	Region: 6
Bui, Michelle	Discipline : Chemistry	TEAM Exhibit: N21
	Borax Recrystallization	
East Boston	East Boston High School	Region: 6
Moran Sanchez, Carlos	Discipline : Biology	TEAM Exhibit: N27
	pH in Algae Balls	
East Boston	East Boston High School	Region: 6
Benouannane, Rania	Discipline : Biology	TEAM Exhibit: G25
	How Sweet It Is!	
East Boston	East Boston High School	Region: 6
Pol Tejeda , Kiana	Discipline : Biology	TEAM Exhibit: N26
	Wild Type Vs. GMO Plants	
East Boston	East Boston High School	Region: 6
Plaza, Illiani	Discipline : Biology How Sweet It Is!	TEAM Exhibit: G25

East Bostpn	East Boston High School	Region: 6
Vazquez, Juliana	Discipline : Environmental Science	Exhibit: J10
	Salinity's Effect on Brine Shrimp	
East Taunton	Taunton High School	Region: 3
Botelho, Jocelyn	Discipline : Biology	Exhibit: J28
	Eliminating E. coli	
Everett	Everett High School	Region: 4
Bartolomeo, Alexia	Discipline : Earth & Space Science	TEAM Exhibit: P23
	Catching Stellar Dust	
Everett	Everett High School	Region: 4
Cardinale, Jason	Discipline : Engineering	TEAM Exhibit: D10
	Inferno the Firefighting UAV: Autonomous Fire Analyzation	
Everett	Everett High School	Region: 4
Mullaly, Grace	Discipline : Earth & Space Science	TEAM Exhibit: P23
	Catching Stellar Dust	
Everett	Everett High School	Region: 4
Boucher, Christopher	Discipline : Engineering	Exhibit: C22
	Front Smart	
Everett	Everett High School	Region: 4
Roca, Francisco	Discipline : Engineering	TEAM Exhibit: D13
	PassOut	
Everett	Everett High School	Region: 4
Dominguez, Manuel	Discipline : Engineering	TEAM Exhibit: D13
	PassOut	
Everett	Everett High School	Region: 4
Aybar Estrella, Emmanuel	Discipline : Engineering	TEAM Exhibit: D13
	PassOut	
Everett	Everett High School	Region: 4
Amico, Anthony	Discipline : Engineering	TEAM Exhibit: D10
	Inferno the Firefighting UAV: Autonomous Fire Analyzation	
Falmouth	Falmouth Academy	Region: 5
Eldredge, Allison	Discipline : Chemistry	Exhibit: G1
	Which Photo Developer is the Most Effective?	
Falmouth	Falmouth High School	Region: 5
Abrams, Max	Discipline : Mathematics	Exhibit: F27
	Graph-Theoretic Implications on Graphs Composed of Complete Bijections	

Falmouth	Falmouth High School	Region: 5
Xu, Charles	Discipline : Environmental Science	Exhibit: D26
	Are Alkenone Paleoclimate Proxies Influenced by Ocean Acidification?	
Falmouth	Falmouth Academy	Region: 5
Kania, Nick	Discipline : Chemistry	Exhibit: P10
	The Geochemistry of Bottled Water	
Falmouth	Falmouth Academy	Region: 5
Metri, Anna	Discipline : Biology	Exhibit: N20
	Studies on Preservation of Vision in the Rotifer Brachionus manjavacus	
Falmouth	Falmouth High School	Region: 5
Kwon, Grace	Discipline : Environmental Science	Exhibit: D28
	The Effect of Pile Driving Noise on Alpheus angulosus	
Falmouth	Falmouth Academy	Region: 5
Weare, Helena	Discipline : Biology	TEAM Exhibit: H23
	The Effects of Huperzine A and Memantine on Hermissenda Crassicornis	
Falmouth	Falmouth High School	Region: 5
Otter, Troy	Discipline : Engineering	Exhibit: C11
	Constructing a Flexible Wing	
Falmouth	Falmouth High School	Region: 5
Singh, Shefali	Discipline : Biology	Exhibit: H22
	Analysis of Favorable Environments for Growth of Probiotic Bacteria	
Falmouth	Falmouth Academy	Region: 5
Keeler, Emma	Discipline : Biology	Exhibit: H11
	Calcium Carbonate Vent Influence on Aspects of a Meiofaunal Community	
Falmouth	Falmouth Academy	Region: 5
Xiao, Violet	Discipline : Biology	Exhibit: H2
	Effect of Microbiota on the Thermal and Lead Tolerance of Nematostella	
Falmouth	Falmouth Academy	Region: 5
Fenske, Charlie	Discipline : Engineering	TEAM Exhibit: B7
	Analysis of Airborne Wind Energy Systems to Enhance Electrical Output	
Falmouth	Falmouth Academy	Region: 5
Oli, Bishakha	Discipline : Environmental Science	Exhibit: K8
	Microplastics in the Coastal Ocean Over Time	
Falmouth	Falmouth Academy	Region: 5
Stewart, Isabelle	Discipline : Biology	TEAM Exhibit: H23
	The Effects of Huperzine A and Memantine on Hermissenda Crassicornis	

Falmouth	Falmouth Academy	Region: 5
Cox, Rebecca	Discipline : Biology	Exhibit: G15
	Bacterial Symbionts of Bathymodiolus Mussels Found in New Cold Seeps	
Falmouth	Falmouth Academy	Region: 5
Clark, Martha	Discipline : Biology	Exhibit: B10
	The Effects of Temperature on Snapping Shrimp Behavior	
Falmouth	Falmouth Academy	Region: 5
Guerin, Theo	Discipline : Engineering	TEAM Exhibit: B7
	Analysis of Airborne Wind Energy Systems to Enhance Electrical Output	
Foxboro	Foxborough Regional Charter School	Region: 3
Koran, Isabel	Discipline : Engineering	Exhibit: N7
	Powering an Athlete Visibility Light through the Seebeck Effect	
Foxboro	Foxborough Regional Charter School	Region: 3
Garhwal, Saatvik	Discipline : Computers	Exhibit: C12
	Is Your Network Safe?	
Foxboro	Foxborough Regional Charter School	Region: 3
Patel, Priti	Discipline : Chemistry	Exhibit: N15
	Plop Plop, Fizz Fizz	
Foxboro	Foxborough Regional Charter School	Region: 3
Green, Mitchell	Discipline : Engineering	Exhibit: B15
	A System to Divert Runoff Containing Road and Residential Contaminants	
Foxborough	Foxborough Regional Charter School	Region: 3
Etienne, Jared	Discipline : Engineering	Exhibit: K15
	Fan Imitation by Acoustic Pressure	
Foxborough	Foxborough Regional Charter School	Region: 3
Kariuki, Judy	Discipline : Engineering	Exhibit: D22
	The Power of the Human Hand	
Foxborough	Foxborough Regional Charter School	Region: 3
De, Sumit	Discipline : Chemistry	Exhibit: K20
	Novel Method for Removing Contaminants from Surfaces Using Nanobubbles	
Framingham	Marian High School	Region: 2
Guerriero, Benjamin	Discipline : Physics & Electronics	Exhibit: H6
	The Change in Resistance of Metals with Temperature	
Grafton	Grafton Memorial Senior H. S.	Region: 2
Wilfong, Kim	Discipline : Biochemistry	TEAM Exhibit: K19
	Reducing Methane Emission in Cow Manure	

Grafton	Grafton Memorial Senior H. S.	Region: 2
Dalal, Aneeha	Discipline : Biochemistry	TEAM Exhibit: K19
	Reducing Methane Emission in Cow Manure	
Grafton	Grafton Memorial Senior H. S.	Region: 2
Deveney, Chloë	Discipline : Biochemistry	TEAM Exhibit: K19
	Reducing Methane Emission in Cow Manure	
Hadley	Hopkins Academy	Region: 1
Cullen, Aedan	Discipline : Computers	
	Awareness: The Functionality-Distribution Network	
Hanover	Hanover High School	Region: 5
Little-Gill, Sierra	Discipline : Environmental Science	Exhibit: P22
	Effect of the Species of Wood on the Heat Produced by a Biomass Pellet	
Holden	Wachusett Regional High School	Region: 2
Matis, Natalie	Discipline : Biology	Exhibit: D17
	The Effect of Arachidonil Acid on Daphnia magna Reproduction	
Holden	Wachusett Regional High School	Region: 2
Mizerak, Evan	Discipline : Biology	Exhibit: A10
	Transgenerational Trends in Fertility of Drosophila melanogaster	
Holden	Wachusett Regional High School	Region: 2
Stark, Nicole	Discipline : Biology	Exhibit: D2
	D.magna as a Bioassay in an Ecotoxicology Study on Pharmaceuticals	
Holden	Wachusett Regional High School	Region: 2
Mathers, Annabelle	Discipline : Chemistry	Exhibit: D3
	The Effect of Chemicals and pH on Coagulation	
Holden	Wachusett Regional High School	Region: 2
Dwyer, Christopher	Discipline : Biology	Exhibit: D20
	Analyzing Necessity of Aeration Vs. Nutrient in Algal Photobioreactor	
Holden	Wachusett Regional High School	Region: 2
Zhuge, Jamiee	Discipline : Biology	Exhibit: A27
	Effect of Metformin on Aβ42-induced Alzheimer's in D. Melanogaster	
Holden	Wachusett Regional High School	Region: 2
Zgurzynski , Mary	Discipline : Biology	Exhibit: D4
	The Effect of Glyphosate on the Navigation of Apis mellifera	
Holden	Wachusett Regional High School	Region: 2
Foster, Abigale	Discipline : Biology	Exhibit: D5
	Effect of Warfarin on Learning and Memory of Drosophila melanogaster	

Holden	Wachusett Regional High School	Region: 2
Danko, Julia	Discipline : Environmental Science	Exhibit: D6
	Finding Better Fuel: Optimizing Algae Biofuel	
Holden	Wachusett Regional High School	Region: 2
Yuan, Andrew	Discipline : Biology	Exhibit: D15
	The Effect of a Low Level Laser on the Speed of Planarian Regeneration	
Holden	Wachusett Regional High School	Region: 2
Jones, Tyler	Discipline : Engineering	Exhibit: A28
	Show Me the Way	
Holden	Wachusett Regional High School	Region: 2
Van Liew, Christopher	Discipline : Biology	Exhibit: D16
	The Effect of TGF-beta1 on Planarian Regeneration After Photodamage	
Hopkinton	Hopkinton High School	Region: 2
Beale, Emma	Discipline : Environmental Science	TEAM Exhibit: K6
	The Effect of Global Climate Change on Spider Silk Proteins	
Hopkinton	Hopkinton High School	Region: 2
Rosen, Elan	Discipline : Computers	Exhibit: D18
	Using Directional Lighting for Fire Escape	
Hopkinton	Hopkinton High School	Region: 2
Sharma, Parima	Discipline : Physics & Electronics	TEAM Exhibit: A5
	Development of Solar Cells Using Conductive Glass	
Hopkinton	Hopkinton High School	Region: 2
Best, Brian	Discipline : Mathematics	Exhibit: N19
	Music Math: Does Music Follow a Zipfian Distribution?	
Hopkinton	Hopkinton High School	Region: 2
Minocha, Himanshu	Discipline : Computers	Exhibit: C23
	Campus Safety Warning and Notification System Using 3D Geofencing	
Hopkinton	Hopkinton High School	Region: 2
Pappas-Byers, Bronwyn	Discipline : Physics & Electronics	TEAM Exhibit: A5
	Development of Solar Cells Using Conductive Glass	
Hopkinton	Hopkinton High School	Region: 2
Woelflein, Kate	Discipline : Environmental Science	TEAM Exhibit: K6
	The Effect of Global Climate Change on Spider Silk Proteins	
Hopkinton	Hopkinton High School	Region: 2
Nene, Advait	Discipline : Engineering	Exhibit: A21
	Harvesting Peizoelectricity for Everyday Use	

Hyannis	St. John Paul ll High School	Region: 5
August, Colby	Discipline : Engineering	Exhibit: B25
	Reception Deception	
Hyannis	St. John Paul ll High School	Region: 5
Skogstrom, Ava	Discipline : Physics & Electronics	Exhibit: B26
	Harp Strings and Humidity	
Hyannis	St. John Paul ll High School	Region: 5
Coty, Will	Discipline : Physics & Electronics	Exhibit: H19
	Let 'Em Fly	
Hyannis	St. John Paul ll High School	Region: 5
Hewson, Madilynn	Discipline : Engineering	Exhibit: P15
	Wave Energy	
Kingston	Silver Lake Reg. H. S.	Region: 5
Ingmanson, Margaret	Discipline : Behavioral Science	Exhibit: G13
	Interactions with the Enviornment by Captive White Cheeked Gibbons	
Leominster	Leominster High School	Region: 2
Casey, Connor	Discipline : Biology	Exhibit: J15
	Inhibition of the GPD Genes in C.elegans Due to the Presence of Sugar	
Lexington	Lexington High School	Region: 4
Saiju, Aman	Discipline : Biology	TEAM Exhibit: H26
	Characterizing the Biomechanics of Runners	
Lexington	Lexington High School	Region: 4
Golowich, Louis	Discipline : Mathematics	TEAM Exhibit: K11
	Maximum Size of a Family of Pairwise Graph-Different Permutations	
Lexington	Lexington High School	Region: 4
Sussman, Rachel	Discipline : Behavioral Science	TEAM Exhibit: H13
	Which Musical Genre Prompts the Greatest Recall of Information?	
Lexington	Lexington High School	Region: 4
Rowley, Peter	Discipline : Mathematics	TEAM Exhibit: K25
	End Behavior of Discrete Curve Shortening Flow	
Lexington	Lexington High School	Region: 4
Bulovic, Katarina	Discipline : Behavioral Science	TEAM Exhibit: H13
	Which Musical Genre Prompts the Greatest Recall of Information?	
Lexington	Lexington High School	Region: 4
Gopalakrishnan, Vivek	Discipline : Biology	Exhibit: F23
	To Floss, or Not to Floss: An Oral Microbiome Investigation	

Lexington	Lexington High School	Region: 4
Raj, Yashasvi	Discipline : Physics & Electronics	Exhibit: D11
	ThermoTap: A Thermal Generator Utilizing the Heat of the Desert	
Lexington	Lexington High School	Region: 4
Allaparthi, Snigdha	Discipline : Biology	Exhibit: J26
	Understanding FUS Mutation Mechanisms in the Cells of ALS Patients	
Lexington	Lexington High School	Region: 4
Zhou, Richard	Discipline : Mathematics	TEAM Exhibit: K11
	Maximum Size of a Family of Pairwise Graph-Different Permutations	
Lexington	Lexington High School	Region: 4
Lee, Christine	Discipline : Engineering	Exhibit: G7
	Actively Growing Hydroponics with Salt Water, Electricity-Free	
Lexington	Lexington High School	Region: 4
Song, Daniel	Discipline : Engineering	Exhibit: C10
	Self-Cleaning Gutter System	
Lexington	Lexington High School	Region: 4
Das, Sanjna	Discipline : Biology	Exhibit: D21
	Effects of ISL and [6]-Gingerol on Invasive Bladder Cancer Cells	
Lexington	Lexington High School	Region: 4
Bhupatiraju, Vivek	Discipline : Biology	Exhibit: J9
	On the Prediction of HIV-1 Drug Resistance to Integrase Inhibitors	
Lexington	Lexington High School	Region: 4
Lim, Katherine	Discipline : Biology	Exhibit: K14
	Designing Guide RNAs for CRISPR Genome Editing	
Lexington	Lexington High School	Region: 4
Puri, Sanjana	Discipline : Behavioral Science	Exhibit: C24
	Utilizing Brain Wave Analysis in Enhancing STEM Education	
Lexington	Lexington High School	Region: 4
DiCerbo, Lucas	Discipline : Biology	TEAM Exhibit: H26
	Characterizing the Biomechanics of Runners	
Lexington	Lexington High School	Region: 4
Defay, Benjamin	Discipline : Engineering	TEAM Exhibit: B28
	Fireflies and Network Synchronization in the Presence of Distractors	
Lexington	Lexington High School	Region: 4
Defay, John	Discipline : Engineering	TEAM Exhibit: B28
	Fireflies and Network Synchronization in the Presence of Distractors	

Lexington	Lexington High School	Region: 4
Maheswaran, Shivi	Discipline : Biochemistry	Exhibit: G12
	Developing A Pre-Diagnostic for Chemotherapy	
Lexington	Lexington High School	Region: 4
Karim, Asiya	Discipline : Physics & Electronics	Exhibit: D9
	Surface Vs. Bulk Heating of Ferrofluid in Alternating Magnetic Field	
Lexington	Lexington High School	Region: 4
Yoo, Seo-Hyun	Discipline : Biology	Exhibit: K23
	miRNA Targets for the Prevention of Drug Resistance in Cancer Cells	
Lowell	Lowell High School	Region: 4
Huang, Katherine	Discipline : Biochemistry	Exhibit: F12
	Molecular Dynamics Simulations of Botulinum Neurotoxin Inhibitor	
Marblehead	Marblehead High School	Region: 4
Lederman, Juliana	Discipline : Biology	Exhibit: N9
	The Effects of Organic Food on Drosophila melanogaster	
Marlboro	Assabet Valley Voc. H. S.	Region: 2
Agyei, Amma	Discipline : Biology	Exhibit: A25
	The Most Effective Acne Treatment	
Marlborough	Marlborough High School	Region: 2
Cameron, Amanda	Discipline : Environmental Science	TEAM Exhibit: J4
	Bioplastic: An Alternative for Environmentally Destructive Polymers	
Marlborough	Assabet Valley Voc. H. S.	Region: 2
Johansen, Lida	Discipline : Environmental Science	Exhibit: B24
	Trash the Ash: The Effect of Smoke on Stomatal Behavior	
Marlborough	Marlborough High School	Region: 2
Bogle, Conner	Discipline : Engineering	TEAM Exhibit: B13
	Outdoor Industries	
Marlborough	Marlborough High School	Region: 2
Konar, Kimberly	Discipline : Environmental Science	TEAM Exhibit: J4
	Bioplastic: An Alternative for Environmentally Destructive Polymers	
Marlborough	Marlborough High School	Region: 2
Rosenzweig, Noah	Discipline : Engineering	TEAM Exhibit: B13
	Outdoor Industries	
Marlborough	Marlborough High School	Region: 2
Carter, Dominic	Discipline : Engineering	TEAM Exhibit: B13
	Outdoor Industries	

Medford	Medford High School	Region: 4
Farah, Joseph	Discipline : Physics & Electronics	Exhibit: D8
	An Analysis of HRRGs with Mid-Range Spectral Indices at z ~ 6	
Medford	Medford High School	Region: 4
Farah, Albert	Discipline : Biology	Exhibit: N6
	Effect of Martian Soil Simulant on Pseudomonas putida	
Methuen	Methuen High School	Region: 4
Machado, Luana	Discipline : Chemistry	TEAM Exhibit: K7
	How Safe Are You from Acid Rain?	
Methuen	Methuen High School	Region: 4
Wong, Kathleen	Discipline : Chemistry	TEAM Exhibit: K7
	How Safe Are You from Acid Rain?	
Mount Hermon	Northfield-Mt.Hermon School	Region: 1
Lim, Cheaheon	Discipline : Environmental Science	Exhibit: B20
	Freshwater Oil Spills: Effects on Daphnia Magna	
Nantucket	Nantucket High School	Region: 5
Trattel, Samantha	Discipline : Environmental Science	TEAM Exhibit: J23
	Neutralizing the Effects of Ocean Acidification on Bivalves	
Nantucket	Nantucket High School	Region: 5
Marks , Mei	Discipline : Environmental Science	TEAM Exhibit: J23
	Neutralizing the Effects of Ocean Acidification on Bivalves	
Nantucket	Nantucket High School	Region: 5
Kitsock, Emily	Discipline : Environmental Science	TEAM Exhibit: J23
	Neutralizing the Effects of Ocean Acidification on Bivalves	
Natick	Natick High School	Region: 4
Cohen, Sam	Discipline : Mathematics	TEAM Exhibit: K25
	End Behavior of Discrete Curve Shortening Flow	
Newton	Newton Country Day School	Region: 5
Delaney, Kate	Discipline : Engineering	Exhibit: B21
	When in Doubt, Draw It Out	
Newton	Newton Country Day Sch/Sacred Heart	Region: 5
Kelly, Emma	Discipline : Biology	Exhibit: G3
	The Mystery of Fallopian Tube Cancer	
Newton	Newton Country Day Sch/Sacred Heart	Region: 5
Weiss, Elizabeth	Discipline : Biology	Exhibit: P11
	Prevalence of Penicillin Allergies	

Newton	Newton Country Day School	Region: 5
McCormick, Kristen	Discipline : Biology	Exhibit: N28
	What Factors Trigger Seizures in Fruit Flies?	
Newton	Newton Country Day Sch/Sacred Heart	Region: 5
Nair, Ambika	Discipline : Biology	Exhibit: P8
	Deprivation Dilemma	
Newton Centre	Newton South High School	Region: 5
Cole, Hannah	Discipline : Biology	Exhibit: P21
	Epigenetic Influences in Cancer	
North Andover	Brooks School	Region: 4
Choi, Si Young	Discipline : Chemistry	Exhibit: N22
	Novel Biochemical Nanoparticles as Contrast Agents For Bio Imaging	
North Attleboro	North Attleboro High School	Region: 3
Gupta, Mahika	Discipline : Environmental Science	Exhibit: B18
	Starch Vs. Cellulosic Derived Ethanol	
North Attleboro	North Attleboro High School	Region: 3
Nandi, Shurobhi	Discipline : Biology	Exhibit: A24
	Designing a New Antibiotic	
North Quincy	North Quincy High School	Region: 5
Liang, Tamara	Discipline : Biology	Exhibit: F8
	Effects of Wi-Fi Router Radiation on Drosophila melanogaster	
Northborough	Algonquin Regional H.S.	Region: 2
Chen, Alexander	Discipline : Engineering	Exhibit: G6
	Optimizing a CNT-Based Kinetic Energy Harvester	
Northbridge	Northbridge Jr.-Sr. H. S.	Region: 2
Babiy, Marcus	Discipline : Chemistry	TEAM Exhibit: J8
	Warriors of the Winter	
Oak Bluffs	Martha's Vineyard Regional H. S.	Region: 5
Roberts, Katharine	Discipline : Engineering	TEAM Exhibit: H16
	Solely Solar	
Oak Bluffs	Martha's Vineyard Regional H. S.	Region: 5
Engler, Rose	Discipline : Engineering	TEAM Exhibit: H16
	Solely Solar	
Oak Bluffs	Martha's Vineyard Regional H. S.	Region: 5
Tillman, Benjamin	Discipline : Engineering	Exhibit: F2
	Solar Charging Station	

Oak Bluffs	Martha's Vineyard Regional H. S.	Region: 5
Fisher, Curtis	Discipline : Environmental Science	TEAM Exhibit: C25
	A Community Connection: Nodal LoRa Modulation for Environmental Data	
Oak Bluffs	Martha's Vineyard Regional H. S.	Region: 5
Gaines, Daniel	Discipline : Biochemistry	Exhibit: N16
	Engineering Recombinent Virus To Express tBid Exclusively In Cartilage	
Oak Bluffs	Martha's Vineyard Regional H. S.	Region: 5
Schmidt, Annika	Discipline : Environmental Science	TEAM Exhibit: C25
	A Community Connection: Nodal LoRa Modulation for Environmental Data	
Oak Bluffs	Martha's Vineyard Regional H. S.	Region: 5
Packer, Nathaniel	Discipline : Engineering	Exhibit: H25
	Tidal Powered Floating Water Wheel	
Oak Bluffs	Martha's Vineyard Regional H. S.	Region: 5
Aiello, Vito	Discipline : Biology	Exhibit: G17
	Buy Less, Save More: An Investigation in Apple Preservation	
Pittsfield	Taconic High School	Region: 1
Ofei, Joseph	Discipline : Biology	Exhibit: F20
	Respiration and Germination	
Pittsfield	Miss Hall's School	Region: 1
Liang, Zifeng	Discipline : Biology	Exhibit: G2
	Comparing Normal Apple Gene and Diseased Apple Gene	
Pittsfield	Miss Hall's School	Region: 1
Su, Anna	Discipline : Biology	Exhibit: C2
	The Parkinson Chain	
Pittsfield	Miss Hall's School	Region: 1
Qian, Amy	Discipline : Biochemistry	TEAM Exhibit: C17
	Separation of Collagen from Eggshell Membranes as Dietary Supplements	
Pittsfield	Taconic High School	Region: 1
Marangoni, Mansel	Discipline : Engineering	Exhibit: H10
	A Better Way To Catch Bass	
Pittsfield	Miss Hall's School	Region: 1
Nguyen, Ngoc Tram	Discipline : Biochemistry	TEAM Exhibit: C17
	Separation of Collagen from Eggshell Membranes as Dietary Supplements	
Pittsfield	Taconic High School	Region: 1
Gillette, Apollo Elizabeth	Discipline : Engineering	TEAM Exhibit: A20
	Dynamo Safety and Charging System	

Pittsfield	Taconic High School	Region: 1
Whitehead, Caylah	Discipline : Engineering	Exhibit: A14
	Crash and Burn Fire Starters	
Pittsfield	Taconic High School	Region: 1
Curry, Tim	Discipline : Physics & Electronics	Exhibit: C19
	DPB - Dimpled Paintball	
Pittsfield	Taconic High School	Region: 1
Morgan, Keerah	Discipline : Engineering	Exhibit: B9
	Can Layers of Carpet, Boards, and Plywood Affect .22LR Penetration?	
Pittsfield	Taconic High School	Region: 1
Arace, Anthony	Discipline : Engineering	Exhibit: A26
	Innovations of Medical Devices Using 3D Printing	
Pittsfield	Taconic High School	Region: 1
Serre, Ryan	Discipline : Engineering	TEAM Exhibit: A20
	Dynamo Safety and Charging System	
Plymouth	Plymouth North High School	Region: 5
AuDuong, Kevin	Discipline : Mathematics	Exhibit: H27
	Solving a Rubik's Cube for a Beginner	
Plymouth	Plymouth South High School	Region: 5
Ferretti, Isabella	Discipline : Physics & Electronics	Exhibit: P5
	All That Matters Is The Spatter	
Plymouth	Plymouth North High School	Region: 5
Egan, Abby	Discipline : Biology	Exhibit: G28
	Myths of Multitasking	
Quincy	North Quincy High School	Region: 5
Valencius, Ilan	Discipline : Engineering	Exhibit: N25
	Floating Water: The Leidenfrost Effect	
Quincy	Quincy High School	Region: 5
Chin , Dashiell	Discipline : Biology	TEAM Exhibit: F10
	Testing the Efficiency of Oil-Degrading Bacteria	
Quincy	Quincy High School	Region: 5
Li, Austin	Discipline : Engineering	Exhibit: G4
	Airfoil Aerodynamics	
Quincy	Quincy High School	Region: 5
Ireland, Alexander	Discipline : Engineering	Exhibit: J16
	Saving Space, Saving Lives; Natural Disaster? No Problem	

Quincy	Quincy High School	Region: 5
Devalla, Kumudini	Discipline : Computers	Exhibit: H3
	Computer Sleuth: Identification by Text Analysis	
Quincy	Quincy High School	Region: 5
Shen, Rachel	Discipline : Environmental Science	Exhibit: F5
	Controlling Phragmites by Depleting Stored Nutrients	
Quincy	Quincy High School	Region: 5
Hamzallari , Klei	Discipline : Biology	TEAM Exhibit: F10
	Testing the Efficiency of Oil-Degrading Bacteria	
Quincy	North Quincy High School	Region: 5
Kelliher, Grace	Discipline : Biology	Exhibit: P17
	The Capability of Trypan Blue as a Viability Dye in Pond Water	
Quincy	North Quincy High School	Region: 5
Wong, Sara	Discipline : Chemistry	Exhibit: N24
	Fruitizymes!	
Quincy	North Quincy High School	Region: 5
Hunter, Derek	Discipline : Environmental Science	Exhibit: F11
	Biodegreadable Plastics: A Worthy Successor?	
Revere	Revere High School	Region: 4
Louaddi, Oulaya	Discipline : Physics & Electronics	TEAM Exhibit: N10
	The Effect of Heat on the Amount of Static Electricity Gathered	
Revere	Revere High School	Region: 4
Sears, Olivia	Discipline : Environmental Science	Exhibit: H9
	The Effect of Toxins in Dirt on the Lifespan of Daphnia Magna	
Revere	Revere High School	Region: 4
DiPietro, Alexa	Discipline : Physics & Electronics	TEAM Exhibit: N10
	The Effect of Heat on the Amount of Static Electricity Gathered	
Revere	Revere High School	Region: 4
Dello Russo, Michael	Discipline : Environmental Science	Exhibit: J22
	Determining Micro-Plastic Pollution in Bivalves by Species and Region	
Revere	Revere High School	Region: 4
Halak, Dania	Discipline : Biochemistry	Exhibit: J24
	Building a Model For Separation and Migration of DNA	
Rockland	Calvary Chapel Academy	Region: 5
Leopold, Grace	Discipline : Engineering	Exhibit: F15
	See the Light	

Rockland	Calvary Chapel Academy	Region: 5
Landry , Christopher	Discipline : Biology	Exhibit: H5
	What are the Effects of Artificial Sweeteners and Sugar on Plant Life?	
Roxbury	Boston Latin Academy	Region: 6
Phan, Huy	Discipline : Biology	TEAM Exhibit: P9
	The Effect of Sound on the Respiratory Rate of the House Cricket	
Roxbury	Boston Latin Academy	Region: 6
Nguyen, Tam	Discipline : Biology	TEAM Exhibit: P9
	The Effect of Sound on the Respiratory Rate of the House Cricket	
Roxbury	Boston Latin Academy	Region: 6
Iqbal, Hasna	Discipline : Environmental Science	Exhibit: H28
	How Does Carbon Dioxide Affect Plant Growth	
Roxbury	Boston Latin Academy	Region: 6
Chen, Eileen	Discipline : Biology	TEAM Exhibit: P9
	The Effect of Sound on the Respiratory Rate of the House Cricket	
Roxbury	John D. O'Bryant School of Mathematics and Science	Region: 6
Burns, Grace	Discipline : Physics & Electronics	TEAM Exhibit: K4
	The Power of PSI	
Roxbury	Madison Park Tech Voc HS	Region: 6
Abdi, Saida	Discipline : Behavioral Science	TEAM Exhibit: C14
	Light Based Emotions	
Roxbury	Madison Park Tech Voc HS	Region: 6
Ali, Halimo	Discipline : Biology	Exhibit: K12
	How Much Bacteria Is on Your Toothbrush?	
Roxbury	John D. O'Bryant School of Mathematics and Science	Region: 6
Soriano, Manyeuiris	Discipline : Biochemistry	TEAM Exhibit: P7
	Investigating Photosynthesis with Algae Balls	
Roxbury	Madison Park Tech Voc HS	Region: 6
Ali, Ardo	Discipline : Behavioral Science	TEAM Exhibit: C14
	Light Based Emotions	
Roxbury	John D. O'Bryant School of Mathematics and Science	Region: 6
Reid, Jayden	Discipline : Chemistry	TEAM Exhibit: P6
	Have Your Cake and Eat It Too!	
Roxbury	John D. O'Bryant School of Mathematics and Science	Region: 6
Jenkins, Genia	Discipline : Chemistry	TEAM Exhibit: P6
	Have Your Cake and Eat It Too!	

Roxbury	John D. O'Bryant School of Mathematics and Science	Region: 6
Lipscomb, Rayne	Discipline : Physics & Electronics	TEAM Exhibit: K4
	The Power of PSI	
Roxbury	John D. O'Bryant School of Mathematics and Science	Region: 6
Hea, Hurryra	Discipline : Chemistry	Exhibit: G10
	Electrifying Fruits and Vegetables	
Roxbury	Madison Park Tech Voc HS	Region: 6
Taylor, Nature	Discipline : Biology	Exhibit: F14
	How Often Do You Get Heartburn?	
Roxbury	John D. O'Bryant School of Mathematics and Science	Region: 6
Bazile, Vanessa	Discipline : Chemistry	TEAM Exhibit: K5
	Denaturing Proteins: In Which Conditions Do Proteins Denature?	
Roxbury	John D. O'Bryant School of Mathematics and Science	Region: 6
Smith, Lenahnia	Discipline : Physics & Electronics	TEAM Exhibit: K4
	The Power of PSI	
Roxbury	John D. O'Bryant School of Mathematics and Science	Region: 6
Joyner, Ky-Auna	Discipline : Chemistry	TEAM Exhibit: K5
	Denaturing Proteins: In Which Conditions Do Proteins Denature?	
Roxbury	John D. O'Bryant School of Mathematics and Science	Region: 6
Tatten, David	Discipline : Engineering	Exhibit: C21
	Creating a Custom Go-Kart from Recycled Materials	
Sandwich	Upper Cape Cod Voc-Tec. H. S.	Region: 5
Rotondo, Joseph	Discipline : Earth & Space Science	Exhibit: K28
	The Accuracy of Weather Applications	
Saugus	Pioneer Charter School of Science II	Region: 4
Najah, Aiman	Discipline : Chemistry	Exhibit: P19
	The Effect of Musa Acuminata Ash's Flame Retardancy Compared to NaHCO3	
Saugus	Pioneer Charter School of Science II	Region: 4
Nouri, Meriam	Discipline : Biology	Exhibit: N14
	The Effect of Spinacia oleracea and Lactuca sativa on Oxygen Productio	
Saugus	Pioneer Charter School of Science II	Region: 4
Bouzit, Imane	Discipline : Biology	Exhibit: K16
	The Effects of Turmeric and Bovine Collagen on the Regeneration of Dug	
Saugus	Pioneer Charter School of Science II	Region: 4
Todorov, Teodor	Discipline : Computers	Exhibit: H14
	Data Mining to Diagnose Heart Disease	

Saugus	Pioneer Charter School of Science II	Region: 4
Najah, Nadine	Discipline : Chemistry	Exhibit: G11
	Catalytic Impact of Nickel Nanoparticles on CKD Mineral Carbonation	
Saugus	Pioneer Charter School of Science II	Region: 4
Falcao, Michael	Discipline : Environmental Science	TEAM Exhibit: K9
	The Effects of Caffeine on the Environment	
Sharon	Sharon High School	Region: 5
Prakash, Indumathi	Discipline : Biology	Exhibit: F16
	Innovative & Affordable Smart Syringe to Contain Epidemic for Billions	
Shrewsbury	Shrewsbury High School	Region: 2
Swamy, Varun	Discipline : Computers	TEAM Exhibit: C7
	Supervised Learning Algorithm for Automated Diagnosis of Dementia	
Shrewsbury	Shrewsbury High School	Region: 2
Chug, Isha	Discipline : Environmental Science	Exhibit: P20
	The Effect of Biodegradable Plastics on Pea Plants: Friends or Foes	
Shrewsbury	Shrewsbury High School	Region: 2
Madhukar, Anshuman	Discipline : Physics & Electronics	Exhibit: D27
	Dynamic Dimples: The Future of Flight	
Shrewsbury	Shrewsbury High School	Region: 2
Pannu, Arashleen	Discipline : Engineering	Exhibit: A11
	Robotics Meets Forensics: A Whole New World: Take Two	
Shrewsbury	Shrewsbury High School	Region: 2
Penubarthi, Vishnu	Discipline : Chemistry	Exhibit: C8
	C "No" 2: A Novel Method to Reduce CO2 Emissions from Motor Vehicles	
Shrewsbury	Shrewsbury High School	Region: 2
Pathalam, Vikram	Discipline : Computers	TEAM Exhibit: C7
	Supervised Learning Algorithm for Automated Diagnosis of Dementia	
Shrewsbury	Shrewsbury High School	Region: 2
Choi, Joshua	Discipline : Biology	Exhibit: D24
	Defying Death: Antibacterial Resistance of E. Coli to Neomycin Sulfate	
Somerville	Somerville High School	Region: 4
Kafka-Gibbons, Charlotte	Discipline : Biology	Exhibit: G14
	Changes in Bacterial Community of Brined Pickles over Fermentation	
Somerville	Somerville High School	Region: 4
Churchill, Andrew	Discipline : Engineering	TEAM Exhibit: K22
	Harnessing the Energy of a Bicycle Commute	

Somerville	Somerville High School	Region: 4
Bass, Rhedise	Discipline : Biology	Exhibit: J25
	Investigating Lung Toxicity in Breast Cancer Patients	
Somerville	Somerville High School	Region: 4
Torra, Celeste	Discipline : Biology	TEAM Exhibit: P12
	Testing Cellular Function with Fluorouracil	
Somerville	Somerville High School	Region: 4
EL-Saudi, Saja	Discipline : Environmental Science	TEAM Exhibit: C28
	From Farm to Cable: The New Forefront of Energy Harvesting	
Somerville	Somerville High School	Region: 4
Beke, Abike	Discipline : Biology	TEAM Exhibit: P12
	Testing Cellular Function with Fluorouracil	
Somerville	Somerville High School	Region: 4
Collins, Mei	Discipline : Environmental Science	TEAM Exhibit: C28
	From Farm to Cable: The New Forefront of Energy Harvesting	
Somerville	Somerville High School	Region: 4
Gedeon, Brittney	Discipline : Environmental Science	TEAM Exhibit: C28
	From Farm to Cable: The New Forefront of Energy Harvesting	
Somerville	Somerville High School	Region: 4
Portelli, Alec	Discipline : Engineering	TEAM Exhibit: K22
	Harnessing the Energy of a Bicycle Commute	
South Boston	Excel High	Region: 6
Pham, Khanh	Discipline : Biology	TEAM Exhibit: F26
	Improving T-cell Engineering to Treat Leukemia by Identifying Cancer	
South Easton	Southeastern Reg. Voc-Tech. H S	Region: 5
Fitzgerald, Catherine	Discipline : Engineering	Exhibit: N23
	Personal Aid	
Southborough	St. Mark's School	Region: 2
Qian, Jason	Discipline : Engineering	Exhibit: A22
	Medication Manager: Administration of Medication	
Southborough	St. Mark's School	Region: 2
Cao, Siyi	Discipline : Behavioral Science	Exhibit: G20
	Semantic Representations of Emotional and Social Concepts in Autism	
Southborough	St. Mark's School	Region: 2
Carmichael, Janelle	Discipline : Biology	Exhibit: J6
	Candida Communities:Comparing Biofilm Growth on Catheter Surfaces	

Southborough	St. Mark's School	Region: 2
Deveaux, Genevieve	Discipline : Biology	TEAM Exhibit: A4
Peripheral Deficits and Social Behavior in Drosophila FMR1 Mutants		
Southborough	St. Mark's School	Region: 2
Yin, Qiuyi	Discipline : Computers	Exhibit: B27
Big Data Analysis: Public Opinions of Breast Cancer in Chinese Females		
Southborough	St. Mark's School	Region: 2
Kuperstein, Harry	Discipline : Behavioral Science	Exhibit: A16
Caffeine's Effect on Learning and Memory in Drosophila		
Southborough	St. Mark's School	Region: 2
Sotir, Dylan	Discipline : Engineering	Exhibit: C18
Safe to Drink: A Biofiltration System for Copper-Contaminated Water		
Southborough	St. Mark's School	Region: 2
Hartigan, Katherine	Discipline : Biology	Exhibit: A3
Antioxidants and Mitochondrial Function in C. elegans mev-1 mutants		
Southborough	St. Mark's School	Region: 2
Sarafin, Samantha	Discipline : Biology	TEAM Exhibit: A4
Peripheral Deficits and Social Behavior in Drosophila FMR1 Mutants		
Stoughton	Stoughton High School	Region: 5
Podesta, Jonathan	Discipline : Engineering	Exhibit: J7
Extending the Range of Electric Cars with Bladeless Turbines		
Stoughton	Stoughton High School	Region: 5
Kavanagh, Conor	Discipline : Biology	TEAM Exhibit: D14
The Glowing Transformation Efficiency in E.coli		
Stoughton	Stoughton High School	Region: 5
Bontemps, Stevens	Discipline : Biology	TEAM Exhibit: D14
The Glowing Transformation Efficiency in E.coli		
Sudbury	Lincoln-Sudbury Reg. H. S.	Region: 2
Isakov, Michael	Discipline : Behavioral Science	Exhibit: N2
Interaction of Mechanisms for Cooperation in Small-Scale Societies		
Sudbury	Lincoln-Sudbury Reg. H. S.	Region: 2
Kundu, Piyusha	Discipline : Biology	Exhibit: G16
The Correlation between Heart Failure and Renal Dysfuntion		
Swansea	Joseph Case High School	Region: 3
Anderson, Henning	Discipline : Biology	Exhibit: G18
How Much "Invisible" Fats Are in Common Snack Foods		

Swansea	Joseph Case High School	Region: 3
Medeiros, Madyson	Discipline : Biology	Exhibit: K1
	How Do Circulatory Diseases Affect the Rate of Blood Flow?	
Swansea	Joseph Case High School	Region: 3
Feilhauer, Alisa	Discipline : Environmental Science	Exhibit: C5
	Hydroponics Vs. Aquaponics	
Taunton	Taunton High School	Region: 3
Tanenbaum, Nicole	Discipline : Biology	Exhibit: H17
	Fixing Oxidative Damage: The Effect of Antioxidants on Telomere Length	
Taunton	Taunton High School	Region: 3
Li, Lorna	Discipline : Environmental Science	Exhibit: B3
	Hydroponics is Growing and the Future Should Too	
Taunton	Taunton High School	Region: 3
Wong, Alice	Discipline : Chemistry	Exhibit: A13
	Brightening At Levels	
Taunton	Taunton High School	Region: 3
Nguyen, Peter	Discipline : Biology	Exhibit: K2
	What Antibiotic is E.Coli Susceptible to?	
Taunton	Taunton High School	Region: 3
Bagdasian, Brianna	Discipline : Engineering	Exhibit: H20
	Spikes Vs. Sneakers	
Taunton	Taunton High School	Region: 3
Hartung, Haylee	Discipline : Biology	Exhibit: J18
	The Best Bend	
Taunton	Taunton High School	Region: 3
Baptiste, Kathryn	Discipline : Biology	Exhibit: D23
	Dominant Vs. Nondominant Hands Determining Weight	
Taunton	Taunton High School	Region: 3
LaCourse, Cameron	Discipline : Chemistry	Exhibit: B6
	Which Fabric is Better Suited to Overall Outdoor Use?	
Taunton	Taunton High School	Region: 3
McAloon, Madison	Discipline : Behavioral Science	Exhibit: P16
	Accuracy of Eyewitness Testimony	
Taunton	Taunton High School	Region: 3
Li, Kamryn	Discipline : Biology	Exhibit: N1
	The Effectiveness of Garlic on Bacteria	

West Boylston	West Boylston High School	Region: 2
Herlong, Amelia	Discipline : Physics & Electronics	Exhibit: D19
	The Physics of Video Games	
West Boylston	West Boylston High School	Region: 2
Jude, Sadie	Discipline : Biology	Exhibit: P2
	Natural Antibiotics Vs. Pharmaceutical Antibiotics	
Westborough	Westborough High School	Region: 2
Nandan, Deepa	Discipline : Biology	Exhibit: P18
	Impact of Genomic Alterations on TADs in Breast Cancer	
Westborough	Westborough High School	Region: 2
Ram, Janani	Discipline : Biochemistry	Exhibit: D25
	Utilizing Biochemistry of Enzymes to Design Effective Stain Removers	
Westborough	Westborough High School	Region: 2
Krishna, Krithi	Discipline : Biology	Exhibit: B11
	Predicting Patterns in Zika and Dengue	
Westborough	Westborough High School	Region: 2
Nathan, Krish	Discipline : Biochemistry	TEAM Exhibit: K18
	Designing A Thyroid Hormone Detection System	
Westborough	Westborough High School	Region: 2
Sane, Eshan	Discipline : Biochemistry	TEAM Exhibit: K18
	Designing A Thyroid Hormone Detection System	
Westborough	Westborough High School	Region: 2
Patta, Anoop	Discipline : Biochemistry	TEAM Exhibit: K18
	Designing A Thyroid Hormone Detection System	
Westfield	Westfield High School	Region: 1
Coffey, Liam	Discipline : Engineering	TEAM Exhibit: A17
	Developing a Filtration System Using Electrolysis	
Westfield	Westfield High School	Region: 1
Diltz, Jackson	Discipline : Engineering	TEAM Exhibit: F3
	Magnetic Vs. Traditional Helmets	
Westfield	Westfield High School	Region: 1
Murray, Ryan	Discipline : Engineering	TEAM Exhibit: P13
	Using Recycled Materials to Create Cost-Efficient Water Filtration	
Westfield	Westfield High School	Region: 1
Stawasz, Kristen	Discipline : Biology	Exhibit: B8
	The Effect of Wi-Fi on Plant Health	

Westfield	Westfield High School	Region: 1
Chisholm, Aiden	Discipline : Behavioral Science	TEAM Exhibit: B1
	Consumption Preferences of the Coenobita clypeatus	
Westfield	Westfield High School	Region: 1
Bower, Allison	Discipline : Physics & Electronics	TEAM Exhibit: H18
	Cymatics: Chladni's Plate	
Westfield	Westfield High School	Region: 1
Znakharchuk, Ilona	Discipline : Biology	TEAM Exhibit: B2
	The Effect of a Static Magnetic Field on the Growth of E. aerogenes, B. megaterium, and B. coagulans Bacteria	
Westfield	Westfield High School	Region: 1
Morrissey, Brendan	Discipline : Behavioral Science	TEAM Exhibit: B1
	Consumption Preferences of the Coenobita clypeatus	
Westfield	Westfield High School	Region: 1
Spice, Abigael	Discipline : Biology	TEAM Exhibit: C16
	The Effects of Ascorbic and Hyaluronic Acid on Zooxanthellae Algae	
Westfield	Westfield High School	Region: 1
Murphy, Skylar	Discipline : Biology	TEAM Exhibit: C16
	The Effects of Ascorbic and Hyaluronic Acid on Zooxanthellae Algae	
Westfield	Westfield High School	Region: 1
Bower, Jordan	Discipline : Physics & Electronics	TEAM Exhibit: H18
	Cymatics: Chladni's Plate	
Westfield	Westfield High School	Region: 1
Farnham, Johnna	Discipline : Biochemistry	Exhibit: G5
	Antimicrobial Copper and Liver of Sulfur	
Westfield	Westfield High School	Region: 1
Williams, Kaylie	Discipline : Physics & Electronics	Exhibit: H1
	Blunt Force against Medieval Armor	
Westfield	Westfield High School	Region: 1
Stinehart, Madison	Discipline : Biology	TEAM Exhibit: B2
	The Effect of a Static Magnetic Field on the Growth of E. aerogenes, B. megaterium, and B. coagulans Bacteria	
Westfield	Westfield High School	Region: 1
Medeiros, Zachary	Discipline : Engineering	TEAM Exhibit: A17
	Developing a Filtration System Using Electrolysis	
Westfield	Westfield High School	Region: 1
Haluch, Trisha	Discipline : Biology	TEAM Exhibit: C16
	The Effects of Ascorbic and Hyaluronic Acid on Zooxanthellae Algae	

Westfield	Westfield High School	Region: 1
Santangelo, Julia	Discipline : Engineering	TEAM Exhibit: F3
	Magnetic Vs. Traditional Helmets	
Westfield	Westfield High School	Region: 1
Arona, Adrianna	Discipline : Biology	Exhibit: C4
	Can You Wash All Your Bacteria Away?	
Westfield	Westfield High School	Region: 1
Legkodukh, Evelyna	Discipline : Engineering	Exhibit: F18
	Redesigning the Flow of Tension in Suspended Cables	
Westfield	Westfield High School	Region: 1
Davignon, Cameron	Discipline : Chemistry	Exhibit: A18
	Dye Concentration in Naturally and Artificially Colored Drinks	
Westfield	Westfield High School	Region: 1
Mitchell, Sean	Discipline : Engineering	TEAM Exhibit: P13
	Using Recycled Materials to Create Cost-Efficient Water Filtration	
Westfield	Westfield High School	Region: 1
Adams, Courtney	Discipline : Biology	TEAM Exhibit: P14
	How Many Germs Are Really on Your Cellphone?	
Westfield	Westfield High School	Region: 1
Moriarty, Brigid	Discipline : Biochemistry	Exhibit: B12
	Effects of Different Sunscreens	
Westfield	Westfield High School	Region: 1
Menzel, Lauren	Discipline : Biology	Exhibit: J3
	The Value of Plants in Our Soil	
Westfield	Westfield High School	Region: 1
Grobe, Sarah	Discipline : Engineering	Exhibit: F6
	Saving Lives with a Solar Powered Air Conditioner	
Westfield	Westfield High School	Region: 1
Downs, Karenna	Discipline : Biology	TEAM Exhibit: P14
	How Many Germs Are Really on Your Cellphone?	
Whitinsville	Northbridge Jr.-Sr. H. S.	Region: 2
Daraphet, Alina	Discipline : Engineering	Exhibit: F22
	Twist Bottle	
Whitinsville	Northbridge Jr.-Sr. H. S.	Region: 2
Szymanowski, Bartek	Discipline : Chemistry	TEAM Exhibit: J8
	Warriors of the Winter	

Winchester	Winchester High School	Region: 4
Han, Ryan	Discipline : Biology	Exhibit: K10
	The Role of Autophagy and Signaling Pathways on Cancer Cell Growth	
Worcester	Bancroft School	Region: 2
Onffroy, Philip	Discipline : Chemistry	Exhibit: C20
	Temperature Dependent Kinetics of a Self-Healing Polymer	
Worcester	Mass. Academy of Math & Science	Region: 2
Sinha, Varnika	Discipline : Engineering	Exhibit: A12
	Enhancing Smart Grid Technology to the Consumer Level	
Worcester	St. Peter-Marian Jr. Sr. CCHS	Region: 2
Qutab, Ali	Discipline : Biology	Exhibit: D7
	Diamagnetic Nanoparticles as Hyperthermia Agents for Cancer Treatment	
Worcester	Mass. Academy of Math & Science	Region: 2
Ta, John	Discipline : Environmental Science	Exhibit: C15
	Enhancing Biodegradability in Polymers Using Silane Chemistry	
Worcester	Bancroft School	Region: 2
Veinbachs, Alessandra	Discipline : Biology	Exhibit: D1
	NMJ and Motor Neuron Degeneration in ALS Tongue and Diaphragm Tissue	
Worcester	Bancroft School	Region: 2
Qin, Felix	Discipline : Biology	TEAM Exhibit: A19
	Effects of Ethanol and Nicotine on Development in Planaria	
Worcester	Mass. Academy of Math & Science	Region: 2
Hoque, Aditya	Discipline : Engineering	Exhibit: B19
	Who's Better? Creating a Novel Simulation for Baseball Player Analysis	
Worcester	Mass. Academy of Math & Science	Region: 2
DeSota, Elianna	Discipline : Engineering	Exhibit: N18
	Preventing Road Kill Using Bioacoustics	
Worcester	Worcester Academy	Region: 2
Adiletta, Matthew	Discipline : Engineering	Exhibit: C9
	Piano Player	
Worcester	Mass. Academy of Math & Science	Region: 2
Dogar, Numaan	Discipline : Biology	Exhibit: A23
	Identifying the NPTN-MET1 Pathway as a Target for Cancer Therapy	
Worcester	Bancroft School	Region: 2
Mehta, Karan	Discipline : Biochemistry	Exhibit: A6
	Using siRNAs to Promote Homology-Directed DNA Repair	

Worcester	Mass. Academy of Math & Science	Region: 2
Hu, Kevin	Discipline : Biology	Exhibit: A7
	Unsupervised Analysis of Gene Expression in Neurological Animal Models	
Worcester	Worcester Academy	Region: 2
Yan, Mingze	Discipline : Biology	Exhibit: F13
	A. of Gene Mutation for BRCA1 Interaction Network in Breast Cancers	
Worcester	Bancroft School	Region: 2
Brote, Tiana	Discipline : Behavioral Science	Exhibit: A15
	The Effects of Clothing on Observer Projection of Perceived Threat	
Worcester	Mass. Academy of Math & Science	Region: 2
Loven, Michelle	Discipline : Engineering	Exhibit: A8
	Vibrating Watch for the Visually Impaired	
Worcester	Mass. Academy of Math & Science	Region: 2
Pendergast, Sam	Discipline : Engineering	Exhibit: A1
	Firearm Safety: An Automated Trigger Lock	
Worcester	Mass. Academy of Math & Science	Region: 2
Karnik, Sathwik	Discipline : Computers	Exhibit: A9
	Safer Security: A Novel Algorithm to Detect Carmichael Numbers	
Worcester	Bancroft School	Region: 2
Lyons, Grace	Discipline : Biology	TEAM Exhibit: A2
	The Effect of Exercise on the Lifespan of C. elegans	
Worcester	Mass. Academy of Math & Science	Region: 2
Sigel, Jonathan	Discipline : Engineering	Exhibit: B22
	Improving The Newton Square Roundabout	
Worcester	Bancroft School	Region: 2
Garcia-Chope, Jose	Discipline : Biology	TEAM Exhibit: A2
	The Effect of Exercise on the Lifespan of C. elegans	
Worcester	Bancroft School	Region: 2
Koul, Akash	Discipline : Biology	TEAM Exhibit: A19
	Effects of Ethanol and Nicotine on Development in Planaria	
Worcester	Mass. Academy of Math & Science	Region: 2
Pralat, Jenna	Discipline : Biology	Exhibit: B16
	Kava and Acetaminophen Induced Hepatotoxicity	
Worcester	Mass. Academy of Math & Science	Region: 2
Zhi, Sally	Discipline : Biology	Exhibit: C6
	The Effect of Malathion on Neurodegeneration in Drosophila melangaster	

Team Projects Listing

Boston	East Boston High School	Region: 6
Santos, Michael	Discipline : Biology	Exhibit: N27
	pH in Algae Balls	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Sharif, Ekran	Discipline : Engineering	Exhibit: J20
	Curing Cystic Fibrosis with CRISPR/CAS 9	
Boston	East Boston High School	Region: 6
Oliva, Leslie	Discipline : Biology	Exhibit: N27
	pH in Algae Balls	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Griffin, Bryce	Discipline : Engineering	Exhibit: G22
	DNA Extraction & Molecular Engineering	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Maduanusi, Precious	Discipline : Engineering	Exhibit: J20
	Curing Cystic Fibrosis with CRISPR/CAS 9	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Brea, Daniela	Discipline : Engineering	Exhibit: G22
	DNA Extraction & Molecular Engineering	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Lazo, Jairo	Discipline : Physics & Electronics	Exhibit: F24
	What Material Blocks the Sound the Best?	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Cremin, Rebecca	Discipline : Engineering	Exhibit: J20
	Curing Cystic Fibrosis with CRISPR/CAS 9	
Boston	East Boston High School	Region: 6
Turcios, Kevin	Discipline : Biology	Exhibit: P1
	How Effective is Your Virtual Reality Experience?	
Boston	Excel High	Region: 6
Duong, Kevin	Discipline : Biology	Exhibit: F26
	Improving T-cell Engineering to Treat Leukemia by Identifying Cancer	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
OBryant, John Richard	Discipline : Physics & Electronics	Exhibit: F24
	What Material Blocks the Sound the Best?	
Boston	East Boston High School	Region: 6
Figueroa, Cristian	Discipline : Biology	Exhibit: P1
	How Effective is Your Virtual Reality Experience?	

Boston	Madison Park Tech Voc HS	Region: 6
Bocage, Portia	Discipline : Behavioral Science	Exhibit: C14
	Light Based Emotions	
Boston	Madison Park Tech Voc HS	Region: 6
David, Jason	Discipline : Engineering	Exhibit: N13
	Air Driven Engine	
Boston	Excel High	Region: 6
Shaw, Rashawn	Discipline : Environmental Science	Exhibit: N8
	The Effect of Mycorrhizal Fungi on the Growth of Tomatoes	
Boston	Madison Park Tech Voc HS	Region: 6
Aragon-Robbins, Michael	Discipline : Engineering	Exhibit: N13
	Air Driven Engine	
Boston	Excel High	Region: 6
Paradis, Andrew	Discipline : Environmental Science	Exhibit: N8
	The Effect of Mycorrhizal Fungi on the Growth of Tomatoes	
Boston	Excel High	Region: 6
Le, Ngoc	Discipline : Biochemistry	Exhibit: F25
	Do Natural Compounds Have Antibiotic Properties?	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
St.Louis-Severe, Christine	Discipline : Chemistry	Exhibit: H7
	Does Less Dense Fruits Contain More Vitiamn C?	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Pereira, Juliana	Discipline : Biochemistry	Exhibit: G27
	Generating Electricity Using Biowaste	
Boston	Excel High	Region: 6
Alves, Ineida	Discipline : Biochemistry	Exhibit: F25
	Do Natural Compounds Have Antibiotic Properties?	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Farah, Saiida	Discipline : Chemistry	Exhibit: H7
	Does Less Dense Fruits Contain More Vitiamn C?	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Sanon , Eunnindy	Discipline : Biochemistry	Exhibit: G27
	Generating Electricity Using Biowaste	
Boston	John D. O'Bryant School of Mathematics and Science	Region: 6
Mai, Do	Discipline : Biochemistry	Exhibit: P7
	Investigating Photosynthesis with Algae Balls	

Bourne	Upper Cape Cod Voc-Tec. H. S.	Region: 5
Nance, Bailey	Discipline : Environmental Science	Exhibit: H8
	The Food For Our Food	
Bourne	Bourne High School	Region: 5
Cohen, Mya	Discipline : Biology	Exhibit: J14
	Automated Plant Monitoring System	
Bourne	Bourne High School	Region: 5
Schmitt, Mary	Discipline : Biology	Exhibit: J14
	Automated Plant Monitoring System	
Bourne	Bourne High School	Region: 5
Bonito, Michael	Discipline : Biology	Exhibit: J21
	The Effects of Global Warming on the Bourne Community Sea Level	
Bourne	Bourne High School	Region: 5
Rubinstein, Foster	Discipline : Biology	Exhibit: J21
	The Effects of Global Warming on the Bourne Community Sea Level	
Bourne	Upper Cape Cod Voc-Tec. H. S.	Region: 5
Marcosa, Bradley	Discipline : Environmental Science	Exhibit: H8
	The Food For Our Food	
Braintree	Braintree High School	Region: 5
Padela, Umar	Discipline : Biochemistry	Exhibit: J19
	Building a Better Microbial Fuel Cell	
Braintree	Braintree High School	Region: 5
Chan, Patricia	Discipline : Biochemistry	Exhibit: J19
	Building a Better Microbial Fuel Cell	
Brockton	Brockton High School	Region: 5
Thou, Starleene	Discipline : Environmental Science	Exhibit: K24
	Filtering with Titanium Dioxide	
Brockton	Brockton High School	Region: 5
Holmgren, Erin	Discipline : Environmental Science	Exhibit: K24
	Filtering with Titanium Dioxide	
Chelsea	Pioneer Charter School of Science II	Region: 4
Muhameiti, Aoguzi	Discipline : Environmental Science	Exhibit: K9
	The Effects of Caffeine on the Environment	
Dudley	Shepherd Hill Reg. H. S.	Region: 2
Patel, Deep	Discipline : Engineering	Exhibit: D12
	Solar Powered Go-Kart	

Dudley	Shepherd Hill Reg. H. S.	Region: 2
Lemberger, Derek	Discipline : Engineering	Exhibit: D12
	Solar Powered Go-Kart	
Dudley	Shepherd Hill Reg. H. S.	Region: 2
Thongphala, Benjamin	Discipline : Engineering	Exhibit: D12
	Solar Powered Go-Kart	
East Boston	East Boston High School	Region: 6
Moran Sanchez, Carlos	Discipline : Biology	Exhibit: N27
	pH in Algae Balls	
East Boston	East Boston High School	Region: 6
Blanco, Rina	Discipline : Chemistry	Exhibit: N21
	Borax Recrystallization	
East Boston	East Boston High School	Region: 6
Zorrilla Santana, Baleriet M.	Discipline : Biology	Exhibit: N26
	Wild Type Vs. GMO Plants	
East Boston	East Boston High School	Region: 6
Bui, Michelle	Discipline : Chemistry	Exhibit: N21
	Borax Recrystallization	
East Boston	East Boston High School	Region: 6
Benouannane, Rania	Discipline : Biology	Exhibit: G25
	How Sweet It Is!	
East Boston	East Boston High School	Region: 6
Pol Tejeda , Kiana	Discipline : Biology	Exhibit: N26
	Wild Type Vs. GMO Plants	
East Boston	East Boston High School	Region: 6
Plaza, Illiani	Discipline : Biology	Exhibit: G25
	How Sweet It Is!	
East Boston	East Boston High School	Region: 6
Lemus, Anny	Discipline : Biology	Exhibit: G25
	How Sweet It Is!	
Everett	Everett High School	Region: 4
Cardinale, Jason	Discipline : Engineering	Exhibit: D10
	Inferno the Firefighting UAV: Autonomous Fire Analyzation	
Everett	Everett High School	Region: 4
Amico, Anthony	Discipline : Engineering	Exhibit: D10
	Inferno the Firefighting UAV: Autonomous Fire Analyzation	

Everett	Everett High School	Region: 4
Bartolomeo, Alexia	Discipline : Earth & Space Science	Exhibit: P23
	Catching Stellar Dust	
Everett	Everett High School	Region: 4
Mullaly, Grace	Discipline : Earth & Space Science	Exhibit: P23
	Catching Stellar Dust	
Everett	Everett High School	Region: 4
Aybar Estrella, Emmanuel	Discipline : Engineering	Exhibit: D13
	PassOut	
Everett	Everett High School	Region: 4
Roca, Francisco	Discipline : Engineering	Exhibit: D13
	PassOut	
Everett	Everett High School	Region: 4
Dominguez, Manuel	Discipline : Engineering	Exhibit: D13
	PassOut	
Falmouth	Falmouth Academy	Region: 5
Guerin, Theo	Discipline : Engineering	Exhibit: B7
	Analysis of Airborne Wind Energy Systems to Enhance Electrical Output	
Falmouth	Falmouth Academy	Region: 5
Stewart, Isabelle	Discipline : Biology	Exhibit: H23
	The Effects of Huperzine A and Memantine on Hermissenda Crassicornis	
Falmouth	Falmouth Academy	Region: 5
Weare, Helena	Discipline : Biology	Exhibit: H23
	The Effects of Huperzine A and Memantine on Hermissenda Crassicornis	
Falmouth	Falmouth Academy	Region: 5
Fenske, Charlie	Discipline : Engineering	Exhibit: B7
	Analysis of Airborne Wind Energy Systems to Enhance Electrical Output	
Grafton	Grafton Memorial Senior H. S.	Region: 2
Dalal, Aneeha	Discipline : Biochemistry	Exhibit: K19
	Reducing Methane Emission in Cow Manure	
Grafton	Grafton Memorial Senior H. S.	Region: 2
Wilfong, Kim	Discipline : Biochemistry	Exhibit: K19
	Reducing Methane Emission in Cow Manure	
Grafton	Grafton Memorial Senior H. S.	Region: 2
Deveney, Chloë	Discipline : Biochemistry	Exhibit: K19
	Reducing Methane Emission in Cow Manure	

Hopkinton	Hopkinton High School	Region: 2
Woelflein, Kate	Discipline : Environmental Science	Exhibit: K6
	The Effect of Global Climate Change on Spider Silk Proteins	
Hopkinton	Hopkinton High School	Region: 2
Beale, Emma	Discipline : Environmental Science	Exhibit: K6
	The Effect of Global Climate Change on Spider Silk Proteins	
Hopkinton	Hopkinton High School	Region: 2
Sharma, Parima	Discipline : Physics & Electronics	Exhibit: A5
	Development of Solar Cells Using Conductive Glass	
Hopkinton	Hopkinton High School	Region: 2
Pappas-Byers, Bronwyn	Discipline : Physics & Electronics	Exhibit: A5
	Development of Solar Cells Using Conductive Glass	
Lexington	Lexington High School	Region: 4
Zhou, Richard	Discipline : Mathematics	Exhibit: K11
	Maximum Size of a Family of Pairwise Graph-Different Permutations	
Lexington	Lexington High School	Region: 4
Golowich, Louis	Discipline : Mathematics	Exhibit: K11
	Maximum Size of a Family of Pairwise Graph-Different Permutations	
Lexington	Lexington High School	Region: 4
Saiju, Aman	Discipline : Biology	Exhibit: H26
	Characterizing the Biomechanics of Runners	
Lexington	Lexington High School	Region: 4
DiCerbo, Lucas	Discipline : Biology	Exhibit: H26
	Characterizing the Biomechanics of Runners	
Lexington	Lexington High School	Region: 4
Defay, Benjamin	Discipline : Engineering	Exhibit: B28
	Fireflies and Network Synchronization in the Presence of Distractors	
Lexington	Lexington High School	Region: 4
Defay, John	Discipline : Engineering	Exhibit: B28
	Fireflies and Network Synchronization in the Presence of Distractors	
Lexington	Lexington High School	Region: 4
Sussman, Rachel	Discipline : Behavioral Science	Exhibit: H13
	Which Musical Genre Prompts the Greatest Recall of Information?	
Lexington	Lexington High School	Region: 4
Rowley, Peter	Discipline : Mathematics	Exhibit: K25
	End Behavior of Discrete Curve Shortening Flow	

Lexington	Lexington High School	Region: 4
Bulovic, Katarina	Discipline : Behavioral Science	Exhibit: H13
	Which Musical Genre Prompts the Greatest Recall of Information?	
Marlborough	Marlborough High School	Region: 2
Bogle, Conner	Discipline : Engineering	Exhibit: B13
	Outdoor Industries	
Marlborough	Marlborough High School	Region: 2
Rosenzweig, Noah	Discipline : Engineering	Exhibit: B13
	Outdoor Industries	
Marlborough	Marlborough High School	Region: 2
Carter, Dominic	Discipline : Engineering	Exhibit: B13
	Outdoor Industries	
Marlborough	Marlborough High School	Region: 2
Cameron, Amanda	Discipline : Environmental Science	Exhibit: J4
	Bioplastic: An Alternative for Environmentally Destructive Polymers	
Marlborough	Marlborough High School	Region: 2
Konar, Kimberly	Discipline : Environmental Science	Exhibit: J4
	Bioplastic: An Alternative for Environmentally Destructive Polymers	
Methuen	Methuen High School	Region: 4
Wong, Kathleen	Discipline : Chemistry	Exhibit: K7
	How Safe Are You from Acid Rain?	
Methuen	Methuen High School	Region: 4
Machado, Luana	Discipline : Chemistry	Exhibit: K7
	How Safe Are You from Acid Rain?	
Nantucket	Nantucket High School	Region: 5
Trattel, Samantha	Discipline : Environmental Science	Exhibit: J23
	Neutralizing the Effects of Ocean Acidification on Bivalves	
Nantucket	Nantucket High School	Region: 5
Marks , Mei	Discipline : Environmental Science	Exhibit: J23
	Neutralizing the Effects of Ocean Acidification on Bivalves	
Nantucket	Nantucket High School	Region: 5
Kitsock, Emily	Discipline : Environmental Science	Exhibit: J23
	Neutralizing the Effects of Ocean Acidification on Bivalves	
Natick	Natick High School	Region: 4
Cohen, Sam	Discipline : Mathematics	Exhibit: K25
	End Behavior of Discrete Curve Shortening Flow	

Northbridge	Northbridge Jr.-Sr. H. S.	Region: 2
Babiy, Marcus	Discipline : Chemistry	Exhibit: J8
	Warriors of the Winter	
Oak Bluffs	Martha's Vineyard Regional H. S.	Region: 5
Fisher, Curtis	Discipline : Environmental Science	Exhibit: C25
	A Community Connection: Nodal LoRa Modulation for Environmental Data	
Oak Bluffs	Martha's Vineyard Regional H. S.	Region: 5
Schmidt, Annika	Discipline : Environmental Science	Exhibit: C25
	A Community Connection: Nodal LoRa Modulation for Environmental Data	
Oak Bluffs	Martha's Vineyard Regional H. S.	Region: 5
Roberts, Katharine	Discipline : Engineering	Exhibit: H16
	Solely Solar	
Oak Bluffs	Martha's Vineyard Regional H. S.	Region: 5
Engler, Rose	Discipline : Engineering	Exhibit: H16
	Solely Solar	
Pittsfield	Taconic High School	Region: 1
Serre, Ryan	Discipline : Engineering	Exhibit: A20
	Dynamo Safety and Charging System	
Pittsfield	Taconic High School	Region: 1
Gillette, Apollo Elizabeth	Discipline : Engineering	Exhibit: A20
	Dynamo Safety and Charging System	
Pittsfield	Miss Hall's School	Region: 1
Nguyen, Ngoc Tram	Discipline : Biochemistry	Exhibit: C17
	Separation of Collagen from Eggshell Membranes as Dietary Supplements	
Pittsfield	Miss Hall's School	Region: 1
Qian, Amy	Discipline : Biochemistry	Exhibit: C17
	Separation of Collagen from Eggshell Membranes as Dietary Supplements	
Quincy	Quincy High School	Region: 5
Hamzallari , Klei	Discipline : Biology	Exhibit: F10
	Testing the Efficiency of Oil-Degrading Bacteria	
Quincy	Quincy High School	Region: 5
Chin , Dashiell	Discipline : Biology	Exhibit: F10
	Testing the Efficiency of Oil-Degrading Bacteria	
Revere	Revere High School	Region: 4
Louaddi, Oulaya	Discipline : Physics & Electronics	Exhibit: N10
	The Effect of Heat on the Amount of Static Electricity Gathered	

Revere	Revere High School	Region: 4
DiPietro, Alexa	Discipline : Physics & Electronics	Exhibit: N10
	The Effect of Heat on the Amount of Static Electricity Gathered	
Roxbury	John D. O'Bryant School of Mathematics and Science	Region: 6
Jenkins, Genia	Discipline : Chemistry	Exhibit: P6
	Have Your Cake and Eat It Too!	
Roxbury	Boston Latin Academy	Region: 6
Chen, Eileen	Discipline : Biology	Exhibit: P9
	The Effect of Sound on the Respiratory Rate of the House Cricket	
Roxbury	John D. O'Bryant School of Mathematics and Science	Region: 6
Bazile, Vanessa	Discipline : Chemistry	Exhibit: K5
	Denaturing Proteins: In Which Conditions Do Proteins Denature?	
Roxbury	John D. O'Bryant School of Mathematics and Science	Region: 6
Joyner, Ky-Auna	Discipline : Chemistry	Exhibit: K5
	Denaturing Proteins: In Which Conditions Do Proteins Denature?	
Roxbury	Madison Park Tech Voc HS	Region: 6
Abdi, Saida	Discipline : Behavioral Science	Exhibit: C14
	Light Based Emotions	
Roxbury	Madison Park Tech Voc HS	Region: 6
Ali, Ardo	Discipline : Behavioral Science	Exhibit: C14
	Light Based Emotions	
Roxbury	John D. O'Bryant School of Mathematics and Science	Region: 6
Lipscomb, Rayne	Discipline : Physics & Electronics	Exhibit: K4
	The Power of PSI	
Roxbury	John D. O'Bryant School of Mathematics and Science	Region: 6
Smith, Lenahnia	Discipline : Physics & Electronics	Exhibit: K4
	The Power of PSI	
Roxbury	John D. O'Bryant School of Mathematics and Science	Region: 6
Burns, Grace	Discipline : Physics & Electronics	Exhibit: K4
	The Power of PSI	
Roxbury	Boston Latin Academy	Region: 6
Phan, Huy	Discipline : Biology	Exhibit: P9
	The Effect of Sound on the Respiratory Rate of the House Cricket	
Roxbury	John D. O'Bryant School of Mathematics and Science	Region: 6
Reid, Jayden	Discipline : Chemistry	Exhibit: P6
	Have Your Cake and Eat It Too!	

Roxbury	John D. O'Bryant School of Mathematics and Science	Region: 6
Soriano, Manyeuiris	Discipline : Biochemistry	Exhibit: P7
	Investigating Photosynthesis with Algae Balls	
Roxbury	Boston Latin Academy	Region: 6
Nguyen, Tam	Discipline : Biology	Exhibit: P9
	The Effect of Sound on the Respiratory Rate of the House Cricket	
Saugus	Pioneer Charter School of Science II	Region: 4
Falcao, Michael	Discipline : Environmental Science	Exhibit: K9
	The Effects of Caffeine on the Environment	
Shrewsbury	Shrewsbury High School	Region: 2
Swamy, Varun	Discipline : Computers	Exhibit: C7
	Supervised Learning Algorithm for Automated Diagnosis of Dementia	
Shrewsbury	Shrewsbury High School	Region: 2
Pathalam, Vikram	Discipline : Computers	Exhibit: C7
	Supervised Learning Algorithm for Automated Diagnosis of Dementia	
Somerville	Somerville High School	Region: 4
Portelli, Alec	Discipline : Engineering	Exhibit: K22
	Harnessing the Energy of a Bicycle Commute	
Somerville	Somerville High School	Region: 4
Churchill, Andrew	Discipline : Engineering	Exhibit: K22
	Harnessing the Energy of a Bicycle Commute	
Somerville	Somerville High School	Region: 4
Gedeon, Brittney	Discipline : Environmental Science	Exhibit: C28
	From Farm to Cable: The New Forefront of Energy Harvesting	
Somerville	Somerville High School	Region: 4
EL-Saudi, Saja	Discipline : Environmental Science	Exhibit: C28
	From Farm to Cable: The New Forefront of Energy Harvesting	
Somerville	Somerville High School	Region: 4
Collins, Mei	Discipline : Environmental Science	Exhibit: C28
	From Farm to Cable: The New Forefront of Energy Harvesting	
Somerville	Somerville High School	Region: 4
Torra, Celeste	Discipline : Biology	Exhibit: P12
	Testing Cellular Function with Fluorouracil	
Somerville	Somerville High School	Region: 4
Beke, Abike	Discipline : Biology	Exhibit: P12
	Testing Cellular Function with Fluorouracil	

South Boston	Excel High	Region: 6
Pham, Khanh	Discipline : Biology	Exhibit: F26
Improving T-cell Engineering to Treat Leukemia by Identifying Cancer		
Southborough	St. Mark's School	Region: 2
Sarafin, Samantha	Discipline : Biology	Exhibit: A4
Peripheral Deficits and Social Behavior in Drosophila FMR1 Mutants		
Southborough	St. Mark's School	Region: 2
Deveaux, Genevieve	Discipline : Biology	Exhibit: A4
Peripheral Deficits and Social Behavior in Drosophila FMR1 Mutants		
Stoughton	Stoughton High School	Region: 5
Kavanagh, Conor	Discipline : Biology	Exhibit: D14
The Glowing Transformation Efficiency in E.coli		
Stoughton	Stoughton High School	Region: 5
Bontemps, Stevens	Discipline : Biology	Exhibit: D14
The Glowing Transformation Efficiency in E.coli		
Westborough	Westborough High School	Region: 2
Nathan, Krish	Discipline : Biochemistry	Exhibit: K18
Designing A Thyroid Hormone Detection System		
Westborough	Westborough High School	Region: 2
Sane, Eshan	Discipline : Biochemistry	Exhibit: K18
Designing A Thyroid Hormone Detection System		
Westborough	Westborough High School	Region: 2
Patta, Anoop	Discipline : Biochemistry	Exhibit: K18
Designing A Thyroid Hormone Detection System		
Westfield	Westfield High School	Region: 1
Morrissey, Brendan	Discipline : Behavioral Science	Exhibit: B1
Consumption Preferences of the Coenobita clypeatus		
Westfield	Westfield High School	Region: 1
Znakharchuk, Ilona	Discipline : Biology	Exhibit: B2
The Effect of a Static Magnetic Field on the Growth of E. aerogenes, B. megaterium, and B. coagulans Bacteria		
Westfield	Westfield High School	Region: 1
Downs, Karenna	Discipline : Biology	Exhibit: P14
How Many Germs Are Really on Your Cellphone?		
Westfield	Westfield High School	Region: 1
Stinehart, Madison	Discipline : Biology	Exhibit: B2
The Effect of a Static Magnetic Field on the Growth of E. aerogenes, B. megaterium, and B. coagulans Bacteria		

Westfield	Westfield High School	Region: 1
Adams, Courtney	Discipline : Biology	Exhibit: P14
	How Many Germs Are Really on Your Cellphone?	
Westfield	Westfield High School	Region: 1
Bower, Jordan	Discipline : Physics & Electronics	Exhibit: H18
	Cymatics: Chladni's Plate	
Westfield	Westfield High School	Region: 1
Medeiros, Zachary	Discipline : Engineering	Exhibit: A17
	Developing a Filtration System Using Electrolysis	
Westfield	Westfield High School	Region: 1
Bower, Allison	Discipline : Physics & Electronics	Exhibit: H18
	Cymatics: Chladni's Plate	
Westfield	Westfield High School	Region: 1
Coffey, Liam	Discipline : Engineering	Exhibit: A17
	Developing a Filtration System Using Electrolysis	
Westfield	Westfield High School	Region: 1
Murphy, Skylar	Discipline : Biology	Exhibit: C16
	The Effects of Ascorbic and Hyaluronic Acid on Zooxanthellae Algae	
Westfield	Westfield High School	Region: 1
Spice, Abigael	Discipline : Biology	Exhibit: C16
	The Effects of Ascorbic and Hyaluronic Acid on Zooxanthellae Algae	
Westfield	Westfield High School	Region: 1
Haluch, Trisha	Discipline : Biology	Exhibit: C16
	The Effects of Ascorbic and Hyaluronic Acid on Zooxanthellae Algae	
Westfield	Westfield High School	Region: 1
Santangelo, Julia	Discipline : Engineering	Exhibit: F3
	Magnetic Vs. Traditional Helmets	
Westfield	Westfield High School	Region: 1
Mitchell, Sean	Discipline : Engineering	Exhibit: P13
	Using Recycled Materials to Create Cost-Efficient Water Filtration	
Westfield	Westfield High School	Region: 1
Diltz, Jackson	Discipline : Engineering	Exhibit: F3
	Magnetic Vs. Traditional Helmets	
Westfield	Westfield High School	Region: 1
Murray, Ryan	Discipline : Engineering	Exhibit: P13
	Using Recycled Materials to Create Cost-Efficient Water Filtration	

Westfield	Westfield High School	Region: 1
Chisholm, Aiden	Discipline : Behavioral Science	Exhibit: B1
	Consumption Preferences of the Coenobita clypeatus	
Whitinsville	Northbridge Jr.-Sr. H. S.	Region: 2
Szymanowski, Bartek	Discipline : Chemistry	Exhibit: J8
	Warriors of the Winter	
Worcester	Bancroft School	Region: 2
Koul, Akash	Discipline : Biology	Exhibit: A19
	Effects of Ethanol and Nicotine on Development in Planaria	
Worcester	Bancroft School	Region: 2
Qin, Felix	Discipline : Biology	Exhibit: A19
	Effects of Ethanol and Nicotine on Development in Planaria	
Worcester	Bancroft School	Region: 2
Lyons, Grace	Discipline : Biology	Exhibit: A2
	The Effect of Exercise on the Lifespan of C. elegans	
Worcester	Bancroft School	Region: 2
Garcia-Chope, Jose	Discipline : Biology	Exhibit: A2
	The Effect of Exercise on the Lifespan of C. elegans	

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2017 Project Abstracts

This Section contains abstracts for the exhibited projects.
April 14, 2017

Discipline

Behavioral Science
Biochemistry
Biology
Chemistry
Computers
Earth & Space Science
Engineering
Environmental Science
Mathematics
Physics & Electronics

Computers

Computers

Awareness: The Functionality-Distribution Network

Computers
Aedan Cullen
Hopkins Academy

This project attempts to address the problem of API discontinuity between internet-connected applications. Almost always, the functionality of services available on the Internet is accessible by other applications only by means of specialized APIs, or application-programming interfaces, which are strict and concrete in that they require deliberate consideration in client software in order to be useful. The data on which each application operates must conform to the constraints of these APIs, and it is often very difficult to pass data between applications that were originally not intended to be used together. In these cases, dedicated translation layers need to be implemented specifically in order to convert data representations between APIs. This project aims to create a more open-ended system of data interchange which allows complex relationships to be computationally configured between software applications.
This project is an experimental "functionality-distribution network", which represents computational problems as a series of individual steps which are distributed across multiple machines on a network. For each specific problem to be solved, machines are algorithmically selected for their ability to perform useful operations. A unique recursive search technique is used over the network, which allows any one machine to quickly assess the capabilities of other machines and assemble a processing 'pipeline' in order to meet the requirements of its computational problem. Machines using such a functionality-distribution network are thus able to 'program themselves' to a certain extent, since human-written software is not necessary in cases where computational resources available on the network can be simply connected together in order to solve a specific problem.

A9 Safer Security: A Novel Algorithm to Detect Carmichael Numbers

Computers
Sathwik Karnik
Mass. Academy of Math & Science

In an era of rapid growth in information technology, a significant danger threatens digital security: cyber-attacks. Public-key cryptosystems are used to overcome virtual vulnerabilities. The objective of this project was to find and prove a probabilistic algorithm for detecting Carmichael numbers, which endanger cryptosystems. An initial observation that many Carmichael numbers have a proportion of Fermat witnesses of less than 50% served as the motivation for the procedure followed in this project. These Carmichael numbers were first classified by deriving an equation involving a determined lower bound to the smallest prime factor and by using Newton's Method. Furthermore, an algorithm for distinguishing between Carmichael numbers and other composite numbers was developed and implemented in Python 3.5.2. This algorithm combined notions from the Fermat Primality Test and a Monte Carlo Simulation that randomly selected a sample of integers from 1 to n-1, where n represents the number that is tested. A second algorithm combined notions from the first algorithm and a highly accurate primality test to further differentiate between Carmichael numbers and prime numbers. In addition, the algorithms determined in this project were shown to be highly accurate through calculations involving Bayes' Rule in conditional probability. Both algorithms were also shown to be relatively efficient through theoretical big-O notation calculations. In this project, a novel algorithm was developed and proven to optimize the accuracy and efficiency in detecting Carmichael numbers with the ultimate goal of enhancing cyber security.

B23 Monitoring, Predicting, and Detecting Muscle Fatigue using a WBAN

Computers
Pratik Bharadwaj
Acton-Boxboro Reg. H.S.

Stress fractures and other muscular injuries affect more than 3 million people in the US alone and usually cause irreversible muscle and bone damage. The leading cause of these injuries are muscle fatigue, a point at which the muscle's ability to generate force declines. This project aims to track the precursors to muscle fatigue, including the stress level of the muscle using aspects of a Body Area Network, and using machine learning algorithms to classify the signals. Past studies have not used a BAN system to track muscle stress, and instead have focused on lactic acid buildup to detect muscle fatigue. A surface Electromyography (EMG) sensor reading at 10 Hz was used to track muscular electrical signals for different weights under different time durations for the bicep muscle of each hand. After statistical analysis, the results show a clear trend in increased stress over time as well as with the weight increase. The average results were then randomly split into test and training datasets of different sizes and put through a k-Nearest Neighbors algorithm implemented in Java. Using 80% of the data as training, the algorithm was able to classify 95% of the signals correctly. These results can be used to prevent harmful muscular disorders for anyone who maintains a gym routine. Future steps include implementing algorithms to autonomously detect muscle fatigue, and taking readings from pulse and body temperature sensors in conjunction with the EMG sensor to get a comprehensive analysis of how these vitals holistically affect the muscle.

B27 Big Data Analysis: Public Opinions of Breast Cancer in Chinese Females

Computers
Qiuyi Yin
St. Mark's School

The public opinions collected on major Chinese online medical forums and social media suggests that Chinese breast cancer patients and their families have the most misconceptions in the four following areas:
1. Unaware of the relative accuracy and effectiveness of various diagnosis methods
2. Overemphasize the power of radical mastectomy and easily reject the value of breast conserving surgery
3. Blindly believe in traditional Chinese herbal conditioning that overshadows the effectiveness of major Western medical therapies
4. Neglect the importance of endocrine therapy
As this project quantitatively conclude the public opinions of breast cancer treatments and diagnosis, there seems to be the major trend that most Chinese breast cancer patients' understanding of breast cancer treatments in mainland China is still stranded in the old times. Unlike some developed European or American cities where about 73.3% early stage breast cancer patients chose breast conserving, China's stats is much lower. After the investigator carefully analyze the data, the reasons are as followed:
1. Many Chinese patients were diagnosed with breast cancer during stage III and stage IV, which is already too late for breast conserving surgery. So it comes back to the relatively low accuracy of diagnosis discussed before
2. The popularizing rate of radiotherapy after breast conserving surgery is insufficient to support breast conserving surgery
3. Many Chinese doctors are conservative. They fear that patients will let them undertake responsibilities if there happens to be disputes about recurrence of breast cancer after the surgery

C7 Supervised Learning Algorithm for Automated Diagnosis of Dementia

Computers
Varun Swamy, Vikram Pathalam
Shrewsbury High School

The prevalence of Alzheimer's disease and other forms of dementia is currently a worldwide health and financial threat. Dementia is an overarching category of diseases which is categorized by the commonality of memory loss. Some prominent forms include Alzheimer's disease, Parkinson's disease, and Mild Cognitive Impairment. Worldwide, over 47.5 million people are currently affected by some form of dementia. Additionally, in the United States alone, over 5.3 million people are living with Alzheimer's disease, however over 55% of these cases are left undiagnosed. In 2015, care for this disease cost the United States an estimated $226 billion. In order to improve both cost efficiency and reduce the time for formal diagnosis, a computer-aided program which could automatically diagnose the presence of several forms of dementia was developed. Utilizing the image processing capabilities of MATLAB, several statistics from axial magnetic resonance images of the patient's brain were extracted. This information was then combined with various other characteristics such as age, gender, and MMSE scores in order to determine an output diagnosis. The program was initially hypothesized to accurately diagnose cases of dementia 90% of the time. After completion of 1000 trials, the program exceeded the initial hypothesis and accurately diagnosed the presence and type of dementia over 90% of the time. This project will be furthered by the creation of a mobile application, alongside implementation into clinical trials and increased forms diagnosed. Due to its comprehensive approach of diagnosing multiple forms of dementia, this program currently surpasses any competing products on the market while advancing previous research done in the field.

C12 Is Your Network Safe?

Computers
Saatvik Garhwal
Foxborough Regional Charter School

In the year 2016, there were dozens of major security breaches from all over the globe. Major corporations like Yahoo, LinkedIn, and even the IRS had data breaches this past year, having millions of users' data either exposed or lost. Many of these attacks were reported to have been carried out for espionage and money. These sudden data breaches can cause millions in monetary loss for large corporations. It was also reported that many breaches were due to the cause of being "baited" by the hackers for login info, and that the hackers used old usernames and passwords to get into databases. Using an old, insecure password is dangerous and makes you more vulnerable to threats. This is where my mobile password tester comes in! Using a "brute force attack" method, the device will tap into a secure wireless network and attempt to "crack" the password. The longer it takes for the device to retrieve the password, the more secure you are and the more time you have to protect yourself against an attack.

C23 Campus Safety Warning and Notification System Using 3D Geofencing

Computers
Himanshu Minocha
Hopkinton High School

70% of 911 calls are made from cell phones. According to USA Today, “911's deadly flaw”, lack of location data can leave 911 callers in grave danger. 911 operators can’t determine the floor/location if a call is made from a cell phone in a multi-floor building. Currently, no solutions or technologies exist that allow absolute location tracking of people on different floors of a multi-floor building in the event of an emergency. The FCC estimates that more than 10,000 lives could be saved annually with accurate location tracking.
My patent pending software: Campus Safety Warning and Notification System using 3D geofencing, allows an authorized school administrator to keep track of students’ absolute (X,Y,Z) location in the event of an emergency. The software is designed as a closed system comprising of two parts:
1.Administrator Console
2.Subscriber app
The administrator can define the campus by identifying buildings, floors and other areas in the campus. The user then defines safety protocols for potential emergencies (fire, bomb threat, intruder etc.). In the event of an actual emergency, an authorized administrator activates a safety protocol. Once an emergency has been initiated, subscribers are notified with evacuation instructions. Only in the event of an emergency can an administrator view a student’s locational information.
The subscriber app constantly updates locational (X,Y,Z) information of a student into a secured database on the cloud. Based on the absolute position detection algorithm, the student’s safety statuses are automatically updated on the Administrator console. In a fluid situation, the administrator can change safety zones and update subscribers in real time, including designating certain floors, buildings or areas around the campus as safe.

D18 Using Directional Lighting for Fire Escape

Computers
Elan Rosen
Hopkinton High School

This project addresses the need for a simple and straight-forward method to communicate important exit pathways for fire evacuees. Traditional fire alarm systems use only sound and do not direct evacuees away from a fire. An alarm system with wireless capabilities was created that incorporates both sound and directional lighting. This system uses green and red lighting system to direct people to viable exits during an evacuation. A green light means an exit is safe and a red light would signal a compromised exit. The alarm system was created by connecting a microcontroller and wireless module to a commercially available smoke detector. The chosen microcontroller was the Arduino for its widespread use and customizability. The Xbee Series One served as the wifi module.

H3 Computer Sleuth: Identification by Text Analysis

Computers
Kumudini Devalla
Quincy High School

In a world of computers today, every document found on paper is one that can be found on the internet. This, however, raises the concern of how authentic the source from which information comes from is. Often, someone can publish information using a pseudonym and claim that they've written it when in reality this was not the situation. Stylometry is the analysis of an author's style and an accurate way to find how authentic someone's claim to a piece of work is. This experiment used samples of text from three popular books and a computer program to find if the author that had claimed to have written it was the real author. In the end, the program proved not to be every proficient in its analyses of the text, often resulting in errors, thus outputting errors. The final results showed that the larger the piece of text that was input, the more accurate the program was in tracing back to the true source of a paper. In an age of computers, stylometry is a science that becomes more important everyday with every new computer system that gets connected to the world wide web, leaving more opportunity for someone to stake claim in a piece of work that is not theirs.

H14 Data Mining to Diagnose Heart Disease

Computers
Teodor Todorov
Pioneer Charter School of Science II

Heart Disease: It affects over 17.3 million people who die from it every year worldwide. That number is expected to jump to 23.6 million by 2030. Heart disease could be diagnosed by using many methods such as a thallium test and an electrocardiogram test. A way to check for heart disease is to see if they are patients with a reversible defect found by a thallium test or patients with an abnormal left vent hypertrophy found by an electrocardiogram test. The data used for the data mining done here came from UC Irvine Machine Learning Repository. The model used was a classification tree, and quite an accurate one at that. When taking into account the fourteen variables, it managed to correctly predict whether someone has heart disease or not over 80% of the time. The research for this project was primarily researching the causes of and how widespread the problem of heart disease is as well as the types of tests that were used in the downloaded data set. This experiment was one with data mining seeing which way of representation would best represent data that could be used to predict which people have heart disease. This experiment is being conducted in order to find a method of predicting whether or not people have heart disease to prevent it and stop the number one killer in the world from claiming so many lives annually and leading to high medical bills and lost productivity that amount to an annual one billion dollar loss.
Key words: heart disease, data mining, diagnose, machine learning, predict

K26 Learning Runner AI

Computers
Julien Marcuse
Mary Lyon Pilot High School

The goal of this project is to create a learning AI to play a simple infinite runner game, proving that it can be done easily at home. A neural network is composed of simple “neurons” that take an input and give an output. These connect together and create complex networks that can perform complex tasks and learn using a heuristic. A relatively modern computer is required to run the program. To create the AI, a game was created, and a simple framework for a player. The AI then was created to act like a player, using certain values to determine what action to perform at a given time, based on the next obstacle. The AI was able to learn and show growth over time, and was able to master the game. It was an AI, but not technically a neural network. However, it did still learn in the same way a neural network would.

Engineering

Engineering

A1 Firearm Safety: An Automated Trigger Lock
A8 Vibrating Watch for the Visually Impaired
A11 Robotics Meets Forensics: A Whole New World: Take Two
A12 Enhancing Smart Grid Technology to the Consumer Level
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D12 Solar Powered Go-Kart
D13 PassOut
D22 The Power of the Human Hand
F2 Solar Charging Station
F3 Magnetic Vs. Traditional Helmets

F6 Saving Lives with a Solar Powered Air Conditioner
F7 Taming the Tsunami
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F18 Redesigning the Flow of Tension in Suspended Cables
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F22 Twist Bottle
G4 Airfoil Aerodynamics
G6 Optimizing a CNT-Based Kinetic Energy Harvester
G7 Actively Growing Hydroponics with Salt Water, Electricity-Free
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H10 A Better Way To Catch Bass
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H25 Tidal Powered Floating Water Wheel
J7 Extending the Range of Electric Cars with Bladeless Turbines
J16 Saving Space, Saving Lives; Natural Disaster? No Problem
J17 Combating Global Warming through A New Air Conditioner Design
J20 Curing Cystic Fibrosis with CRISPR/CAS 9
K15 Fan Imitation by Acoustic Pressure
K22 Harnessing the Energy of a Bicycle Commute
N7 Powering an Athlete Visibility Light through the Seebeck Effect
N13 Air Driven Engine
N18 Preventing Road Kill Using Bioacoustics
N23 Personal Aid
N25 Floating Water: The Leidenfrost Effect
P3 Theoretical Spacecraft Propulsion
P13 Using Recycled Materials to Create Cost-Efficient Water Filtration
P15 Wave Energy

A1 Firearm Safety: An Automated Trigger Lock

Engineering
Sam Pendergast
Mass. Academy of Math & Science

Recreational use of firearms led to 3,800 accidental deaths from 2005-2010 (Law Center to Prevent Gun Violence, 2016). The new device that was engineered for this project uses an infrared sensor and emitter pair to communicate with the firearm lock. The purpose of this device is to improve the safety of firearms using modern technology. The system prevents friendly fire accidents at gun ranges and while hunting by locking the firearms when they are not aimed safely. The system is designed for an infrared emitter to be placed at each target at ranges, or on the firearm when hunting. The firearm will lock when it is not aimed safely. The range of the current prototype is about 7.5 m. To increase the range of the system over greater distances, a stronger infrared emitter is the only component that must be changed. In conclusion, by selectively locking firearms to prevent friendly fire, this device increases the safety of using recreational firearms.

A8 Vibrating Watch for the Visually Impaired

Engineering
Michelle Loven
Mass. Academy of Math & Science

In the United States, more than 3.4 million people are visually impaired, and many more are affected by hyperopia and presbyopia. Because these conditions cause objects nearby to appear unclear, small watch faces often fail to convey reliable time information. The goal of this project was to engineer a watch that allowed the visually impaired to receive accurate time information using specific vibrations on the wrist. Similar devices on the market are accurate within 5 minutes. A testing prototype was engineered using Arduino based modules, and three vibration patterns were designed. These vibrations were tested on volunteer participants ($n = 31$) and the participants relayed their perceived time back to the tester. The vibration pattern selected for the final prototype was significantly better than the other two patterns devised for this project ($p = 0.027$) and the commercially available devices ($p = 0.0001$). The final prototype conveyed time information with an average time deviation of 18.6 seconds. This watch could significantly improve the lives of all visually impaired people.

A11 Robotics Meets Forensics: A Whole New World: Take Two

Engineering
Arashleen Pannu
Shrewsbury High School

Crime scene investigation is an integral part of forensics, and many adversities faced by investigators revolve around the inefficiency of substance identification. This project served as development work towards this problem and was a continuation of a project from the previous year. Last year, a robot was created with the ability to detect substances which glow under UV light such as blood, cocaine, LSD, antifreeze, and other potential pieces of evidence. To comply with research rules but still demonstrate a proof of concept, substances like antifreeze and detergent were used as simulated evidence. This year's focus was enhancing the prototype and solving the problem: Officials affiliated with crime investigation require more accurate methods to identify, or narrow down found evidence to more effectively carry out investigation. This was done through practical applications of quantum yield with an ambient light sensor. An alcohol sensor was assembled and programmed to aid investigators in detecting the presence of alcohol in body fluids and found substances. Other aspects such as geolocation, auto pilot operation, remote operation, live footage and obstacle detection through an ultrasonic sensor were also included. Certain aspects of the robot were tested for success through preliminary and revised trials. The data revealed an overall success rate of 94%, and two sample t-tests comparing data from both years indicated significant increases in functionality. The prototype of this year could be put to use in investigations by altering thresholds to fit the quantum yield ranges for luminescent body fluids and drugs. This prototype has visible potential as it can reduce the need for manpower, and could be an effective substitute if an area is deemed hazardous.

A12 Enhancing Smart Grid Technology to the Consumer Level

Engineering
Varnika Sinha
Mass. Academy of Math & Science

Consumers often waste electricity because they use their appliances inefficiently, contributing to the spread of global warming. Smart grid, an innovative technology which helps utility companies monitor electricity generation and consumption, promotes the use of renewable energy in households to reduce the consumption of fossil fuels. The goal of this project was to engineer a consumer extension of smart grid, a device which accurately monitors the electricity consumption of household appliances and educates consumers on how to use electricity efficiently. The device, featuring a microcontroller and a current circuit, measures the consumer's electricity consumption safely and non-intrusively from the appliance wire. An app was developed with the device to entice consumers to learn about their electricity consumption, such as a preferred amount of electricity to use and optimal times to use their appliances to minimize fossil fuel consumption. The device was tested on a variety of appliances with different energy efficiencies. The measurements obtained by this novel device were compared to measurements obtained from commercially available instruments. The device is extremely accurate ($p = 0.995$) and extremely precise (STDEV = 0.012 A). When this project is used in conjunction with smart grid, the consumer and energy provider can work together to reduce the consumption of fossil fuels and to increase consumer awareness and education. People who use this device will have the power to help secure the future of the Earth and its environment by decreasing their contributions to global warming.

A14 Crash and Burn Fire Starters

Engineering
Caylah Whitehead
Taconic High School

I learned I need a larger sample size and I had tow board errors. one being than instead of then, the second was my bibliograpghy was not in alphabetical order. I did have very positive feedback on my verbal presentation skills.

A17 Developing a Filtration System Using Electrolysis

Engineering
Zachary Medeiros, Liam Coffey
Westfield High School

Clean drinking water is a basic need for survival. As Americans, almost all of us are provided easy access to this necessity. Elsewhere on our planet though, people have no access to water at all, and what water these people can obtain is often contaminated and infected. How then, we asked, can we develop a cost effective, portable, and successful water filtration system? We planned on designing a purification and filtration system using electrolysis as our primary source of bacteria killing power. We hypothesized that if we ran water through our electrolysis treatment, then it would show less bacteria and other harmful elements than water than was simply run through our system with no treatment. To test this hypothesis, we set out to constructed our prototypical design. We conducted a controlled, random experiment and ran a control group through our prototypical system and a treatment group through our system and compared their results. For further comparison, we also tested Westfield DPW water (tap water) and compared these results to our experimental findings. We found that all harmful chemicals except copper were reduced by electrolysis, and to improve our copper levels we redesigned our system to also incorporate a homemade active carbon filter which proved to make all chemicals in our water fall within EPA standards. As our results were normally distributed, we were able to conclude that all of our results were statistically significant proving causation in the relationship between our treatment and results. We also concluded that because our design met our criteria for space consumption, cost, and general safety, we had successfully created an effective filtration and purification system using electrolysis.

A20 Dynamo Safety and Charging System

Engineering
Ryan Serre, Apollo Elizabeth Gillette
Taconic High School

The need to reduce greenhouse gases has created a need for cleaner transportation. The goal of this project is to improve cycling safety by designing an affordable system using common components that generates enough voltage to power lights bright enough to meet stringent safety requirements while providing comforts usually exclusive to cars. This project utilizes common components and to create a comprehensive system that can:
Pass legal safety requirements for night visibility (even when the cyclist is stopped).
Allow cyclists to access a form of battery charging while on the go
Avoid loss of battery life in cold conditions
Costs less than $50, keeping it affordable and competitive with many systems on the market.
When riding at a comfortable pace (~60 RPM) the average voltage output of the dynamo (measured using a multimeter) ranged from 9 - 13 volts. At this voltage the headlight and taillight met or exceeded the minimum state safety regulations for night riding use. The system generates 3 to 4 volts more than needed to run the lights at a comfortable riding pace. The next phase of the project involves the insertion of a rechargeable battery pack that can be used to keep the lights at a steady glow when the bike is stalled for at least a minute. The extra energy that is stored in the cell can also be used to recharge a low voltage battery inside a device such as a cell phone. This step requires the energy from the dynamo to first be converted from an unsteady DC current to a steady AC current of approximately 5v.

A21 Harvesting Peizoelectricity for Everyday Use

Engineering
Advait Nene
Hopkinton High School

What if you were able to charge your phone while you were walking? Piezoelectric materials generate an electrical current when pressure is applied on them. Through experimentation and theoretical analysis, this project determined whether piezoelectric materials can charge a phone in a reasonable amount of time. Furthermore, this project explores other potential applications of piezoelectric materials.

A22 Medication Manager: Administration of Medication

Engineering
Jason Qian
St. Mark's School

The rise of diseases such as hypertension and diabetes create the need for more and more medication to be created every year. The number of people taking prescription grows dramatically as well. Remembering to take the medication and to take it accurately is only of a minor inconvenience to some people; however, this becomes an issue with elderly patients who find it challenging to take medication daily and accurately. Forgetting to take certain medication can will make the disease linger in the body longer than needed, which can cause other issues to arise. Taking medication in the wrong doses can even lead to death.
Current technologies in pill dispensing still require patients to preload every pill into a small tray and to remember to take the medication themselves. These technologies are generally not effective. The purpose of the project is to create an automatic pill dispenser that requires no preloading. Starting with user interviews will define and clarify the problem that needs to be solved. The goal is to design a working model and to test the functions with small candies such as Skittles and M&M's. The device could change the way patients take any type of medication or supplement in the future.

A26 Innovations of Medical Devices Using 3D Printing

Engineering
Anthony Arace
Taconic High School

According to Harvard-affiliated Brigham and Women's Hospital (BWH), about 90 percent of the world's investment in medical research benefits only the most affluent 10 percent of its population. This means that 5 billion people are left out and are not properly served. A solution to increasing access to surgical instruments in undeveloped regions is to 3D print the tools, which can be made at a fraction of the cost compared to stainless steel surgical instruments. This project aimed to look at the feasibility of 3D printing disposable surgical instruments for use in third world countries. Experimentation included a sterility test on PLA and Purement, a beam deflection test of the surgical instruments, a cost analysis comparing the cost to 3D print the tools, injection mold them, and the cost to make them out of stainless steel. A biodegradation test of PLA was also done. Results showed that the surgical instruments can be properly sterilized using a UV light and a 10% solution of bleach. It was also found that the PLA material was stronger than Purement through the beam deflection test. The cost analysis showed a 91% decrease in price to 3D print the surgical instruments compared to making them out of stainless steel. The biodegradation test showed an increase in mass of the parts, which is due to the PLA absorbing moisture from the soil which helps the plastic break apart into H2O and CO2. This feasibility test showed successful results, which support the idea of 3D printing surgical instruments in undeveloped areas for use for humanitarian aid organizations administering surgeries in these regions.

A28 Show Me the Way

Engineering
Tyler Jones
Wachusett Regional High School

Many lives are lost everyday because fire victims and firefighters are unable to find the quickest and safest way out of a burning building. From interviewing firefighters, it was learned that after the Worcester Cold Storage Warehouse fire procedures were changed, requiring firefighters to crawl along the floor staying in constant contact with a wall. They all agreed that pathway lighting close to the ground and on a wall will be beneficial for both victims and firefighters.
Outlet covers that have red pathway lights in the shape of an arrow, pointing to the nearest exit were built as a simple and effective solution that can potentially save lives. These outlet covers contain a backup power source in case the electricity is turned off. A diode OR logic gate was used to draw current from the mains of a house and when the electricity is turned off, the pathway lighting draws current from the secondary power source and remain lit. The outlet cover will act as a visual path to the nearest exit, decreasing exposure time and increasing safety which could potentially save many lives including firefighters and victims.

B7 Analysis of Airborne Wind Energy Systems to Enhance Electrical Output

Engineering
Charlie Fenske, Theo Guerin
Falmouth Academy

Airborne Wind Energy Systems (AWESs) offer an efficient, environmentally sustainable, cost-effective, portable, and safe method of generating electricity. An AWES consists of a tethered glider, with wind turbines attached to the wings, that flies along the circular path of the blade tips of a horizontal axis wind turbine (HAWT), eliminating over 90% of materials while significantly increasing generation efficiency. Since the glider's aerodynamic design is the main determinant of efficiency, by implementing new and experimental airframe designs into mainstream AWES technology, the cost of electricity and the effects of climate change can be reduced.
In this experiment, a prototype flying wing configuration and the conventional configuration were tested in a 25-foot-long wind tunnel with a 30-mph maximum airspeed that was designed and built for this project. The wind tunnel models were optimized for the highest Lift Coefficient / Drag Coefficient (Cl/Cd) ratio and incorporated integrated 3D printed pressure taps, which is a concept invented during this project. Dynamic pressure, lift force, and drag force were measured at angles of attack (AOAs) ranging from -5° to 20° in order to optimize the glider's propeller position and to determine efficiency.
Analysis of the wind tunnel data shows that the flying wing had a 42% higher maximum Cl/Cd ratio than the conventional configuration. The flying wing configuration has the potential to be implemented in AWES design and would increase electrical output, lower electricity costs, lower production costs, and reduce carbon emissions.

B9 Can Layers of Carpet, Boards, and Plywood Affect .22LR Penetration?

Engineering

Keerah Morgan
Taconic High School

The purpose of this experiment was to find a way to protect sheds at a range that was shot. The materials that were most commonly found at the range used were carpet and plywood, these were the unused and extra materials found on site. Each protective layer was comprised of both plywood or carpet. Each layer was shot followed by preliminary analysis and another layer was added with a total of five layers. Conclusions to this research project include accepting the hypothesis and being able to make range sheds safer with shed protection which also fixes a real world problem.

B13 Outdoor Industries

Engineering

Conner Bogle, Noah Rosenzweig, Dominic Carter
Marlborough High School

Conner, Noah and Dom investigated the feasibility and effect of an outdoor classroom within the Marlborough public schools. The Marlborough High School has a need for an outdoor classroom. An outdoor classroom needs to be designed that can hold a minimum of 28 students, has internet access, provides environmental protection, is handicap accessible, utilizes the natural environment, and is cost efficient. In addition, it must include technological integration and protection of that technology, must account for the location of the sun at all times of the day, follow state and federal building codes, incorporate a minimum of 5 disciplines effectively, and lastly must provide protection from intruders, animals, and other weather hazards. Initially the group researched many aspects of the implication of an outdoor classroom. Next a 3D model of the classroom was designed using a CAD program called CREO. It was then printed to represent its physical location on the topographical map. Finally the group concluded that an outdoor classroom would greatly benefit the Marlborough High school.

B15 A System to Divert Runoff Containing Road and Residential Contaminants

Engineering
Mitchell Green
Foxborough Regional Charter School

This project seeks to engineer a better barrier for the diversion of toxic runoff. The initial phase created a device to simulate rain induced road and residential runoff heading towards a basin or vernal pool. The goal was to determine in a lab setting the best barrier structure and media. Initial data confirms that the common use of rectangular barriers of hay and plastic sheeting is not ideal. Combining both was still less efficacious than tubular designs with other media.
A single tube had fewer spaces for water to pass than multiple rectangular blocks. Media that maintained shape (e.g. saw dust and mulch) allowed the barrier to maintain height versus those that flattened as they absorbed moisture (e.g. cotton).
Media with small spaces absorbed more runoff (e.g. saw dust and mulch) versus media with larger spaces (e.g. moss). Media with no spaces (plastic sheeting) absorbed no runoff. Phase 1 testing is currently evaluating if media absorb road salt and contaminants.
Phase 2 testing of samples in the field is in progress. Phase 3 testing for effect, durability, and ergonomics with a full size device will follow. Preliminary data has identified shapes and media which out-perform the current devices in use. The results of Phase 2 and 3 testing are planned to give data to revise the engineering for full scale testing.
In summary, the device was able to achieve the goal of improved runoff diversion. Testing with runoff contaminants is in progress.

Keywords: pollution, diversion, wetlands, vernal pool, runoff, barrier, mapping

B19 Who's Better? Creating a Novel Simulation for Baseball Player Analysis

Engineering
Aditya Hoque
Mass. Academy of Math & Science

Many baseball teams use sabermetrics, the use of formulas on conventional statistics to create more complex metrics, as a means of evaluating players. Sabermetric formulas are useful, but they do not factor in team impact on individual players, and they cannot be applied to hypothetical situations. The goal of this project was to engineer a simulation, with a high accuracy and a high number of features, for individual player analysis. Many versions of the program were created, with each version iteratively improving upon the previous one. Accuracy was measured by calculating the % error of the number of runs scored by each team. The individual impact of each player was measured by incorporating a Run Expectancy Matrix. The simulation could also determine the optimal lineup of nine given players. The best version, according to a scoring matrix that valued accuracy and number of features, with accuracy being twice as important as number of features, had less than 16.2% error when predicting the runs per game of each team in 2016 and over 26 features. Because the simulation can assist with player analysis, team analysis, and lineup optimization, along with making predictions in all three of those fields, the features developed in this study can help general managers form a team and managers make in-game decisions.

B21 When in Doubt, Draw It Out

Engineering
Kate Delaney
Newton Country Day School

Parents and nurses struggle to draw the appropriate amount of medicine into syringes for young patients and this can lead to serious issues such as death. In the experiment done by Dr. H. Shonna Yin, parents were given one of five different pairings of labels and tools used to administer medicine. Out of 2,110 parents, 84.4% of them made at least one error and over 64% of the errors were overdoses (New York Times, 2016). In another study conducted by Shawn R. McMahon, it was shown that with more education, people are less likely to make medication dosing errors (AAP, 1997). While it is known that people educated in administering medicine are less likely to make errors, there is a lack of time especially if they are visiting the hospital for a short period of time. Because of the challenges of find time and educated teachers, this project hopes to develop a machine that is reliable and accessible for parents to use until they become properly trained. The goal of this project is to build a device that accurately draws 0.1, 0.2, 0.3, 0.4, and 0.5mL into a 1mL oral syringe with no more than a 10% error. The initial design had an average percent difference between the theoretical and actual volumes drawn that ranged from 88.0% to 95.5%. The modifications include custom designing an arm that connected the servo to the syringe and adjusting the time for the motor to move to account for the frictional force between the walls of the syringe and the plunger. The final had an average percent difference between the theoretical and actual volumes drawn that ranged from 1.6% to 5.0%. Because all of the percent differences are less than the 10% difference that was stated in the goal, this project was successful. Future improvements could be made to make the design more accessible.

B22 Improving The Newton Square Roundabout

Engineering
Jonathan Sigel
Mass. Academy of Math & Science

The traffic congestion at the Newton Square roundabout hinders the efficient operation of nearby schools and businesses. An outdated design and a lack of proper road markings contributes to the dysfunction of the intersection. In order to optimize the traffic flow in Newton Square, an alternative design for the traffic structure was generated in Game Maker Studio 2. The simulated roundabout is based upon a queue model, a method of replicating traffic that splits each section of the road into a line of cars. After programming a basic queue model in the form of a generic roundabout, features such as pedestrian crosswalks and car accidents were gradually added. The features in this model were tested, then the generic roundabout was converted into the Newton Square roundabout. Following the program's conversion, four variants were created, each with a minor adjustment. After testing each variant of the Newton Square roundabout, it was determined that shrinking the central median was the optimal choice, based on the resulting decrease in congestion. The elements of this alternative design suggest that increasing a roundabout's capacity is the most effective way of improving it.

B25 Reception Deception

Engineering

Colby August
St. John Paul II High School

Saving money is something people try to do by cutting back on extra expenses and unnecessary purchases. One thing in the modern day US people don't use as much anymore and spend a lot of money on is their cable bill. By building a TV antenna people can still pick up the locally broadcasted channels while at the same time being able to save the average American around 1000 US dollars per year. Some of the questions I was wondering was if the surface area of the antenna would affect the antenna reception. I decided to build three different antennas, a mclapp, a penny loop, and a fractal antenna. From the bit of research I have done I hypothesis that the mclapp antenna will perform the best due to its larger surface area so there is more space to pick up the airwaves. The type of experiment that I constructed consisted of building three different types of radio antennas. A fractal antenna, a mclapp antenna, and a penny loop antenna were the three different designs which I tried. Once building them I first tested them by connecting the antennas to my home TV through a COAX cable. Once connected to the TV I ran a channel scan to see how many channels the antenna would pick up. From the testing I have done I have concluded that on the smaller scale that I had built my antennas on the design didn't matter.

B28 Fireflies and Network Synchronization in the Presence of Distractors

Engineering

John Defay, Benjamin Defay
Lexington High School

Biomimicry is the implementation of natural processes and concepts in artificial structures. Our intent was to model the workings of fireflies for this overall project. We first completed an engineering project, designing and building an Arduino swarm. We then carried out a Science Fair project investigating the impact of various algorithms on swarm synchronization.
The swarm of synchronous fireflies is modeled as a network of independent Arduinos. Each Arduino module is a simple computer. It is only connected to its immediate neighbors, just as real fireflies can only see and respond to their immediate neighbors. We have developed simple algorithms to demonstrate ideal synchronous behavior, synchronization in the presence of distractors, and a generalized "follow the leader" pattern synchronization algorithm. Each of these algorithms captures our interpretation of natural phenomena, and could plausibly account for the behavior observed in real firefly swarms.

C9 Piano Player

Engineering
Matthew Adiletta
Worcester Academy

An Engineering Approach to a Robotic Piano Player-The purpose of this project is to create two working robotic hands to mechanically play a piano keyboard. Each hand hovers above the keyboard like a human hand, and glides along a rail to change positions. The piano player can play beautiful music that is coded into an Arduino program.

This project is a creative blend of my engineering skills with my piano skills. There are many applications for this project. To begin, there are many quiet pianos. I want to give quiet pianos their music again. Secondly, I was at my sister's chorale concert and saw the conductor leave to play the piano while trying to lead the middle school choir. It would have been much easier if she could have remotely controlled the piano. Next, the piano player can allow someone with a hand injury to continue to play the piano. Finally, the robotic piano player allows one person to play a duet.

This was an engineering project which included mechanical, electrical and software components. Key areas include developing my own Arduino Music Control Language (AMCL), a compiler which reads in a MIDI file and produces an output file of AMCL, and an Arduino program which takes in the AMCL and controls a series of solenoids, which when actuated, depress keys on a piano keyboard. I had to calibrate the movement of each “hand”, optimize the movement of each hand based on forward looking of music against different window sizes, and minimize the cost function – based on minimum hand movement. I also had to research building different electronic circuits (e.g. flyback diodes and ground noise suppression) and control elements such as pulse width modulation for dynamic sound control. My robotic piano player is fully functional and lots of fun!

C10 Self-Cleaning Gutter System

Engineering
Daniel Song
Lexington High School

Without gutters, rain water would drip down on people, erode dirt near foundation, and damage the house. However, cleaning gutters can be quite dangerous. Many people are injured from ladder falls while cleaning gutters. In addition, getting the gutters cleaned professionally costs over $100 for an average multi-story home several times a year.

There are many products available that are designed to keep the gutters from clogging up, but they do not work very well. There are sponges and screens that tend to clog up over time, and gutter helmets that let debris in along with the water through large openings.

I have designed a gutter system that cleans itself, so that nobody has to risk their lives and health to clean their gutters, while at the same time saving money. The new gutter consists of a gutter base and a flap that automatically flips up to form a V-shaped gutter when it rains. In dry weather, when most of the debris is collected in the traditional gutter, the gutter flap lies flat letting the debris slide down to the ground. When it rains, the rain sensor activates the relay which turns on the air pump. The pump then inflates the rubber tube actuator that flips up the gutter flap.

The gutter system has been tested with a rain simulator which pumps the equivalent of 6 inches of rain per hour and performed perfectly. The new gutter design is very simple and highly manufacturable with a very similar parts cost as the conventional gutter. I believe that the new gutter system is the first automated, reliable, and affordable self-cleaning gutter system ever devised. My ultimate goal is to revolutionize how people think about gutters and gutter maintenance while saving lives, preventing injury, and saving people money.

C11 Constructing a Flexible Wing

Engineering
Troy Otter
Falmouth High School

Flexible wings offer many benefits over traditional fixed or single actuation point wings. One of the main advantages is the ability to have smoother airflow over the surface of the wing during times when the control surfaces are at high angles of attack. The goal of my project is to construct a wing with two actuation points for the control surface, in order to view the differences between the airflow on the different wing types. The wing is a small scale airfoil constructed with plywood, and using servos as the actuation points. It is wrapped in cling wrap to ensure a smooth surface for the airflow. To compare the two wings, a wind tunnel and smoke generator are used to visualize the airflow over the wings at different control surface angles of attack. The scale flexible wing did appear to offer benefits over the simple fixed wing, although it does not fully represent all of the benefits of a true flexible wing, due to time and budget constraints.

C18 Safe to Drink: A Biofiltration System for Copper-Contaminated Water

Engineering
Dylan Sotir
St. Mark's School

Heavy metal contamination of drinking water supplies has been recognized as a major health concern in the past few years. Despite the many current solutions to removing heavy metals from drinking water, there are still dangerous levels of various heavy metals in drinking water systems around the world, including the United States, and there is no universal and cost-effective solution. Biosand filters, a filtering system in which the water runs through fine sand, effectively remove biological hazards, but are less effective for heavy metals. In this research, a biosand filter has been examined to determine its efficiency in removing copper ions from water, and then locally sourced biomaterial, such as grass clippings and fallen leaves, has been added to the filter in order to create a filtration system that not only has the advantages of a biosand filter, but also removes heavy metal ions. To accomplish this, a prototype biosand filter has been built and water with varying levels of copper ions has been run through it. After these tests were completed, a sheet of biomaterial was added to the filter and the same tests were rerun in order to accurately compare the two levels. The biomaterial shows promise as an addition to a biosand filter system, and the availability of the materials needed to build this filtration system allows for the system to be built at a low cost.

C21 Creating a Custom Go-Kart from Recycled Materials

Engineering
David Tatten
John D. O'Bryant School of Mathematics and Science

The purpose of my project was to turn trash into treasure by recycling an old worn ATV that i had. I used most of the ATV’s parts, plus some parts from a junk Lance Cabo 50 scooter, and some parts that I bought at various swap meets. Using these parts for something totally different than their manufactured purposes in order to make my own functioning creation was the purpose of my project.
I began drawing a prototype of the vehicle, which allowed me to visualize the final product, and then I took the ATV and cut in a half and alter the frame that will become the go-kart frame. During the building process I had to cut, rearrange, replace and redesign the many pieces I used to build the car, it was a long but regarding process.
After working very hard I have to say that my finished design was a major success. The go-kart is fully operational and drives lot smoother than the original ATV did. By extending the frame, this lowered the center of gravity and made the vehicle nearly impossible to tip over while the ATV had a very high center of gravity with the rider being positioned on top. The only drawback of the go-kart compared to the ATV is that the turning radius was severely widened and it takes a lot more open space to turn the go-kart around than it took the ATV. I am very happy of the outcome of my project and I am very pleased with the final design of my go-kart.

C22 Front Smart

Engineering

Christopher Boucher
Everett High School

In the endeavor to find a counter to solar glare, it was proposed that a windshield with the ability to change its level of transparency would be created. Such a windshield would have properties that allow only small portions of the glass to independently change its level of transparency to best shield the driver's eyes. In order to maintain proper visibility while undergoing a color change, it is crucial to make sure the dyes only react to sunlight. Therefore, the dye implemented into the windshield will only be activated upon UV exposure. This allows for the windshield to remain perfectly clear during the evening and night hours. Moreover, to further empower and focus the driver behind the wheel, the side view mirrors on the vehicle will be removed and replaced with side view cameras, which link to a Head Up Display. This HUD is projected directly in front of the driver on the lower portion of the windshield. Therefore, the driver no longer has to completely take his/her eyes off of the road; they can simply shift their eyes downwards to view their surrounds.

D10 Inferno the Firefighting UAV: Autonomous Fire Analyzation

Engineering

Jason Cardinale, Anthony Amico
Everett High School

The necessity of this project stems directly from the harm caused by fires all across the nation. By utilizing our knowledge in engineering, electronics, and programming in unison with the application of several electronic components such as range finders, gas sensors, motors, ESCs, and a high definition camera, we were able to achieve an efficient solution to slow firefighter response times while providing firemen with a tactical advantage in the line of duty. With the creation of our first tested prototype, we found that, when operating in a large field, the drone was able to travel to a destination determined by the operator, hover over it while maintaining a consistent latitude and longitude position within three to five meters of the desired coordinates, and produce a constant output of gas sensor data to a firefighter's mobile device. By comparing our time trials with the response times provided by the U.S. Fire Administration, Inferno was capable of reducing the travel time by upwards of 2 minutes on 5 test flights.
One of the most crucial aspects of our project was the development of the flight controller which we built and programmed entirely from scratch. Through the clever application of an accelerometer, barometric pressure sensor, and GPS module, all paired with an Arduino Mega 2560 microcontroller, we essentially enabled the quadcopter to not only stabilize itself autonomously, but fly to a target with a simple input of an address from the user. In addition to the performance characteristics of the drone, the mobile application also allows for flight customization. Given the success of our endeavors, we wish to ultimately apply our technology to real world situations in which they can truly aid in combating fires.

D12 Solar Powered Go-Kart

Engineering

Derek Lemberger, Benjamin Thongphala, Deep Patel
Shepherd Hill Reg. H. S.

Our aim is to build a go-kart that will not rely on fossil fuels. We are using a solar panel to power our go-kart and batteries to store the energy. We stripped a go-kart which originally had a gas powered motor. We are using the go-kart frame just as a body and have made modifications to add brakes, batteries, a dashboard and install many other needed components. Our goal is to have our go-kart run for a minimum of 30 minutes. Once our go-kart is complete we plan on obtaining data such as runtime, max velocity and appropriate conditions to operate the vehicle.

D13 PassOut

Engineering

Emmanuel Aybar Estrella, Manuel Dominguez, Francisco Roca
Everett High School

Our science fair project revolves around using RFID scanners in order to replace the paper hall pass system and the attendance system in our school. The hall pass system and attendance system in our school is inefficient and outdated in today's age of technology, greatly frustrating teachers and students in the amount of time, paper, and money wasted just through using slips of paper. We came about our solution in robotics class through the recommendation of our robotics teacher Mr. Steven Blake. Our goal was to make the code for the scanners work and upload the data that was originally on the paper hall passes onto a network that is easily accessible by the school staff and administration. As we were working through the project we thought up of how to use the RFID scanners we anything that is already in place and found that we could use the ID cards given to us by the school by buying ones that have unique chips inside of them for the low prices of ninety-nine cents a card or fifty cents buying them in bulk. The code works really well with the cards and so the next step is to create the network for the data to be uploaded on. Ultimately this project will help our school's students and teachers have more time in their classes. In regards to our design we still need to make the circuit board for the RFID scanner smaller and make a case to protect the circuitry.

D22 The Power of the Human Hand

Engineering

Judy Kariuki
Foxborough Regional Charter School

This experiment was conducted to investigate an alternative mode of electricity and to investigate the effectiveness of Peltier tiles to produce enough voltage to light up a light emitting diode (LED). A digital multimeter was used to record the voltage and current of the flashlight's components. These measurements were used to add additional features so the device could illuminate 3.5 volt LED. The Peltier tiles, or thermoelectric modules, were used for power generation because a temperature difference applied across the modules can generate power. Before calculating exact temperatures, the temperature difference of the human hand and the ambient air was thought to be a sufficient amount. Prior to the final design, the assumption that the modules being able to like the LED was incorrect, and the component of a simple electrical circuit was added. The circuit is known as a joule thief, which is an electric circuit that allows someone to make use of batteries normally considered "dead." Instead of using a dead battery, the negative and positive charges of the Peltier tiles were connected to the corresponding charges of the joule thief circuit. However, the ability of the circuit to increase the voltage and currency of the modules still was not high enough to light the LED. The final addition to the project was to intensify the temperature difference of the thermoelectric modules by placing an ice pack to one side of the modules and a warm hand to the other side. These additions were vital to making the final product a success in lighting the LED.

F2 Solar Charging Station

Engineering
Benjamin Tillman
Martha's Vineyard Regional H. S.

The goals for this project is to be able to build a solar charging station that can provide 16 watts of electricity for $250 or under for people when they are away from sources of electricity or if they can not afford electricity. Solar energy is a cheap alternative for people who can not afford electricity in their homes, is better for the environment, and is readily available. It is able to fold up into its stand so that it will be able to be easily taken with you when you need to travel or bring it somewhere.
I soldered each cell to each other in columns of 8 and then soldered each of the 4 columns to each other. I then used silicone to connect them to the aluminum backing and then put the Plexiglas cover on. To test it I took it outside and measured the amount of sunlight in certain areas. Then I measured how many watts I was getting out of my solar panel. In the highest amount of lux which was a little over 28000, I was able to get 17.28 watts of energy from the solar panel, 1.28 watts over the expected amount.
The charging station was able to produce enough watts to charge the 12 volt battery which is connected to a charge controller. The charge controller can then send that energy to an inverter or straight through its USB port to charge different devices and appliances. The panel was also able to charge my cell phone to different percentages charged. This project was built for the price that I was aiming for and is able to produce more energy than I wanted.
The solar charging station is good for anyone who does not have access to electricity because they can charge and power cellphones or any technology they want that runs off of 16 watts. This is enough to power a phone they can call hospitals and schools with and lights children can study with.

F3 Magnetic Vs. Traditional Helmets

Engineering
Julia Santangelo, Jackson Diltz
Westfield High School

This project intends to show how magnets affect the force of impact when used in sports helmets. Based on testing, magnets are the most effective material in a helmet to reduce the force of impact, or damage to the brain. This led to our experimental research to test whether magnets have the potential to prevent concussions.
Testing was conducted with two sports helmets hung on chains covered in PVC in a Newton’s cradle design with weights inside each helmet. Two types of testing were conducted, one where a helmet was pulled back parallel to the ground and one at 45 degrees. Trials were done without and with 2 magnets/in2 (36 per helmet). A board was placed behind the helmets measuring every 2 cm. Data was recorded via videos of how far the helmet reacted.
After 40 trials the data shows the averages for helmets with magnets were overall lower than helmets without magnets. When placed on bar graphs with error bars they don’t overlap which indicates a significant difference between traditional and magnetic helmets. This shows that magnets reduced the force of impact more than a helmet with just foam would.
Based on our results magnets have the potential to prevent damage to the brain. Injuries like concussions can be serious and life changing which emphasizes the importance to prevent them, or to reduce their effects. With this potential, if these magnets were placed in helmets for sports it would be an effective way to help athletes everywhere.

F6 Saving Lives with a Solar Powered Air Conditioner

Engineering
Sarah Grobe
Westfield High School

Exactly 700 children have died from heat stroke from being left in hot cars from 1998 to present. After seeing this devastating figure, I decided to construct an air conditioner that could run on solar power and connect to a heat sensor to cool off a car when it gets too hot, potentially saving dozens of lives every year.
The air conditioner made for this stage of the project was essentially a glorified refrigerator, designed to blow out cold air that has come in contact with ice. I used a cardboard box insulated with Styrofoam and aluminum foil, and placed two fans on the top; the fans were then connected to a capillary tube thermostat (heat sensor) and to a solar panel. When experimenting, a fish tank represented a car, and a heat lamp represented the sun.
Four different experiments were run in total. In the first two, the air conditioner didn't do much except merely slow the heating up of the fish tank. The last two, however, which featured aluminum trays of ice and two working fans, actually managed to cool the car down to a relatively safe temperature.
I am able to conclude based on the data that this was the best design for the air conditioner. Future goals for this project would be making it function more like a traditional air conditioner (that is, with chemicals rather than ice) and make it small enough to actually be installed in a real car.

F7 Taming the Tsunami

Engineering
Chase Beausoleil
Bishop Feehan High School

This experiment was chosen because it was something that was found interesting as soon as it had been researched. It was very interesting to learn that the information on tsunami waves were not very well documented, and what was documented was highly controversial. It was wanted to figure out why this was a controversial topic, and have accomplished this as it was figured out how difficult it is to accurately recreate the intensity of a tsunami wave. The hypothesis of this experiment was that if wooden posts that are aligned in a staggered position are used as a barrier, then the tsunami wave will be mostly broken up by the time it comes in contact with the shore. To conduct this experiment, the experimenter has to get the supplies that are needed to create the barriers. Once they are built, the experimenter will place one of the barriers in a bin filled with water and with sand or fish tank gravel on one side to create a beach. Then, the experimenter will create a tsunami wave with the precisely trimmed cover for the bin by placing the cover in the water and pulling up on the side facing away from the experimenter. The person will record the waves in slow motion with a preferred recording device, making sure that there are a minimum of five recorded for the barrier. The experimenter will then swap out the barrier for one of the other four, repeating the steps to create the wave and record the data. The steps will also be repeated for the other two barriers. The expected outcome was that the barrier with the staggered pillars would work better than the mangrove/forest, the wall, and the coral reef barrier. The final results resembled the hypothesis, stating that the staggered pillars barrier did work the best.

F15 See the Light

Engineering
Grace Leopold
Calvary Chapel Academy

The goal of this project was to determine if the spectrophotometer was able to investigate the absorption of light in differently colored solutions. The objective was that the spectrophotometer will be able to take a picture through a diffraction grating to determine the wavelength of maximum absorbance of differently colored solutions. In this project an LED was shown through differently colored solutions at a diffraction grating. A photo was taken through the diffraction grating. This photo was then put into a Microsoft software which analyzed the spectrum. The software then calculated the Wavelength of Maximum Absorbance of the spectrum. The average Wavelength of Maximum Absorbance for the Blue #2 dye was 575 nanometers. The average Wavelength of Maximum Absorbance for the Red #3 dye was 525.7 nanometers. The average Wavelength of Maximum Absorbance for the Yellow #5 dye was 441.7 nanometers. The spectrophotometer was able to investigate the absorption of visible light in differently colored solutions.

F18 Redesigning the Flow of Tension in Suspended Cables

Engineering
Evelyna Legkodukh
Westfield High School

The projects purpose was to prove that if a suspension bridge's cables were redesigned than it would make the bridge stronger and more cost effective. This hypothesis that the bridge would be stronger was supported based on the data and was only partially supported in the cost effectiveness aspect.
The method for testing the live load of the bridges was to add mass to them until they faulted and then collapsed. Calculations that were performed involved the length of cables used to design the bridges.
The original suspension bridge first faulted at 6.8kg and completely collapsed at 9.1kg. The cable-stayed bridge first faulted at 7.7kg and completely collapsed at 11.3 kg. Lastly, the newly designed suspension bridge did not have a first fault but instead collapsed immediately and all together at 15.9kg. While measuring the length of the cables, I found that the original suspension bridge had 548.64 cm of cables, the cable-stayed bridge had 487.68cm of cable, while the newly designed suspension bridge used 538.48 cm of cable.
This project can apply to engineers and city planners because it shows that the newly designed suspension bridge, although used a similar length of cable as the other bridges, held much more live load making it stronger.

F19 London Bridge is Eroding Down

Engineering
Matt Correia
Bishop Feehan High School

This experiment was chosen because it is based around the field of engineering. A good engineer knows the dangers and hazardous materials to their bridge and would like the bridge to stand for a long time, so knowing the results of this experiment achieves both of those goals. Also, it was interesting to see the results of different materials on concrete. The hypothesis of this experiment was that the oil would cause the most mass loss in the concrete columns. In the experiment, concrete columns were soaked in different substances for a period of time, weighed periodically, and stress tested at the end. The expected outcome of this experiment was that the oil would cause the most mass loss in the concrete columns. Significant results were that the freshwater caused the most material loss over the experimental period. Also, concrete left in freshwater resulted in the weakest concrete, requiring the least amount of force to break. Furthermore, while it was hypothesized that oil would cause the most material loss and the weakest concrete, in reality the oil resulted in material gain and the strongest concrete out of the experimental groups.

F22 Twist Bottle

Engineering

Alina Daraphet
Northbridge Jr.-Sr. H. S.

This invention was created with hopes to prevent the waste of personal care products (lotions, creams, etc.) and to make the process of getting material, such as lotion, out of a bottle easier. While attempting to pump out or squeeze lotion out of a bottle, the remaining product at the end of the bottle is difficult to reach. This invention was tasked with the thought of making the leftover lotion easily reachable and used in its entirety by the consumer. The criteria was to create a better functioning bottle for personal care products, aiming towards lotions and creams specifically. The constraints were the amount of time given for the design, the materials, and experience with constructing and using knives. After researching, it was found that bottles have similar base structures and that by changing the base structure to be able to break into different sections, the lotion would be easier to reach. In conclusion, the main addition needed for easier functioning bottles is a twistable function.
Possible solutions were adding a twistable section directly on the bottom of the bottle, in the center of the bottle, or solely on the top with a differently shaped bottle. The best possible solution was the twistable function in the center of the bottle. Knowing the best possible solution, a prototype was created out of old bottles and silicon within 2-3 days. The prototype was tested by seeing if the bottle could pump out lotion, such as an existing bottle, and if the bottle could twist off to reach the end of the bottle easier. During communication, it was found that the prototype worked as planned, however could be developed further by locating the twistable function approximately 2 inches above the bottom of the bottle, rather than in the center of the bottle.

G4 Airfoil Aerodynamics

Engineering

Austin Li
Quincy High School

Airfoils have, for many years, been used for many things throughout history such as for the wings of airplanes, the blades of a windmill, and the blades of a helicopter’s rotor. Through the years the designs for the airfoils have changed in their design to suit the needs of the specific objective they were designed for. In the aviation industry airfoils are used for the wings to generate lift while creating little drag to allow faster flight. This experiment tested different designs for airfoils and how much drag and lift would be generated and tested whether an airfoil with a rounded top and a flat bottom would generate the least drag while the most lift compared to more symmetrical airfoils. To test each design of airfoil chosen a wind tunnel was built and each airfoil design was put inside of the tunnel and tested in two separate trials in the same conditions. The results of the experiment showed that out of the all of the airfoils that were tested, an airfoil with a flatter bottom side and a rounder topside generated the most lift while generating the least amount of drag. In this experiment the semi-symmetrical airfoil design had the best result. In the end the experiment showed that the airfoils used by most modern day plane which have flat bottoms and rounded tops are better than airfoils that are more symmetrical or have a round bottom and a flat top. The semi-symmetrical was probably the best because the flatter bottom side created a bigger high pressure zone while the top created a smaller lower pressure zone generating the most lift while still have a thin design to generate a little amount of drag thus making airfoils with rounded topsides and flatter undersides better.

G6 Optimizing a CNT-Based Kinetic Energy Harvester

Engineering
Alexander Chen
Algonquin Regional H.S.

This project centers itself around improving a carbon nanotube (CNT)-based kinetic energy harvester prototype. The idea behind this prototype is increasing efficiency in situations where the kinetic energy being harvested from the external environment is not necessarily consistent and at a high enough power density. Current conventional generators require a higher power level for optimal efficiency. Rather than coupling the harvesting mechanism directly to the generator, a CNT yarn acts as a torsional spring, storing the harvested energy until a higher (and more efficient) power output can be achieved. To increase the feasibility of an efficient CNT-based kinetic energy harvester, components of the prototype were isolated, tested, and optimized for reliability and efficiency. An Instron 5943 Single Column Tabletop Testing system was used to test the mechanical properties of materials. The raw data (extension length and force) was then used to analyze behaviors under load in various different conditions, such as under tension, compression, or cantilevered bending. The raw data was also used to calculate the Young's modulus of the material, which was used in theoretical calculations, including yield strength. 3D printing and rapid prototyping were used to create pieces of apparatus to test individual components using the Instron machine, replicating the linear and rotational movements within the full prototype. Improvements in gear teeth design and unidirectional tab angles decreased the maximum force required by 33.8% and 66.0%, respectively, while also making it significantly more difficult for the CNT yarn to unwind. These design contributions and the resulting decrease in the required force should translate to a decrease in energy loss, and thus improved efficiency.

G7 Actively Growing Hydroponics with Salt Water, Electricity-Free

Engineering
Christine Lee
Lexington High School

The project goal is to develop a low-cost, electricity-free, active hydroponic solar still garden that uses saltwater to grow plants. The set-up harnesses solar energy to desalinate saltwater and utilize the water to hydroponically grow crops.

The procedure involved setting up a solar still to purify saltwater for hydroponics. Typical active hydroponics entails utilizing a pump and electricity to circulate water, which is costly. To minimize cost and effort, the design was configured to move distilled water directly to the plants, which allowed for better oxygen absorption and promoted healthier plant growth. The integration of a solar still with hydroponics required balancing the exposed surface area of the saltwater in the reservoir to ensure sufficient water for hydroponics with the growing area to maximize crop production.

To evaluate the system, plant height and leaf count were measured. On average, the experimental group grew 7.7cm while the control group grew on average 10.9cm. Leaf count in the experimental group increased by 11.3 leaves, and the control group surpassed the experimental group, on average increasing by 14.0 leaves.

Given the results, the system successfully satisfied the design criteria of providing sufficient water to grow plants hydroponically. While the plants grown hydroponically were stunted compared to the control group, the experimental plants did grow and are likely to bear fruit.

Ultimately, the active hydroponic solar still garden provides an inexpensive, non-mechanical solution to produce food in locations where sunlight is plentiful but arable land and fresh water are scarce. Given the success of the project, further research is warranted to enhance the output of the garden.

G22 DNA Extraction & Molecular Engineering

Engineering

Bryce Griffin, Daniela Brea
Edward M. Kennedy Academy for Health Careers

Droughts are an issue that need to be addressed. Rather than focusing on how to stop droughts it's important to understand how solve the effects of drought. Droughts effect crop growth, when there is not enough water for plants to grow and reach full potential than there will be lower crop yields, leading to lower food resources. Will using detergent to extract DNA allow for improvements in the molecular structure in order to make it more drought resistant? Our goal is to create a better molecular structure for drought resistance. The application of this is improvement is in order to create more equitable grounds for local farmers when trying to compete with big companies. Many people assume that because DNA is so small, we are unable to see it without a powerful microscope. The idea we cannot extract DNA from living organisms without complicated and expensive laboratory equipment. However, this is not true. We have outlined a simple experiment showing how DNA can be extracted from a strawberry and made visible to the naked eye. We have analyzed out data and researched ways to genetically modify plants so that they become much more drought resistant for the benefits of local farmers.

H10 A Better Way To Catch Bass

Engineering

Mansel Marangoni
Taconic High School

Improper handling and misuse of equipment leads to a high mortality rate in largemouth bass. Catch and release fishing causes 27% of largemouth bass' mortality. The hook is one of the largest factors of the fish's mortality, do to physical damage done to the fish's mouth. A hookless lure was developed with a goal of reducing the mortality in largemouth bass after the catch and release process. The lure was compared with a normal bass lure , with two barbed treble hooks. Testing was done on an artificial bass mouth made of ballistics gelatin. Tests were done to find the number of tears the lures caused, the length of tears, and the total amount of time for the lures removal from the artificial mouth. The results showed that the hookless lure caused less damage, but took more time to remove, than a normal lure. This shows that the lure was effective in not physically harming the fish, however it took more time to remove the lure and could lead to mortality in the fish due to stress.

H16 Solely Solar

Engineering
Katharine Roberts, Rose Engler
Martha's Vineyard Regional H. S.

Energy, as we know, is a significant resource to keep our society alive. However, along with energy comes from the burning of fossil fuels. Our hopes in creating this solar powered cell phone were to use our resources efficiently and with the safety of the environment in mind. Considering natural light is a renewable resource that is clean to our environment, it makes it the perfect resource to provide energy to one of our daily necessities, a cell phone. The goal of this year's part of our solar powered cell phone was more focused on the appearance and complete functionality of the actual phone. This included modeling a phone case on Tinkercad and printing it from our 3D printer at MVRHS. In addition to the appearance of the phone, we wanted the phone to be free from technological errors. Since we already had some knowledge of Arduino and other technological vocabulary from our prior project, this made our process this year much more efficient. We began by fixing the parts of the phone that had not been stably added to the phone last year, such as the polymer charger. Next, we added a new layer to the phone, a breadboard. Although this ultimately made the phone larger and thicker, it was a more stable way to connect both the RTC and the USB / DC / Solar Lithium Ion / Polymer charger to the phone. Lastly, we focused on the appearance of the phone, including fitting the phone to a case made out of renewable cardboard. Our method this year was not so much trial-and-error based because we had now had the technological knowledge due to last year's project.
Results showed that the phone was able to be functioning fully and correctly, while also be appealing to one's eye. Our technological knowledge from last year definitely helped us with the efficiency of this year.

H20 Spikes Vs. Sneakers

Engineering
Brianna Bagdasian
Taunton High School

The purpose of this experiment was to determine how the utilization of track spikes while racing impacts a runner's performance. It was hypothesized that if the athlete races in his/her track spikes, they will have a faster time than if competing in traditional running sneakers due to the spike's lightness and extra traction. A large group of high school track athletes were gathered and asked to perform three trials of racing: three times wearing sneakers and three times with racing spikes. Each athlete ran a distance of 100m at full speed for each trial. After calculating an average time for each individual's trial, the results proved the hypothesis to be correct. When the athlete races in his/her track spikes, they will have a faster time than if competing in traditional running sneakers due to a combination of lightness and extra traction.

H25 Tidal Powered Floating Water Wheel

Engineering
Nathaniel Packer
Martha's Vineyard Regional H. S.

The tidal ponds of Martha's Vineyard are suffering due to the excess nitrogen in the water. Excess nitrogen results in algae and phytoplankton growth, and their decomposition results in using up the dissolved oxygen in the water. With the increased occurrence of hypoxia in saltwater ponds around Martha's Vineyard, I made a water wheel that could aid in the aeration of local waters.
My prototype has the potential to move air using currents and tidal flows to the areas which need oxygen. I used recycled materials for this project, and that did not adequately allow me to make a full servicing prototype. To prove beneficial to the environment, larger scale units would have to be built..The beauty of these devices is their simpleness, easy to maintain, and can be anchored in shallow non navigable areas of the ponds channels. The finished product would have a shield over the water wheel and the pump linkages to protect wildlife from the moving parts.The need for them isn't extreme enough to be mass produced. Before one were to build a production model a professional mechanical engineer should be consulted to help optimize the design and specify the lowest friction and most suited materials to be used in the corrosive saltwater environment while still keeping the unit economical.
The idea for this project was to create something that could be used around the island of Martha's Vineyard to help with the aeration of local waters, and to help with local ecosystems. This can be used anywhere in the world where there is moving water and a need to aerate estuaries. My design might be used by the local shellfisheries, harbormasters, harbors management, local environmental groups as well as conservationist.

J7 Extending the Range of Electric Cars with Bladeless Turbines

Engineering
Jonathan Podesta
Stoughton High School

The title of my experiment is, "Extending the Range of Electric Cars with Bladeless Turbines." The purpose of my experiment is to implement a possible system that will extend the range of electric cars by recharging their batteries using a Tesla Turbine. My hypothesis is: If a Tesla Turbine is attached to an alternator, the electricity produced will recharge the car's batteries and extend the range. The first step in the continuation project was to construct the alternator-Tesla Turbine pulley and belt system. The alternator was mounted on a metal bracket and the turbine was mounted 6" away. A v-belt connected the two pulleys. The air compressor fed compressed air into the turbine which turned the pulley and belt which turned the pulley on the alternator and produced electricity. Ultimately, during a drive averaging 37.5 mph, the charge in the battery pack in a Tesla Model S will be depleted completely in 8 hours. However, with the air compressor-Tesla Turbine system and a 10kW belt driven generator attached, a user may now drive for 13.62 hours at the same speed, 37.5mph, increasing the range by 210.57 miles (from 300 miles to 510.57 miles).

J16 Saving Space, Saving Lives; Natural Disaster? No Problem

Engineering
Alexander Ireland
Quincy High School

This project demonstrates how to save housing space in a post-disaster environment. People who have lost their homes in a natural disaster may need to wait extensive periods until they can return back to their rebuilt homes. Until then, the area required to house these individuals often surpasses the limit of the surrounding geography. The engineering goal of the project is to reduce this area. Victims would be housed in pods shaped as truncated octahedrons. By stacking these pods, it is possible to save up to 72.9% of space when compared to conventional methods. This project shows how to reduce the area required to house those who have lost their homes.

J17 Combating Global Warming through A New Air Conditioner Design

Engineering
Nessie Dubuisson
Brockton High School

As the world advances, there is a greater focus on new technology but people often forget the environmental effects these developments in technology can have. The increased use of air conditioners has caused a climb in HFC (hydrofluorocarbon) emissions from 303 to 463 million metric tons between the years 2007 and 2012. HFCs are more potent because this greenhouse gas can trap a thousand times more heat than carbon dioxide, which continues the cycle of warming the earth and forces people to use the air conditioners more in response. Sometimes, solutions to the problems present today can be applied through combining past advances. The focus of this study was to improve the air conditioner, a contributor to global warming, through pre-existing technology: the Peltier device. Two identical air conditioners were donated for this project. One of the air conditioners had its compressor replaced with four small Peltier devices with heat sinks attached. Pulses were used to optimize the performance of the Peltier device as a means to overcome joule heating. This study determined that surface area plays a vital role in performance since the Peltier air conditioner performed as planned, but failed to transfer the thermal energy into surrounding air due to the lack of surface area between the Peltier system and the air. The obvious next step in development of this technology is a dual system of pumps, pushing hot and cold antifreeze solution into radiators similar to those already used in HFC-based air conditioners.

J20 Curing Cystic Fibrosis with CRISPR/CAS 9

Engineering
Ekran Sharif, Precious Maduanusi, Rebecca Cremin
Edward M. Kennedy Academy for Health Careers

What is CRISPR/Cas9? CRISPR (Clustered regularly interspaced short palindromic repeats) is a gene modification system that can be used to edit genes with mutation. It has two components. Cas9 and guide RNA (gRNA). Cas9 is a molecular scissor that cuts two strands of DNA and allows bits of DNA to be added or removed. Guide RNA (gRNA) is a guide for Cas9, first recognizing the right DNA sequence and then flagging Cas9 to act as a pair of molecular scissors and cut the DNA sequence. This is important because we will be able to correct specific mutations in specific genes.
Our science fair project is using CRISPR/Cas9 to correct an E. coli gene and have it grow on a media (LB Strep/Kan) that it would not otherwise grow on. We will then apply this to design a gRNA that corrects a specific mutation in the CFTR gene. CFTR is a gene that is mutated in Cystic Fibrosis. Cystic Fibrosis is a Mendelian genetic disorder that causes lung infections in 70,000 people across the world.

K15 Fan Imitation by Acoustic Pressure

Engineering
Jared Etienne
Foxborough Regional Charter School

As hover technology is continually being improved, new types of hoverboards have been observed to repeatedly have a problem of either being unsafe, having a small active time, or being too costly, these are caused by the use of the same hovering methods in each new invention. This project is an attempt at using acoustic force with illusory motion as a new hovering method to see whether or not these problems can be resolved. To carry out this goal two prototypes were created, the first using ultrasonic waves and pressurized sound, but was not able to work due to complications with coding. The second used multiple small speakers stacked on top of each other, but was not able to work due to a low amount of force created. Though the prototypes had not hovered, much information had been learned as to how to make an acoustic hovering device to work. Currently, a new prototype is being made using the information gained form the two previous prototypes.

K22 Harnessing the Energy of a Bicycle Commute

Engineering
Andrew Churchill, Alec Portelli
Somerville High School

In our everyday lives, there is lots of potential energy that we are totally unaware of that can be harnessed for use. Inspired from the urban environment in which this project took place in, bicycles are powerful sources of mechanical energy, having both potential and kinetic within its joint movements. Keeping this in mind along with looking out our current day society's dependence on mobile devices, designing a bike that charged a phone seemed to be a practical idea. By utilizing Electromagnetic Induction, this project centered itself by designing a small generator using Faraday's Law. By attaching neodymium magnets to the spoke of a bike which rotated through a copper coil with 200 turns. This current was then taken into two individual converters, the first one an AC to DC, then a DC to DC step up. Eventually we were able to produce the correct voltage of 5 volts for the outlet to output to any mobile device into the USB port. The system provides no sort of resistance to the function of the bike, and all a user has to do is pedal as fast as they can to produce as much voltage as possible.

N7 Powering an Athlete Visibility Light through the Seebeck Effect

Engineering
Isabel Koran
Foxborough Regional Charter School

The purpose of this project was to design and implement a light powered by human body heat which provides athlete visibility in the dark. A Peltier tile was used as a thermoelectric generator by creating a temperature difference between the hot and cold plates. The hot side was warmed by the heat energy radiated from the skin of the wearer, and the cold side was cooled by the flow of air over its surface. A transformer with a 1:100 turn ratio, as well as the LTC3108, an ultralow voltage step-up converter and power manager that could operate on as little as 20 mV, were used to increase the voltage enough to power an LED. The LTC3108 was soldered to a breakout board, and all of these components – along with the necessary capacitors, resistors, and a diode – were soldered to a perforated prototype board, where the two Peltier tiles were also soldered in series. The resulting circuit did not provide enough voltage to light the LED with the temperature difference between the palm of a hand and the ambient temperature, but was able to light the LED with the use of an ice cube to create a larger temperature difference. The perforated board was wrapped in a static protection bag with a hole pierced in it for the LED and with the two Peltier tiles protruding from the top. The Peltier tiles were encased in Styrofoam, then the arrangement was placed inside an active armband used for large electronic devices. The Peltier tiles were exposed on both sides, with one side resting against the skin of the user and the other exposed to the air. Furthering the project may involve adding more Peltier tiles, or using a heat sink to quickly cool the colder side of the Peltier tiles.

N13 Air Driven Engine

Engineering
Jason David, Michael Aragon-Robbins
Madison Park Tech Voc HS

The purpose of our experiment is to find out if an engine can be converted to an air operated engine. We wanted to know if compressed air can be an alternative source for fuel which will one day no longer be available. The air operated engine was invented in the 1880s and 1890s and was used in metropolitan street transit but then disappeared in 1913 because of the death of General Herman Haupt. Haupt was one of the original inventors of the air compressed engine. Since 1913, the air driven engine has made a comeback and now there are different variations of the air driven engine. The hypothesis for this experiment was if there was a way to convert a regular engine into an air driven engine. In this experiment we used two engines to compare running time these tests were used to determine efficiency.The result was the engine ran and is very effficient and can be combined with electric engines.

N18 Preventing Road Kill Using Bioacoustics

Engineering
Elianna DeSota
Mass. Academy of Math & Science

Recently a new beast of prey has usurped the position of top predator: the automobile. Although infinitely useful for humans, this machine kills around 1 million animals every day. These deaths can be disastrous for some ecosystems and although there are existing solutions, most are either unrealistically expensive or troublingly ineffective. The goal of this project is to engineer a flexible apparatus that will prevent animal-vehicle collisions using bio-acoustics. To create this tool, an infrared sensor and speaker were connected to one Arduino, then an ultrasonic sensor was connected to another Arduino board. The two devices communicated using radio technology. After completion, both the ultrasonic and infrared components were tested. The data from these tests indicated that the device was 99% reliable with a p-value of 2.46 * 10^-13. Further, preliminary testing was completed to determine if animals were deterred from the chosen sound. With a global device that can be adapted to the protect any animal around the world, animal-vehicle collisions could be virtually eradicated.

N23 Personal Aid

Engineering
Catherine Fitzgerald
Southeastern Reg. Voc-Tech. H S

The question I asked myself was “what can I do to help people”. After a month of planning and 2 months of continuous coding, I developed an app that can be used on Android devices by people who it would benefit. The app includes:
Closed Captions,Text to Speech, Google link, Remember Location, Translator, Emergency Calls
I created a product backlog that contained a running list of everything I wanted the app to be able to do. Once I was content with the 6 things above, I created a sprint task list for each capability and coded until each one worked. After the code was done, I began the design process of the app. I wanted to make it aesthetically pleasing so I used an assortment of colors and a 6-pack block design for screen 1 and each screen had a back to screen 1 button.

N25 Floating Water: The Leidenfrost Effect

Engineering
Ilan Valencius
North Quincy High School

The purpose of this research was to determine which type of pan is the most “non-stick”. If a substance, such as food, is placed on a “non-stick” surface it will slide off will relative ease. It was predicted that if a pan is advertised as “non-stick” then it will have a lower Leidenfrost temperature than a pan that is not labelled as “non-stick”. Drops of water were dropped on three different pans at varying temperature to measure the temperature at which they would undergo a certain type of boiling called film boiling. During film boiling the bottom of a drop of liquid vaporizes and is thus supported entirely by a vapor layer which give a drop unique properties. This temperature at which a drop of liquid undergoes film boiling is called the “Leidenfrost point” and varies depending on the surface. By determining the Leidenfrost point of a surface it is possible to determine how “non-stick”/ hydrophobic a pan is. Being a hydrophobic surface means that a surface repels water and thus is often called a “non-stick” surface. It was found that pans labelled as “non-stick” and coated with supposed “non-stick” coatings have lower Leidenfrost temperatures than pans not labelled as “non-stick”, proving that they are more “non-stick”/hydrophobic then other pans. By supporting this correlation between “non-stick” coatings and the Leidenfrost point of a pan it is possible to compare the hydrophobic properties of any surface by utilizing the Leidenfrost point.

P3 Theoretical Spacecraft Propulsion

Engineering
Dylan Palmer
St. John Paul II High School

The purpose of my experiment is to determine which reaction would be a good candidate for long term interstellar spacecraft propulsion. With a more advanced version of this experiment you could find a way to release a steady amount of gas that could theoretically propel a spacecraft without need for other propellants. This entire experiment is based off of Newton's third law of motion which states, “For every action, there is an equal and opposite reaction.” This basically states in relevance to this experiment that if you release a stream of pressured gas in one direction, your vehicle with move in the other. I tested two different reactions in this experiment: the reaction between baking soda and vinegar (acetic acid). and the sublimation of dry ice. Both of these reactions create CO2 as a product and can be pressurized and harnessed in a small 500mL flask. My hypothesis was that the baking soda and vinegar would create a large amount of pressure and energy, but for a very short amount of time, while the dry ice would sublimate at a constant rate and release a lower but still steady amount of pressure and energy for a longer time. The purpose of this experiment is to find a potential candidate for interplanetary spacecraft propulsion. We will determine this by using two reactants and comparing them to discover the better fit. With results from a more advanced version we could find a way to propel a spacecraft with no need for other propulsion.

P13 Using Recycled Materials to Create Cost-Efficient Water Filtration

Engineering
Sean Mitchell, Ryan Murray
Westfield High School

The purpose of our project is to find a use for wasted plastic water bottles, while simultaneously providing cost-efficient water filtration to mass produce for developing countries. Many citizens of developing countries struggle daily to access clean drinking water. As many as 1.8 million people die each year from diarrhea linked to poor water and sanitation. Additionally, it is estimated that there is around 2 million tons worth of water bottles flooding landfills around the U.S alone. To solve these problems, we designed a water filter with the use of a recycled plastic water bottle, one small filter paper, and refillable low-cost materials such as activated charcoal, filter sand, and play sand. We created the filter by cutting off the bottom of a 16.9 fl oz. water bottle, turning the bottle upside down, placing the filter paper against the drinking hole, and adding the filter material on top of the filter paper. Contaminated water is then able to be poured through the bottom opening of the water bottle, and effectively filtered water will pour out the drinking hole of the upside down bottle. Our design that was successful in completely filtering out E. Coli from water consisted of 60 grams of sand (either filter or play sand), and 15 grams of activated charcoal on top of the sand. We have concluded that it is possible to construct a low-cost water filter, and we can expand upon this to create a filter to rid water of all possible contaminants, and aid developing countries with these filters through mass production.

P15 Wave Energy

Engineering
Madilynn Hewson
St. John Paul II High School

For my science fair project, I tested whether a wave with higher or lower amplitude would produce greater amounts of energy. To answer my question, will a wave with higher or lower amplitude produce more energy, I began by doing some background research. My literature review led me to hypothesize that waves with higher amplitude would produce more energy after learning about how the amplitude of a wave is measured and how it relates to energy production. I built an apparatus, which would measure the voltage created by the swinging of a magnet that was caused by a raft moving when waves of different sizes went by. The results show that waves with higher amplitude cause larger amounts of energy to be produced, thus supporting my hypothesis.

Biology

Biology

A2	The Effect of Exercise on the Lifespan of C. elegans
A3	Antioxidants and Mitochondrial Function in C. elegans mev-1 mutants
A4	Peripheral Deficits and Social Behavior in Drosophila FMR1 Mutants
A7	Unsupervised Analysis of Gene Expression in Neurological Animal Models
A10	Transgenerational Trends in Fertility of Drosophila melanogaster
A19	Effects of Ethanol and Nicotine on Development in Planaria
A23	Identifying the NPTN-MET1 Pathway as a Target for Cancer Therapy
A24	Designing a New Antibiotic
A25	The Most Effective Acne Treatment
A27	Effect of Metformin on Aβ42-induced Alzheimer's in D. Melanogaster
B2	The Effect of a Static Magnetic Field on the Growth of E. aerogenes, B. megaterium, and B. coagulans Bacteria
B4	DNA Mutations and Drug Resistance in Cancer
B8	The Effect of Wi-Fi on Plant Health
B10	The Effects of Temperature on Snapping Shrimp Behavior
B11	Predicting Patterns in Zika and Dengue
B16	Kava and Acetaminophen Induced Hepatotoxicity
C2	The Parkinson Chain
C4	Can You Wash All Your Bacteria Away?
C6	The Effect of Malathion on Neurodegeneration in Drosophila melangaster
C16	The Effects of Ascorbic and Hyaluronic Acid on Zooxanthellae Algae
C27	Cell Phone Microscope Vs. Compound Light Microscope
D1	NMJ and Motor Neuron Degeneration in ALS Tongue and Diaphragm Tissue
D2	D.magna as a Bioassay in an Ecotoxicology Study on Pharmaceuticals
D4	The Effect of Glyphosate on the Navigation of Apis mellifera
D5	Effect of Warfarin on Learning and Memory of Drosophila melanogaster
D7	Diamagnetic Nanoparticles as Hyperthermia Agents for Cancer Treatment
D14	The Glowing Transformation Efficiency in E.coli
D15	The Effect of a Low Level Laser on the Speed of Planarian Regeneration
D16	The Effect of TGF-beta1 on Planarian Regeneration After Photodamage
D17	The Effect of Arachidonil Acid on Daphnia magna Reproduction
D20	Analyzing Necessity of Aeration Vs. Nutrient in Algal Photobioreactor
D21	Effects of ISL and [6]-Gingerol on Invasive Bladder Cancer Cells

D23 Dominant Vs. Nondominant Hands Determining Weight
D24 Defying Death: Antibacterial Resistance of E. Coli to Neomycin Sulfate
F8 Effects of Wi-Fi Router Radiation on Drosophila melanogaster
F10 Testing the Efficiency of Oil-Degrading Bacteria
F13 A. of Gene Mutation for BRCA1 Interaction Network in Breast Cancers
F14 How Often Do You Get Heartburn?
F16 Innovative & Affordable Smart Syringe to Contain Epidemic for Billions
F20 Respiration and Germination
F21 Development of an Antigen-Detection Diagnostic Assay for Lyme Disease
F23 To Floss, or Not to Floss: An Oral Microbiome Investigation
F26 Improving T-cell Engineering to Treat Leukemia by Identifying Cancer
G2 Comparing Normal Apple Gene and Diseased Apple Gene
G3 The Mystery of Fallopian Tube Cancer
G14 Changes in Bacterial Community of Brined Pickles over Fermentation
G15 Bacterial Symbionts of Bathymodiolus Mussels Found in New Cold Seeps
G16 The Correlation between Heart Failure and Renal Dysfuntion
G17 Buy Less, Save More: An Investigation in Apple Preservation
G18 How Much "Invisible" Fats Are in Common Snack Foods
G23 Analysis of the Ebola Glycoprotein from the 2014 Outbreak
G24 The Effect of Heat Indices on Dermestid Beetle's Decaying of Carcasses
G25 How Sweet It Is!
G28 Myths of Multitasking
H2 Effect of Microbiota on the Thermal and Lead Tolerance of Nematostella
H5 What are the Effects of Artificial Sweeteners and Sugar on Plant Life?
H11 Calcium Carbonate Vent Influence on Aspects of a Meiofaunal Community
H17 Fixing Oxidative Damage: The Effect of Antioxidants on Telomere Length
H22 Analysis of Favorable Environments for Growth of Probiotic Bacteria
H23 The Effects of Huperzine A and Memantine on Hermissenda Crassicornis
H26 Characterizing the Biomechanics of Runners
J3 The Value of Plants in Our Soil
J6 Candida Communities:Comparing Biofilm Growth on Catheter Surfaces
J9 On the Prediction of HIV-1 Drug Resistance to Integrase Inhibitors

J13 Yeast Lab: Antifungals
J14 Automated Plant Monitoring System
J15 Inhibition of the GPD Genes in C.elegans Due to the Presence of Sugar
J18 The Best Bend
J21 The Effects of Global Warming on the Bourne Community Sea Level
J25 Investigating Lung Toxicity in Breast Cancer Patients
J26 Understanding FUS Mutation Mechanisms in the Cells of ALS Patients
J27 Quantitatively Comparing cECM Protein in Different Scenarios
J28 Eliminating E. coli
K1 How Do Circulatory Diseases Affect the Rate of Blood Flow?
K2 What Antibiotic is E.Coli Susceptible to?
K10 The Role of Autophagy and Signaling Pathways on Cancer Cell Growth
K12 How Much Bacteria Is on Your Toothbrush?
K13 Capping Cancer: Cancer Prognosis through Telomere Length
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A2 The Effect of Exercise on the Lifespan of C. elegans

Biology
Grace Lyons, Jose Garcia-Chope
Bancroft School

Exercise is essential for humans to maintain a healthy existence. While exercise may decrease age-related degeneration, few studies have looked at the impact of exercise at different stages of life upon human longevity. This experiment investigated the effects of exercise at different stages of life on the longevity of Caenorhabditis elegans (C. elegans), a soil nematode with significant genetic similarities to humans. An electrotactic flow chamber (worm treadmill) was used to provide daily exercise to C. elegans. Three different experimental exercise groups were created: early in life (Early Exercise); late in life (Late Exercise); and entire lifespan (Whole Life Exercise). One control group was not exercised throughout their lives. On each day from the onset of exercise, the number of live worms in all four groups was tabulated. Consistent with the study's hypotheses, more worms in the Whole Life Exercise condition remained alive at later days in the experiment than worms in the No Exercise and Early Exercise conditions ($p<0.01$). More worms in the Late Exercise condition remained alive at later days than worms in the No Exercise and Early Exercise conditions ($p<0.01$). No differences emerged between the Whole Life Exercise condition and the Late Exercise condition in the percentages of worms alive at later days. In contrast to the study's hypotheses, fewer worms in the Early Exercise condition remained alive in comparison to the control group ($p<0.05$). An ongoing experiment is underway to replicate the study's findings and to validate the research protocol. Future research could investigate the underlying mechanisms that prevent degeneration in C. elegans as a result of exercise at different stages of life.

A3 Antioxidants and Mitochondrial Function in C. elegans mev-1 mutants

Biology
Katherine Hartigan
St. Mark's School

Mitochondrial disease refers to a class of hundreds of disorders related to the mitochondria that are caused by mutations in either mitochondrial DNA (mtDNA) or nuclear DNA (nDNA). These mutations disrupt cellular respiration and the production of ATP, resulting in the overproduction of damaging free radicals. Mitochondrial diseases were once thought to be rare, but links between mitochondrial defects and many diseases of aging have been discovered, making these diseases far more prevalent than previously thought. A cure is nonexistent, and treatments are often individualized or ineffective. Antioxidants, such as Coenzyme Q10, have the ability to neutralize free radicals, making them a logical choice as a dietary supplement for mitochondrial disease patients. In this experiment, the C. elegans mev-1 mutant was used as a model organism for human mitochondrial disease. MitoQ, a reengineered form of Coenzyme Q10 targeted to the mitochondria, was added as a supplement to the diet of mev-1 mutants. The groups of mev-1 mutants were observed and data was collected every 12 hours until their death to determine their approximate lifespan. Following experimentation and data collection, it was found that there was not a significant difference in between the lifespans of the control mev-1 mutants without MitoQ, and the experimental mev-1 mutants with the MitoQ added to their diet. It is necessary to repeat this experiment while collecting data in shorter time intervals than 12 hours in order to draw more accurate conclusions when completing future research.

A4 Peripheral Deficits and Social Behavior in Drosophila FMR1 Mutants

Biology
Samantha Sarafin, Genevieve Deveaux
St. Mark's School

Fragile X syndrome is a genetic disorder caused by a trinucleotide repeat mutation in the FMR1 gene, occurring in one in 4,000 males and one in 8,000 females. The syndrome is characterized by a variety of social, learning, and cognitive deficits specific to each patient. The pathways surrounding the expression of the fragile X phenotype are largely unknown, and there is no current treatment for the disorder. Numerous studies have been conducted to investigate the role of the central nervous system in developmental disorders such as Fragile X Syndrome; however, there is a lack of studies focusing on the role of the peripheral nervous system. In our study, we developed a line of Drosophila melanogaster, using the GAL4-UAS system, that expresses the dFMR1 mutation only in the olfactory sensory neurons, a vital part of the Drosophila's peripheral nervous system. We conducted aggression and courtship assays to test the social behavior of the peripheral dFMR1 mutants. We compared these behavioral results with the results of control wild-type flies and with Drosophila that have the dFMR1 mutation in their entire anatomy. Our preliminary results suggest that both aggression and courtship should be further researched, as it was found that specific characteristics of each social behavior were impaired in some way. The most noteworthy data that was collected was significantly lower courtship index in the experimental line and a complete lack of dominance of the experimental line in the aggression assay. Because the Drosophila that were genetically crossed using the GAL4-UAS system had the dFMR1 gene silenced in their olfactory sensory neurons, the flies had an abnormality in their ability to detect pheromones, which studies show are the basis of Drosophila social interaction.

A7 Unsupervised Analysis of Gene Expression in Neurological Animal Models

Biology
Kevin Hu
Mass. Academy of Math & Science

Mouse models serve as a readily available base for experimentation in neurodegenerative drug development. However, less than 10% of drugs that have shown success in mouse-based preclinical trials show similar success in subsequent human clinical trials. Although previous studies found a high conservation between human-mouse expression, many such studies exclusively examined the late adult brain. A direct comparison of cerebral gene expression in the embryonic and early postnatal stages would require the existence of precise analogous timepoints. In this study, the developmental transcriptomes of mouse and human brains were indirectly compared with the assumption being that similar landscapes of expression would yield similar clusters in each organism. ISH and RNA-seq data were compiled into species-specific datasets containing expression matrices for 1,912 mouse-human orthologs. Correlation networks were constructed in each dataset, and a hierarchical method was applied to identify clusters of inter-correlated expression. A deep manifold projection model was further applied to assess the similarity between the two organisms through density-based clustering. Cross-organism adjusted rand index analysis revealed a high degree of divergence that was evident in the correlation clusterings, manifold projection results, and correlation networks. Furthermore, comparison of regulatory genes failed to identify a significant intersection of DNA-binding elements between the two organisms. Immediate applications of this study include justification for the low success of mouse-derived treatments, a method of validation for future transgenic mouse models, and a robust process for deep analysis and visualization of high-dimensional transcriptomic data.

A10 Transgenerational Trends in Fertility of Drosophila melanogaster

Biology
Evan Mizerak
Wachusett Regional High School

It has been established that high-, low-, and non-fat dairy may potentially act as driving factors in varying fertility rates. Given the unprecedented global rate of infertility, this project was focused on how this dietary aspect can impact fecundity. D. melanogaster was used as a biological model, and a powdered dairy supplement was added to fly media in three concentrations (high-, low-, and non-fat), using plain yeast paste as a control. Through a multifaceted procedure including egg, pupae, and eclosed adult counts, the effect of augmented dairy intake on reproductive output was determined in both male and female flies. Furthermore, the transgenerational effects of dairy intake were tested in subsequent generations of flies, which were then dissected to be assessed for any variance in ovary/germarium function. Finally, RNA-sequencing technology was used to assess altered genetic expression as a result of the aforementioned augmented dietary intake.
It was determined that high-fat dairy intake in both male and female D. melanogaster promotes significantly increased fertility in measures of eggs, pupae, and adults. Moreover, three subsequent generations of flies exhibited trends in reproductive output almost identical to those of their parents without consuming augmented dairy additives. Flies consuming high-fat dairy (and their progeny) showed heightened intermediate stage development in ovarioles and what appeared to be increased localization of pole plasm in the germarium. This could serve as an indicator of increased stem cell count/division rate or variation in the function of a mid-oogenic quality control checkpoint. RNA-sequencing is ongoing with a focus on isolating a potentially causative mechanism in this transgenerational effect.

A19 Effects of Ethanol and Nicotine on Development in Planaria

Biology
Felix Qin, Akash Koul
Bancroft School

The purpose of this project was to determine the effect of ethanol and nicotine on cellular differentiation of Dugesia dorotocephala. Experiments have been conducted to prove that nicotine, arsenic, tar and other teratogens in tobacco and alcohol have a negative impact on fetal development. While harmful effects of tobacco and alcohol are well-known, their harmful impact on growth at a molecular level is not as well understood. Our research involved taking planaria and placing them into petri dishes that would simulate the blood concentrations of nicotine and alcohol in a smoker or an alcoholic. We compared these results with the results in the control, which was a normal petri dish that contained spring water with planaria. First, we cut the planaria and placed them in petri dishes containing alcohol at concentrations of 0.7mL, 1.6mL, and 2.3mL per 1 L of spring water. Then we measured the lengths of the head and tails, and then performed the same task with petri dishes containing nicotine at concentrations of 0.04 mL, 0.32 mL, and 0.71 mL per 1 L of spring water. After measuring initial lengths, we measured the lengths of each head and tail at the various concentrations on day 2, day 4, day 6, day 8, and day 10. We observed a weird trend in our results. The percent growth for the heads and tails increased from day 0 to day 8, but then decreased after day 8 for solutions of nicotine and ethanol. While our results regarding percent growth might not support our hypothesis currently, we are doing research that involves looking at the digestive tracts as well as internal and external deformities. Looking at these samples and determining these things can show us that deformities of the planaria are caused by nicotine and alcohol interfering with cell differentiation.

A23 Identifying the NPTN-MET1 Pathway as a Target for Cancer Therapy

Biology
Numaan Dogar
Mass. Academy of Math & Science

Some drugs currently in clinical trials target the lactic cycle in order to inhibit glycolytic tumor growth. They specifically target monocarboxylate transporter 1, or MCT1, because MCTs are responsible for effluxing lactic acid from cells after anaerobic cellular respiration. In order to function, these transporters need to be translocated to the cell membrane during cell development by ancillary proteins. In normal tissues, basigin performs this function, but, in glycolytic tumors, basigin is not expressed in sufficient quantities to perform this task. A homolog of basigin, neuroplastin, is over-expressed in these tumors and is known to interact with MCT2, a homolog of MCT1. This project investigated whether neuroplastin could act as an ancillary protein to MCT1. Homology models of MCT1 and MCT2 were created using SWISS-MODEL. These models were then docked with the known structure for neuroplastin-55 using ClusPro and PatchDock. Models were validated using Ramachandran Plots, G-Factors, and Z-scores. The best-predicted models from both interactions were observed to bind in the same area. Because the interaction residues for MCT1 and MCT2 are conserved, it is likely that neuroplastin is able to bind MCT1. The model of the interaction between neuroplastin and MCT1 is accurate enough to be used in designing a drug to stop neuroplastin from binding with MCT1.

A24 Designing a New Antibiotic

Biology
Shurobhi Nandi
North Attleboro High School

The purpose of this project was to find out if E. coli had enough similarity within its own species that did not overlap with similarity in the human genome. These regions of similarity could be used to create an antibiotic that targets DNA. I hypothesized that it would be extremely difficult to find a region with a high degree of similarity that did not overlap with the human genome. However, I found a great degree of similarity and very little lined up with the human genome. To conduct this experiment, NCBI's Genbank and BLAST were used as well as a free genome editing program called Bioedit. By using Genbank to find different types and strains of E. coli, BLAST to align them, and Bioedit to manipulate these alignments, I was able to find 22 regions of high similarity among O157:H7 organisms which totaled about 800,000 base pairs in length. I also found six regions of high similarity among all E. coli which totaled about 47,000 base pairs in length. While this experiment could certainly be improved by aligning more genomes and covering the whole genome rather than just the 42% which had the most similarities, the data thus far suggests that specific types have a lot of similarity, and that species also have a certain amount of similarity which could be used to create a new antibiotic.

A25 The Most Effective Acne Treatment

Biology
Amma Agyei
Assabet Valley Voc. H. S.

Acne is a prolonged skin disease in which dead skin cells and oil from the cells clog hair follicles. It has been estimated to affect 660 million worldwide. There is a need to find an acne medication which is not just effective but affordable and does not destroy the acid mantle of the face. This research aimed to determine which acne medication was most effective at killing and averting the growth of E.coli k-12. Over a span of 14 days, an experiment was conducted to test the effectiveness of natural acne medication against that of over-the-counter acne medication. Diffusion disks were soaked in the different treatment conditions and placed on agar plates streaked with E.coli k-12. The main results of this trial were that no zones of inhibition were visible for the over-the-counter acne medication. Hence, a second trial was conducted using only natural acne medications namely; witch hazel, apple cider vinegar and tea tree oil, highly concentrated tea tree oil and diluted tea tree oil. The pH of the various medication was tested. Based on the conclusions, highly concentrated tea tree oil proved most effective without destroying the acid mantle.In the future, Propionibacterium acne would be used instead of E.coli k-12.

A27 Effect of Metformin on Aβ42-induced Alzheimer's in D. Melanogaster

Biology
Jamiee Zhuge
Wachusett Regional High School

Links between diabetes and Alzheimer's diseases (AD) have been found, leading some to call AD "Type 3 Diabetes." Amyloid beta aggregates into plaques which are present as hallmarks of AD. The purpose of this project was to determine whether metformin, an anti-dibaetic drug, has an ameliorative effect on the physical and behavioral symptoms of AD in a D. melanogaster model. For the project two mutant strains of flies, GMRAbeta42-KJ/CyO and UASAbeta42-HJ2.12/CyO, which express human Aβ42 in their central nervous system were used in the locomotion, memory, and imaging assays performed in this experiment.
For each assay two control groups were used, one being wild type flies and the other untreated mutant flies. Experimentally, two doses of metformin were administered to the mutant flies: 20mM and 60mM. The locomotion assay was performed with geotaxis tests, while the memory assay was performed with a modified t-maze. Both assays tested wild type and UASAbeta42-HJ2.12/CyO mutants. To perform the imaging assay, fly eyes were dissected and imaged using reflective light stereo microscopy as well as autofluorescence confocal microscopy.
The metformin treatment had significant restorative effects in locomotor ability, memory, learning ability, and the rough eye phenotype of the mutant flies compared to the control groups. A dose dependent effect was also observed, with the drug working more effectively at a 20mM dosage than a 60mM dosage.
The fly model of Aβ42-induced AD allowed for acquisition of data relevant to human AD, providing evidence that metformin may be a viable treatment option with further human testing. Additional testing may be done with an amyloid beta 42 human ELISA kit or to quantify qualitative data, such as effects on reproduction and longevity.

B2 The Effect of a Static Magnetic Field on the Growth of E. aerogenes, B. megaterium, and B. coagulans Bacteria

Biology
Ilona Znakharchuk, Madison Stinehart
Westfield High School

The goal of this project was the study the effect, if any, that a magnetic field of approximately 5.5 mT can have on E. aerogenes, B. megaterium, and B. coagulans. Multiple studies suggest that a magnetic field can disrupt the electrochemical gradient present in the cell membranes of bacteria. This in turn hinders the production of ATP and deprives the bacterium of energy. The hypothesis was that bacteria exposed to a magnetic field would have smaller turbidities than bacteria not exposed to a magnetic field as evidenced by % absorbency readings obtained from a spectrophotometer. After experimentation on these three strains of bacteria, it was found that magnetism has a detrimental effect on E. aerogenes and B. megaterium. No significant difference in turbidities was noted between the B. megaterium control and magnet treatment. Although this is the second round of investigation of each of these three bacterial strains, further studies can be conducted on different parameters of susceptibility in order to further bolster these results.

B4 DNA Mutations and Drug Resistance in Cancer

Biology
Salima Amiji
Bishop Feehan High School

Lung cancer remains a leading cause of mortality worldwide. One of the major challenges in effective treatment of lung cancer is the development of resistance to first-line drugs, such as cisplatin.
In this study, I have examined the role of an anti-apoptotic gene called survivin, in non-small cell lung cancer as a major contributor to the resistance development. Using A549 wild-type and A549-DDP cisplatin-resistant lung cancer cells, I compared survivin expression and compared against a non-cancerous buccal epithelial (cheek) cells. Following confirmation of survivin expression in the lung cancer cells, I determined the concentrations of cisplatin that is required to kill 50% of the cells (IC50). Ultimately, I have also silenced survivin expression in the resistant cells using a small interfering RNA (siRNA) sequence that was delivered in the cells using hyaluronic acid nanoparticles.
The results of the study showed that the A549-DDP (resistant) cells had a much higher level of survivin expression, which corresponds to its ability to resist cisplatin-induced cell death by apoptotic mechanism. The resistant cells also required a significantly higher concentrations of cisplatin was needed to kill 50% of the cells in culture. 50% cell death is the IC50 value and it is how you indirectly measure the resistance. The IC50 value was 9.80 μM in wild-type A549 cells and 25.09 μM for A549-DDP cells. Lastly, in a separate trial, survivin specific siRNA when delivered using hyaluronic acid nanoparticles. These results showed significantly decreased the cell viability of A549-DDP cells at lower doses of 50 and 100 μM of cisplatin.
Overall, this study led me to understand that chemotherapy effectiveness in lung cancer is comprised by drug resistance.

B8 The Effect of Wi-Fi on Plant Health

Biology
Kristen Stawasz
Westfield High School

The purpose of this project was to investigate whether modern technology has damaging effects on the environment. This was tested by putting spider plants into two Faraday cages, with one containing a Wi-Fi router. It was hypothesized that Wi-Fi exposure would have a negative effect on the health of the plants.
A baseline test was taken for each plant by measuring the length of the longest leaf and the rate of photosynthesis, as determined by an assay in a 5% sodium bicarbonate solution. The health of the eight plants was evaluated over time by testing the length of the longest leaf and rate of photosynthesis, and adding the z-scores for both measures for each plant to construct a health for each time interval.
The overall mean health index for plants without Wi-Fi was 0.40, compared to -0.61 for plants exposed to Wi-Fi when measured from the previous test, with a p-value of 0.33, and 0.51 and -0.71 respectively when measured from the baseline, with a p-value of 0.0075. The central tendency shows that the health of the plants in this experiment was greatly decreased when exposed to Wi-Fi. However, the scope of the research could be broadened by testing a variety of plants, lengthening the growing time, and starting from seeds.
The project establishes evidence that modern technology may have detrimental effects on the environment. Environmental degradation is occurring rapidly due to human activity, and technology may inhibit the environment's ability to replenish its resources and ecosystems' ability to support its life. This project justifies the need for further research on the consequences of radiofrequency radiation on the environment.

B10 The Effects of Temperature on Snapping Shrimp Behavior

Biology
Martha Clark
Falmouth Academy

Since the early 20th century, rise in atmospheric greenhouse gas concentration has caused ocean temperatures to increase drastically. These shifts in temperature pattern may have dramatic impacts on the marine ecosystem. The purpose of this experiment was to compare the behavior of big-clawed snapping shrimp, Alpheus heterochaelis, when exposed to warm and cold temperatures. It was hypothesized that shrimp exposed to warmer temperatures would engage more readily in active behaviors and snap more often than those exposed to cold temperatures. Shrimp activity was monitored both in shrimp kept individually and in male-female pairs. Prior to testing, shrimp were given 24 hours to acclimate in temperatures at the same range of those in which they were tested. Shrimp were then transferred to a new tank at the same temperature to which they had acclimated. Shrimp behavior was recorded over a fifteen minute period, and video footage was analysed to assess different behaviors. Data was quantified as percentage of total trial time spent by the shrimp engaged in a given activity. In both shrimp pairs and individuals, little significant difference was observed in behavior. Shrimp in cold temperatures spent an average of 47.9±23.1% of the trial engaged in non-active behaviors. In warm temperatures, shrimp spent an average of 42.2±26.5% of the trial inactive. Although temperature may affect Alpheus heterochaelis, the results of this experiment indicate that they can adjust, at least temporarily, to temperatures beyond their natural range, and that exposure to new environments, gender, and the presence of other shrimp may have a greater immediate influence on their behavior.

B11 Predicting Patterns in Zika and Dengue

Biology
Krithi Krishna
Westborough High School

Zika has been a hidden problem for many years. All of a sudden, many neurological diseases and new complications due to Zika were being reported in Brazil that weren't present with the original African strains of Zika. Why did it take so long for such serious effects to manifest? What changed over the years? This is where genetics and the field of bioinformatics come into play. In this project, different patterns of the Zika virus were observed and analyzed to determine how much the genetic sequence of Zika has varied since one of its first reportings in 1968 in Nigeria.

B16 Kava and Acetaminophen Induced Hepatotoxicity

Biology
Jenna Pralat
Mass. Academy of Math & Science

The increased popularity of kava in the U.S. and Europe was accompanied by unexpected hepatotoxicity (liver toxicity) cases. Kava (an extract from the roots of the Piper methysticum plant) is used to treat anxiety or insomnia. Variance in the extraction method or the interaction of the extract with other medicines could account for the prevalence of liver failure. The aim was to observe the hepatotoxic effects kava produced when combined with acetaminophen (APAP) in Danio rerio larvae. Liver failure is associated with changes to the size of the liver and yolk sac, and the color of the liver. It was hypothesized that the addition of APAP to the kava would increase the severity of the hepatotoxicity found in the larvae. Larvae were administered either kava, APAP, or both for two days, then their pictures were taken under a microscope. ImageJ was used to find the area of the liver and yolk sac and the average RGB values of the liver. There was contradictory data but, the yolk sac areas indicate the administration of APAP and kava increased the severity of hepatotoxicity compared to kava alone. Kava and APAP at the doses in this experiment should not be administered at the same time.

C2 The Parkinson Chain

Biology
Anna Su
Miss Hall's School

This project focuses on how the mutations of LRRK2 gene contribute to the development of Parkinson's disease. My hypothesis was that if the amino acids were changed, the disease would appear. I also hypothesized that if the amino acids were not changed by the mutations, Parkinson's disease would not appear. The result of my research only supports half of my hypothesis by showing that most of the pathogenic mutations have protein change, but not all of them. Most of the benign mutations do not have protein change, but one does. This means that even though we do not know the cause of Parkinson's disease, protein change may be a relevant factor.
Keywords: mutations, amino acids, LRRK2

C4 Can You Wash All Your Bacteria Away?

Biology
Adrianna Arona
Westfield High School

As you see, this project is in its final result of what works best to clean a toothbrush. The main goal of this project was to see what worked best for cleaning a toothbrush, the results were found by the amount of bacteria each toothbrush had. This was tested by using a toothbrush for a month and a half before cleaned/soaked for 15 minutes. Three types of cleaners were used, Scope mouthwash, hydrogen peroxide, and boiling water. To see what worked best, nutrient agar was used to see the growth of bacteria on each toothbrush. Bacteria growth was measured in bacteria colonies. Bacteria growth occurred most on the toothbrush that was cleaned with the boiling water, showing a result of 15 bacteria colonies. The other toothbrushes that were cleaned with Scope mouthwash and hydrogen peroxide were tied with one bacteria colony. These were compared to the control toothbrush that sat on the bathroom counter for a month and a half showing about 35 bacteria colonies. To come to a conclusion, this project was a great experiment to do. As stated in my hypothesis and further research, boiling water was supposed to work the best, clearly that was proved wrong.

C6 The Effect of Malathion on Neurodegeneration in Drosophila melangaster

Biology
Sally Zhi
Mass. Academy of Math & Science

Alzheimer's Disease (AD), the 3rd highest cause of death for the elderly in the USA, is characterized by memory loss and learning deficits. Although the causes of this neurodegenerative disease are still unknown, exposure to organophosphate pesticides, such as malathion, have been correlated with an increased risk of developing AD. Drosophila melanogaster, or fruit flies, were used to test the effects of malathion on memory and learning. It was hypothesized that signs of neurodegeneration would occur in D. melanogaster after they were exposed to increased dosages of malathion. Experimental groups were given different dosages of malathion before testing. The flies were then trained to associate apple cider vinegar with the aversive stimulus of shaking. The number of flies in the vinegar section was counted after each training session. Finally, the flies were tested zero, two, four, and six hours post-training to assess their memory. A multivariate regression yielded p-values of 0.0208 and 0.00261 for memory and learning respectively, showing that malathion significantly affected the flies and suggesting that exposure to pesticides can cause serious neurological damage in humans.

C16 The Effects of Ascorbic and Hyaluronic Acid on Zooxanthellae Algae

Biology
Skylar Murphy, Abigael Spice, Trisha Haluch
Westfield High School

Humanity is destroying the Earth. What many don't realize is the effect temperature change is having on oceanic life. Coral reefs make up .1% of the ocean but house 25% of all ocean life, and that zone of the ocean is dying rapidly. Coral bleaching occurs when coral gets stressed and it expels the zooxanthellae algae from its polyps. The team believed that Ascorbic Acid will reduce the expulsion of the zooxanthellae algae. To test this 14 tanks were set up with the proper living conditions for Elkhorn Acropora coral colonies. After a cycling period of three weeks corals were added and after a week of adjustment testing began. There were three days of sampling collection each collection set being five days apart. After the final day of testing the coral fragments were processed using pressurized air and a centrifuge to separate the algae from the actual coral. The alae was placed under a microscope and counted. The hypothesis was disproven, but throughout the experimentation process new information was gathered about the life and habits of coral including their genetic make up. With this new information new experiments based off of the original idea can be created for future research.

C27 Cell Phone Microscope Vs. Compound Light Microscope

Biology
Alyssa Morgan
Matignon High School

Throughout the last few months, I built a fully-functioning cell phone microscope, and I followed up by comparing the performance of the cell phone microscope to that of a compound microscope. The purpose of this project is to display the innovation of modern scientists, as they incorporate lab materials into portable devices and to test the functionality of these new devices in my own way. Cell phone microscopes can save lives; if medical workers are on trips away from the lab, they can use this lightweight and portable microscope to diagnose diseases. Additionally, if schools can not afford regular microscopes, they can build their own inexpensive cell phone microscopes for their classrooms. My work revolved around the question in which I asked: is a cell phone microscope a practical replacement for a compound light microscope for those without access to a traditional microscope?

To go about answering my question, I gathered my materials and constructed them into a microscope with a base, a specimen stage, a camera stage, and focus adjustments. After retrieving a compound light microscope and prepared slides, I began comparing the images that were produced when the slides were placed under the two different microscopes at various magnifications. With the results of these images, I was able to conclude that cell phone microscopes are practical replacements for traditional microscopes because the images produced by the cell phone microscope met the standards of quality that make this device comparable to an ordinary microscope. Although improvements can be made to this device by making variations to the quality and number of lenses, the engineering provided a strong tool, and the experiment proved that science can be accessible from virtually anywhere.

D1 NMJ and Motor Neuron Degeneration in ALS Tongue and Diaphragm Tissue

Biology
Alessandra Veinbachs
Bancroft School

Amyotrophic lateral sclerosis (ALS) is a fatal, neurodegenerative disease that results in death within 3-5 years of onset. 10% of all ALS cases are inherited and are known as familial ALS (fALS). 20% of fALS cases are due to a mutation in the superoxide dismutase 1 (SOD1) gene. The dying forward and dying backwards hypotheses of ALS pathogenesis are investigated in this paper. The rate of NMJ degeneration and motor neuron death across different timepoints in the disease progression in an SOD1 mouse model are compared.

Preliminary motor neuron data show that there is a significant difference between the amount of motor neurons present in the XIIth cranial nerve, which innervates the genioglossus muscle, between end stage NTG and ALS mice. Further research into the rate of motor neuron death in comparison to the rate of NMJ degeneration is to be conducted.

D2 D.magna as a Bioassay in an Ecotoxicology Study on Pharmaceuticals

Biology
Nicole Stark
Wachusett Regional High School

This experiment focused on the impact that pharmaceuticals (NSAIDs) can potentially have on the environment. As NSAIDs are growing in use and popularity, their frequency in the environment also grows. By introducing Daphnia magna to an environment contaminated with aspirin and ibuprofen the impact of the NSAIDs was analyzed. D. magna populations were exposed to three concentrations of aspirin and ibuprofen (1 mg/L, 2 mg/L and 3mg/L). The NSAIDs were crushed and then dissolved in spring water, which the D. magna would be exposed to. Each level of independent variable had ten populations of D. magna, each with ten organisms. Over the course of nine days the population levels were recorded for each NSAID, as well as a control group unexposed to any substances.
After analyzing the population sizes it was clear that the exposure to NSAIDs resulted in a significant decline. All of the populations from both trials exposed to any substance ended with less than four D. magna still alive, and the control groups ended with above six. There was no clear difference between concentrations, simply the presence of the NSAIDs was enough to cause a sharp population decline. Student t-tests confirmed these results and showed that all values were significant in comparison to the control groups. This data shows that with the increasing popularity of anti-inflammatory drugs, ineffective filtration could spell disaster for natural ecosystems.

D4 The Effect of Glyphosate on the Navigation of Apis mellifera

Biology
Mary Zgurzynski
Wachusett Regional High School

The purpose of of this project was to learn if the herbicide glyphosate negatively impacts the navigational abilities of the honey bee (Apis mellifera). It was hypothesized that if honey bees ingest a sublethal amount of glyphosate their navigational abilities will decrease in the form of slower maze navigation and increased regressions when completing a maze to an indoor observation hive.
Glyphosate (the active ingredient in RoundUp) is an organophosphorus compound that serves as a non-selective herbicide used for killing plants. An indoor honey bee hive colony was established to to obtain honey bees and have a controlled environment. Different doses of glyphosate were administered to each honey bee including a full sublethal dose (LD_{50}) and a half sublethal dose (LD_{25}). For two hours honey bees were fed a sucrose and glyphosate solution in a separate terrarium. Simple and complex mazes were constructed and the time taken to complete each as well as the number of regressions was measured for each group. A total of twenty bees were tested in each group for in two trials of ten bees. This process was used in an LD_{50} group for both maze designs and a post 24 hour trial. The same procedure was conducted for the LD_{25} dosed honey bees in the simple and complex mazes followed by a post 24 hour trial.
The effect of glyphosate was found to be dose dependent because the amount of time taken for a honey bee to complete a simple and complex maze increased exponentially with the amount of glyphosate the bees were exposed to. Each honey bee exposed to glyphosate experienced decreased motor skills, abnormal motion, lack of spatial awareness and increased regressions.

D5 Effect of Warfarin on Learning and Memory of Drosophila melanogaster

Biology
Abigale Foster
Wachusett Regional High School

Atrial Fibrillation (AFib) is the irregular beating of the heart and leads to pooling of blood and promotes the formation of blood clots. Warfarin, the active ingredient in Coumadin®, is the most common and cost effective anticoagulant prescribed to AFib patients. Blood clot formation is dependent on the synthesis of Vitamin K clotting factors. Warfarin disrupts two clotting pathways: the formation of Vitamin K hydroquinone and the recycling of Vitamin K. The role of Vitamin K as a mitochondrial electron carrier molecule necessary for the production of chemical energy to sustain life has been established. A lack of Vitamin K has been linked to cellular damage and neurodegenerative diseases.

This study was conducted to determine whether Warfarin would affect memory and learning of wild-type Drosophila melanogaster. The adult flies and larvae were treated with 4 doses of Warfarin. Short term memory was measured after adults were conditioned to avoid apple cider vinegar. Larvae were subjected to a fructose rewarded olfactory learning assay.

As the concentration of Warfarin increased, the time it took for the adult flies to avoid the conditioned odor decreased. There was a statistically significant decrease in time as the flies avoided the conditioned odor when untreated and treated results were compared. A statistically significant decrease in the time it took the adults to avoid the conditioned odor suggests that Warfarin is affecting Drosophila memory. As the concentration of Warfarin increased, the number of larvae attracted to the rewarded odor decreased. A statistically significant difference in Performance Indexes when treatment groups were compared to the untreated groups suggests that Warfarin is negatively affecting Drosophila larvae learning.

D7 Diamagnetic Nanoparticles as Hyperthermia Agents for Cancer Treatment

Biology
Ali Qutab
St. Peter-Marian Jr. Sr. CCHS

Colorectal cancer is a devastating disease and is treated with immunosuppressive medications. A less expensive, less toxic and more effective treatment, magnetic nanoparticle (MNP)-based hyperthermia, may be used to treat colorectal cancer. MNP-based hyperthermia is a procedure in which MNPs are intravenously entered into a patient's body to reach a tumor via the tumor's blood vessels. The patient is then placed under an alternating magnetic field (AMF) which causes the MNPs to heat up and melt the tumor. Although complications may arise due to the toxic iron levels of the patient, iron core nanoparticles seem to show the highest potential among scientists due to iron's high sensitivity to magnetic fields. An alternative to iron may be bismuth. Unlike iron which is ferromagnetic (attracts to a magnetic field), bismuth is diamagnetic (repels a magnetic field) and has a much weaker sensitivity to magnetic fields than iron. However, iron has a lower heat capacity of 25.10 J/(mol·K), whereas bismuth has a higher heat capacity of 25.52 J/(mol·K). Out the many heavy metals, bismuth has also been proven as the least toxic. In this experiment, cancer cell proliferation of cancer cells in solution with bismuth particles was measured in vitro. A DC power supply regulator was used as a power source to regulate the voltage and amps (measured with a voltmeter and ammeter) of an induction heater that served as the AMF. A thermometer was used to measure the temperature of the solution and a timer was used to measure the time it took for the solution to reach sixty degrees celsius. The solution was then left at sixty degrees celsius for two minutes. The data of cancer cell proliferation was analyzed to determine if the bismuth particles melted the cancer cells resulting in cell loss.

D14 The Glowing Transformation Efficiency in E.coli

Biology
Stevens Bontemps, Conor Kavanagh
Stoughton High School

The problem being looked looked at in this experiment was how transformation efficiency was affected by the length of time the plasmid DNA spent at a certain temperature. The plasmid being encoded into the E. coli bacteria had the GFP gene from jellyfish which would allow the E. coli to glow under a UV light. The plasmid DNA also had an ampicillin resistance gene which would allow the bacteria to grow in the presence of ampicillin. The results of the experiment showed that the plasmid was successfully inserted into the bacteria. This was supported by the fact that the bacteria with the jellyfish gene grew on plates with ampicillin. Since the plasmid would have allowed the bacteria to grow in the presence of ampicillin, then it makes sense that the plasmid was given to the bacteria. The bacteria also glowed in the presence of arabinose which also supports the idea the plasmid was inserted since the plasmid would have allowed the bacteria to glow. The successful results from the insertion of the GFP jellyfish gene into the E. coli demonstrates the potential for using artificial DNA transformation for future medical advancements.

D15 The Effect of a Low Level Laser on the Speed of Planarian Regeneration

Biology
Andrew Yuan
Wachusett Regional High School

One of the many prevalent problems in science is related to wound healing and ways to improve, speed up, and aid in the process of healing. Low Level Laser Therapy (LLLT), a therapeutic technique using low powered laser radiation to aid wound healing, has been claimed to be able to speed up the wound healing process. LLLT has been seen to increase ATP production, reduce inflammation, and relieve chronic pain but its effectiveness has been disputed as several studies have seen little effect when laser therapy was applied to injury healing. However, if regeneration speed is significantly faster, LLLT could lead to major changes in how doctors treat patients. This project tested the effects of lasers on planaria, organisms known for their ability to regenerate body parts lost through wounds.
The hypothesis is that the planaria would regenerate faster with laser treatment than those without it. The experiment was performed through the use of two 20 mW lasers (one red and one green) on 20 planaria (10 per laser) with a untreated control group that contained 10 planaria. Treatment groups were cut and then dosed for 30 seconds each day until they had regenerated their eyespots.
Results suggested that there was no statistically significant change in regeneration speed. However, treatment groups were observed to regenerate slightly slower. Oddly though, more planaria survived in the treatment groups than the control group. LLLT was ineffective in regeneration speed in planaria in this experiment, but further investigation is needed.

D16 The Effect of TGF-beta1 on Planarian Regeneration After Photodamage

Biology
Christopher Van Liew
Wachusett Regional High School

Ultraviolet radiation, due to its damaging effects on the skin's cellular DNA, is the primary cause of nonmelanoma skin cancer that affects over one million people annually, and is believed to play a role in the development of melanoma skin cancer. Both UVA and UVB rays damage keratinocytes in the basal layer of the epidermis, resulting in the skin darkening that prevents more damage to the DNA. However, the TGF-β1 protein, which plays a role in a variety of functions, most importantly in wound regeneration, is found in most organisms including planaria, which are widely studied due to their advanced tissue regenerative capabilities.
From this, the purpose of the experiment was to determine if doses of TGF-β1 increased the regeneration rate of planaria that were previously exposed to UV radiation to decide if the protein could be applicable to healing wounds both related and unrelated to UV radiation. Experimental groups consisted of ten planaria each that were cut, dosed with one minute of UVA radiation, and administered 1, 2, and 4 ng of TGF-β1, respectively; an extension was later conducted that doubled the protein doses.
Despite observing that doses above 2 ng increased regeneration speed, t-tests and ANOVA tests displayed statistical insignificance. Additional research supported the conclusion that vitamin D from the UVA doses interacted with the TGF-β1 to aid the regenerative process. With this in mind, using a combined treatment of vitamin D and TGF-β1 could eliminate the danger and cost of many current medical procedures.

D17 The Effect of Arachidonil Acid on Daphnia magna Reproduction

Biology
Natalie Matis
Wachusett Regional High School

The purpose of this experiment was to determine if adding arachidonic acid to the diet of Daphnia magna would increase the organism's reproduction rates. If this proved to be true, it was hoped that arachidonic acid intake could increase fertility rate in humans. Arachidonic acid has recently been found in small traces in the ovaries, and is thought to have a correlation with egg function and production.
To carry out this project, the Daphnia magna were separated into four large containers with ten Daphnia each. The control was fed one Daphnia magna food pellet, the second container, one Daphnia magna food pellet and 1 mL of an arachidonic acid solution, the third, one Daphnia magna food pellet and 3 mL of an arachidonic acid solution, and the fourth, one Daphnia magna food pellet and 5 mL of an arachidonic acid solution. Every three days, eggs in the brood chamber of each Daphnia were counted during a two week testing period. Through two trials, eighty Daphnia were tested using these methods.
The results of this experiment suggested that arachidonic acid increased the fertility of Daphnia magna, but at high concentrations, the arachidonic acid was harmful to the fertility. T-Tests suggested the findings were statistically significant in the container with 3 mL of the solution administered. However, although the arachidonic acid caused an increase in fertility, the organisms produced from these eggs produced developmental abnormalities when compared to the mother, suggesting arachidonic acid may be causing negative effects on the physiology of Daphnia magna, and potentially humans as well.

D20 Analyzing Necessity of Aeration Vs. Nutrient in Algal Photobioreactor

Biology
Christopher Dwyer
Wachusett Regional High School

Today, the reliance on nonrenewable, pollutant fossil fuels is a major obstacle to humanity. Global Warming, poverty, and hunger could be all but solved by the presence of a sustainable, non-pollutant, efficient energy source. Biofuel, liquid fuel created from algae, could be the solution. The only obstacle to this ideal fuel is cost. It is currently too expensive to maintain a photobioreactor to grow enough algae for the industry. The stirring apparatus used to better disperse substances in the system is a major cost contributor.
However, algae often thrives in stagnant conditions. Is stirring, through aeration, really crucial to growth? It was hypothesized that aeration would not be crucial to Nannochloropsis oculata growth due to its similarity to stagnant species.
To determine this, aeration rates were tested against nutrient levels. This called for 4 groups, each containing a different combination of replete or deplete variants of each variable. Each group was composed of 10 bottles, which were exposed to a growth light and some level of aeration.
After Trial 2, the total deplete group grew the least algae, while the other three groups were homologous in growth. Thus, aeration was not crucial, and the effects of nutrient and aeration made them interchangeable. Also, because the total replete group did similarly, the benefits of each variable were not cumulative.
This experiment suggests that aeration may not be crucial to Nannochloropsis oculata growth in a bioreactor, and large budget cuts could be made when growing algae, thus making biofuel globally accessible.

D21 Effects of ISL and [6]-Gingerol on Invasive Bladder Cancer Cells

Biology
Sanjna Das
Lexington High School

Invasive bladder cancer, a subtype of the most common form of bladder cancer, often requires the removal of the entire bladder in a complicated surgery or treatments that exert undesirable side effects on the body. This project addresses the potential of ISL (Isoliquiritigenin), which comes from licorice, and [6]-Gingerol, derived from ginger, to inhibit bladder cancer metastasis, thereby reducing the adverse effects posed by other compounds and the need for bladder removal. ISL and [6]-Gingerol were used to treat UMUC3 and T24, two invasive bladder cancer cell lines, and the effects of these compounds were then observed and analyzed using a variety of assays including the MTT assay and Western blotting, as well as existing literature. The results revealed that migration and proliferation both decreased in the treated cells, and that specific genes that have been implicated in bladder cancer, namely ACTA2, EZH2, MMP-2, and MMP-9 were downregulated following treatment with ISL. As a result, ISL and [6]-Gingerol may possess the ability to decrease the invasive potential of invasive bladder cancer by natural means.

D23 Dominant Vs. Nondominant Hands Determining Weight

Biology
Kathryn Baptiste
Taunton High School

Many people everyday go to two of the same objects and want to see the quality of both of them. A lot of the time, people measure that by the weight of an object. This experiment was made to find out which hand is more accurate at weight determination. The hypothesis was if both dominant and non-dominant hands were tested on determining which weight is heavier, then the dominant hand will determine the weight more accurately because we use that hand for most tasks. The procedure is to basically get some volunteers and have them put a hand in the box to weigh a pair of weights and guess which one is heavier. After that you would do the same with the other hand. The result of this experiment was the non-dominant hand was more accurate than the dominant. I believe that the hypothesis was not supported because the non-dominant hand handles less objects in an average day so when it does have an object it's easier to remember.

D24 Defying Death: Antibacterial Resistance of E. Coli to Neomycin Sulfate

Biology
Joshua Choi
Shrewsbury High School

Antibacterial Resistance is a monumental problem worldwide, making diseases that were once easy to treat very dangerous and deadly due to this phenomenon. We tried to find just how quickly bacteria could become resistant after doing background research, and came up with the hypothesis that if bacteria are exposed to subtherapeutic levels of an antibiotic, then they will become resistant to therapeutic levels. To reduce risk to the researchers, the KL16 strain of the E. Coli k-12 bacteria was used, and due to time constraints, exposure to UV was used to increase mutagenesis. Using this technique, low-level resistance to G418 sulfate was easily derived. Additionally, it was found that the resistant bacteria also withstood higher concentrations of drug than they had been originally exposed to, which displays that low-level resistance could be more dangerous than previously thought, and makes assessing how resistant a bacterial strain is unpredictable. It was then attempted to create additional resistance to the antibiotics streptomycin and ampicillin with the resistant bacteria, as well as the KL16 strain (non-resistant). However, this was unsuccessful, but the experiment could have been flawed as the UV exposure may not have created enough mutants. Overall, the bacteria did not show resistance to therapeutic levels of the antibiotic, and thus the hypothesis was disproven.

F8 Effects of Wi-Fi Router Radiation on Drosophila melanogaster

Biology
Tamara Liang
North Quincy High School

The problem I researched with my experiment was if constant radioactive frequency exposure to Drosophila melanogaster eggs would cause their genes to mutate. My researchable question was, “what are the effects of wi-fi router radiation on Drosophila melanogaster?”. My hypothesis was, “if Drosophila melanogaster are exposed to 0 minutes, 45 minutes, and 90 minutes of wi-fi router radiation, then the flies exposed to 90 minutes will show more mutations and signs of illness during development than 45 minutes or 0 minutes wi-fi router radiation exposure”. The dependent variable of my experiment was mutation or symptoms of illness. My independent, or manipulated, variable was the amount of time of wi-fi router radiation exposure. The controls of my experiment were the amount of food intake, the type of fruit fly, the environment, amount of radiation being exposed, and the type of wi-fi router emitting radioactive frequencies. My hypothesis was supported. Every day for 9 days, the fruit flies were exposed to wi-fi router radiation for their respective amounts of time. For the curly wing (Cy) mutation, the control group only had 1 fruit fly out of all three trials. 45 minutes group had 10 total fruit flies. 90 minutes group had 19 total fruit flies. For the serrated wing shape mutation (Ser), 3 total fruit flies out of the control group had it. For 45 minutes, 9 had it. For 90 minutes, 13 had it. For the white eye mutation, the control group had 0 in total. 45 minutes group had 16 total, and 90 minutes group had 21 total. Furthermore, there were more dark pupae on the walls of the vials for the control group on day 9 of exposure, indicating the health of the flies. If this experiment was to be replicated, there are some changes that could result in more accurate results.

F10 Testing the Efficiency of Oil-Degrading Bacteria

Biology
Dashiell Chin , Klei Hamzallari
Quincy High School

Fuel from crude oil in an integral part in the lives of the entire human population. Its use ranges from powering vehicles to heating homes. Although it is essential, it also poses great risks, especially when mishandled. In the past decade, there have been countless oil spills such as the Deepwater Horizon oil spill in which 210 million gallons of petroleum were spilled into the Gulf of Mexico. These catastrophic spills possess great hazards for the environment; many of these include the destruction of estuaries, demise of wildlife, and contamination of habitats. A variety of approaches have been tried regarding the spill cleanup but, they lead to more damage to the affected area and the cost for such operations is colossal. Thus far, no method has shown to be efficient or yield immediate success. The overarching purpose of this experiment is to find how oil waste can be removed from the environment more efficiently. The solution that is proposed in this experiment is one that involves bioremediation, or the degradation of oil by bacteria. The purpose of this experiment is to determine which essential nutrients promote the rapid growth of hydrocarbon-consuming bacteria and its fuel consumption. In doing so, the rate at which the fuel is decomposed will be determined. This experiment may lead to improved efficiency in how oil spills are cleaned up in a way that does not damage the environment. If the use of oil eating bacteria is more effective, costly and environmentally harmful methods of oil cleanup, such as controlled burnings and the deployment of relief vessels, may be potentially less necessary.

F13 A. of Gene Mutation for BRCA1 Interaction Network in Breast Cancers

Biology
Mingze Yan
Worcester Academy

The project is mainly about the data statistics of BRCA1 interaction network mutation rate. The breast cancer is the most common diagnosedly cancer in U.S. women and it is also a cancer that has the highest death rate in U.S. women in 2016. Besides, men can also have breast cancer, however, men have a lower rate to have a breast cancer than women. Many celebrities are dead of breast cancer, so breast cancer needs to be paid more attention. Then, one of the main risk factors in having breast cancer is the inherited gene mutation, and BRCA1 and BRCA2 are the most common genes in the inherited gene mutations. However, only BRA1 gene mutation is no higher than 5 percent in the analyzed 6 databases, therefore the BRCA1 interaction network should be considered. By analyzing more than one thousand different cancer samples, the conclusion, which is that the interaction network of BRCA1 mutation rate is high up to more than 80 percent to support my hypothesis, has been got. By looking carefully into the BRCA gene structure and all the interacted genes, further research about how to kill the cancer more effectively can be laid a good foundation.

F14 How Often Do You Get Heartburn?

Biology
Nature Taylor
Madison Park Tech Voc HS

Heartburn, the burning sensation in your upper chest and the burning discomfort moving up to your throat. Heartburn usually occurs when you're eating oily foods. The symptoms you will experience are difficulty breathing, burning pain, and a sore throat. The purpose of my experiment is to see whether or not ethnicity and age are the reasons people get heartburn. I also hoped to learn how people prevent it. The hypothesis for this experiment was heartburn does not have to do with your ethnicity but does have to do with age. In this experiment I interviewed 15 subjects to determine if they get heartburn, how many times a week they get it, and how do they treat their heartburn. The survey helped me learn the average age of when people get heartburn. My results were that older people are more at risk for frequency of heartburn than teenagers. In conclusion, the result of my experiment is that the risk of heartburn increases with age and that ethnicity is not an additional risk factor.

F16 Innovative & Affordable Smart Syringe to Contain Epidemic for Billions

Biology
Indumathi Prakash
Sharon High School

Syringe reuse is the top most cause of human death, which we can prevent, that needs action. Annually, 1.3 million people die and 25 people million get affected by deadly diseases due to syringe reuse. There are 16 billion medical injections administered every year and millions of new people are infected with HIV, hepatitis, and other diseases due to 40% re-use of syringes. In 2015, WHO (World Health Organization) declared an urgent priority to design and adopt “smart” safety-engineered single-use syringes, which can prevent this crisis. Due to economic and procedural inadequacies, mainly in developing countries, even the disposable syringes are recycled and reused. The “smart” syringes available so far do not directly eliminate the fundamental scientific principle of differential pressure required for it to function after the first use. Hence, those do not fully deter the syringe reuse. In addition, they are also costly, so there is a need for cheaper alternatives without these pitfalls, which is a challenge for WHO to replace in such a massive scale of 90% of 16 billion injections for curative usage. The innovative smart syringe that was designed and modeled in this project could be implemented within just 6% of the 500 million dollars additionally required for the nearest possible “smart” syringe solution to replace the simple disposable syringes. This project model has been developed in a widely used disposable syringe with an insert made with short piercing needles of 22G thickness mounted in it, which would puncture the head of the syringe plunger at the end of first dispensing the medicine. Thus, the plunger can no longer hold the differential pressure and cannot intake the medicine into the syringe the second time.

F20 Respiration and Germination

Biology
Joseph Ofei
Taconic High School

The project was to see how respiration is affected by germination. Through literary research and current knowledge, it was thought that respiration will be positively affected by an average increase of temperature of 5 and 10 degrees higher as compared ambient temperature. To test for changes in respiration, carbon dioxide from the germination of the the corn seed was tested using a CO2 probe and recorded every morning and evening. Though temperature is a very large part to successful germination, it would be of great interest the test the respiration rates to of germinating corn seeds in varying temperatures in the future.

F21 Development of an Antigen-Detection Diagnostic Assay for Lyme Disease

Biology
Sophia Tang
Boston Latin School

Lyme disease, the most prevalent tick-borne illness in the United States, is transmitted through the bite of ticks carrying the bacterium, Borrelia burgdorferi (B. b.). Current serological diagnosis assays commonly misdiagnose the critical early stages of the disease due to the late or slow build-up of antibodies raised against the bacteria that the tests rely on.
This study aimed to purify a protein that was found to be associated with B. b. from urine samples of patients with confirmed Lyme disease and to determine its reactivity against antibodies raised against the protein with the goal of developing a more noninvasive and direct form of diagnostic test.
A recurring antigen associated with B. b. was chosen as a biomarker candidate. Its gene was cloned into the pET17b expression vector and the protein of interest was over-expressed in BL21 pLysS E. coli hosts. Each stage was confirmed by a double digestion with corresponding restriction enzymes and a western blot to confirm a polyhistidine tag, respectively. The protein was purified by metal-affinity chromatography and antibodies to this antigen were raised and tested against the purified antigen for sensitivity using an immunological assay (ELISA). The resulting tests show detectable reactivity between antigen and antibody even at a 1/51,200 dilution factor. In the future, the antibodies will also be tested against clinical urine samples from patients with Lyme or other diseases to further test its sensitivity and specificity.

F23 To Floss, or Not to Floss: An Oral Microbiome Investigation

Biology
Vivek Gopalakrishnan
Lexington High School

Recent scientific and journalistic publications have called into question the validity and efficacy of flossing. This project aims to determine whether flossing benefits dental health by analyzing its impact on the oral microbiome. For this study, 22 age-matched, high school juniors and seniors were blocked into three different groups: flossers, non-flossers, and a transitional group. Oral microbiome samples were collected from these volunteers 4 times over a period of 2 months. Next-generation sequencing data and bioinformatics analysis revealed that the oral microbiome of flossers is statistically different from that of non-flossers and that with habitual flossing, the oral microbiome of a non-flosser can change over time. Lastly, the study also found that non-flossers have significantly more gum disease-causing microbes present in their oral microbiome. Taken together, these results lend confidence that flossing is beneficial to dental health.

F26 Improving T-cell Engineering to Treat Leukemia by Identifying Cancer

Biology
Khanh Pham, Kevin Duong
Excel High

Our goal is to improve T-cell engineering to treat Leukemia by identifying cancer-specific antigens. We performed both Western blotting and immunofluorescence microscopy to determine the relative expression levels of surface proteins CD47, CD99, and CD123 on a few cell lines (Chronic Myelogenous Leukemia (K-562), acute promyelocytic Leukemia (HL-60), and CD34+ bone marrow progenitor cells) in order to evaluate which, if any of these proteins are more highly expressed on cancerous vs. non-cancerous cells. According to our preliminary data, we observed a faint CD123 band and multiple CD99 bands with expected protein sizes on the Western blots. Using immunofluorescence microscopy, we observed similar levels of CD47 expression in all cells tested, with perhaps a slight decrease in the CD47 expression in K562 cells. We also observed higher expression of CD99 in the non–cancerous cells compared to the cancerous cell lines tested. The results from our experiments suggest that further work is needed to identify optimal cancer-specific antigens and, in the future, additional cell lines can be tested. While both CD47 and CD99 are expressed on the cell surface, previous studies showed that CD47 acts as a "do not eat me" signal for macrophages. Research suggests that a potential next step may be an immuno-oncology approach in which one creates a drug to decrease CD47 expression specifically in cancer cells so that the body recognizes them as foreign and then attacks them as a cancer treatment.

G2 Comparing Normal Apple Gene and Diseased Apple Gene

Biology
Zifeng Liang
Miss Hall's School

In most instances, plants can grow up normally, however, some could not grow properly even from the beginning, due to the presence of abnormalities in their genomes. The most common genetic disorder happened on apple is the pale green lethal. Pale Green lethal seedling fail to turn green or fully developed. They are unable to photosynthesis due to a lack of chlorophyll. Farmers and agricultural scientists strive to find solutions and reduce the cases of genetic disorders on plants. In this project, I compare the genes of a normal apple and an apple of pale green lethal disorder by mapping the genes and comparing their sequence. The goal of this experiment is to identify the difference to see what is "wrong" with the abnormal genes.

G3 The Mystery of Fallopian Tube Cancer

Biology
Emma Kelly
Newton Country Day Sch/Sacred Heart

If the data of fallopian tube cancer patients' history of child delivery, hormonal contraceptive use, body mass indices, diets, physical activity, and breastfeeding as well as their geographic locations and their races are collected and analyzed, then the women who have more children, have used hormonal contraceptives for longer periods of time, had lower body mass indices, had adequate vegetable intake, adequate physical activity, and breastfed for a longer period of time would have a lower likelihood of developing the cancer, and that Caucasian women and Midwestern women will have a later stage cancer.The women who lived in the Midwest had a 35%chance of having an early cancer and a 65%chance of having a regional or distant cancer. Of the Caucasian women, 35%had early cancer and 65% had regional or distant cancer. The women who breastfed for 13-24 months and got fallopian tube cancer made up 17%of the group, but those in the control group made up 29%of the group. Women who had the most children in the 3 or more category for fallopian tube cancer patients comprised 18% of the group, and 27% of the control group had 3 or more children. Women who used hormonal contraceptives for 181-240 months and had fallopian tube cancer made up 2%of the group compared to the 9%of the control group women who did not use hormonal contraceptives. Over weight women comprised 49.3%of the patient group.The control group of women had around 31.1% of the group comprised of overweight women, proving a 20%difference between the control and patient groups. Lack of physical activity contributes to these increased body mass indices, especially since 69%of the patients were physically inactive and 89%of the patients had inadequate vegetable intake.In conclusion, the whole hypothesis was supported.

G14 Changes in Bacterial Community of Brined Pickles over Fermentation

Biology
Charlotte Kafka-Gibbons
Somerville High School

This experiment explores the changes that occur in the bacterial communities of brined pickles over the course of fermentation. To determine this, chopped cucumbers, water, and salt were placed into sterile wine bags and left to ferment for 21 days. Over the course of fermentation DNA was extracted and PCR (Polymerase Chain Reaction) was used to select and amplify the 16s rRNA gene. This gene is a crucial ribosomal RNA that is present and unique in every bacteria, making it extremely useful for genetic sequencing. The results show that heterofermentative lactic acid producing bacteria made up most of the genera that were able to survive and thrive in the environment of fermentation. Many of these bacteria are safe for human consumption and provide helpful probiotic benefits in the microbiome, especially benefitting colon health and the immune system.

G15 Bacterial Symbionts of Bathymodiolus Mussels Found in New Cold Seeps

Biology
Rebecca Cox
Falmouth Academy

This experiment analyzed how chemosynthetic gill endosymbionts of Bathymodiolus mussels collected from recently discovered cold seeps off of New England were related to the gill endosymbionts of Bathymodiolus populations from other sites. It was hypothesized that endosymbionts of Bathymodiolus mussels used in this experiment would be most closely related to methanotrophic endosymbionts. The 16S rRNA gene was PCR amplified and sequenced from the gill endosymbionts of 25 mussels collected on two HOV Alvin submersible dives from cold seeps in Veatch Canyon (depth of ~1444 m). Comparison of all sequences to the GenBank nt database via BLAST showed that all sequences were most similar to methane-oxidizing bacterial endosymbionts of Bathymodiolus mussels found at hydrothermal vents along the Mid-Atlantic Ridge. A maximum likelihood phylogenetic tree was calculated with 21 unique sequences after quality control and trimming. All mussel endosymbionts were within the methanotrophic clade with symbionts of mussels of the Mytilid family, mostly of the genus Bathymodiolus. PCR with primers specific for the 16S rRNA genes of sulfur-oxidizing endosymbionts of Bathymodiolus were used to test the Veatch Canyon mussels for their presence. Sulfur-oxidizer-specific amplification was positive in almost all of the mussels collected on one dive, but negative, or very weak, in the mussels from the other dive. This suggests that these collections may have inhabited distinct chemical environments, since the mussels from one collection host sulfur-oxidizers. The hypothesis was partially supported, since sequenced endosymbionts were in the methane-oxidizing clade, but sulfur-oxidizer specific primers revealed sulfur-oxidizing endosymbionts in mussels from one dive.

G16 The Correlation between Heart Failure and Renal Dysfuntion

Biology
Piyusha Kundu
Lincoln-Sudbury Reg. H. S.

Heart failure is one of the leading causes of mortality in the U.S. resulting in 610,000 deaths each year; accounting for about one in every four deaths. Heart failure reduces blood flow to the rest of the body, which can eventually cause kidney failure. More than 40% of heart failure patients suffer from chronic kidney disease. Looking into mechanisms that underlie the connection between the kidney and the heart could lead to possible therapeutics and are thus an important area of study. Indeed, this has been an active area of investigation. However, recent developments in the functionality of non-coding RNAs in heart disease suggest that further exploration of their role in the relationship between heart failure and kidney dysfunction is warranted. As such, I explore the relationship of the kidney and the heart in mice with heart failure, focusing on noncoding RNAs as important regulatory molecules.

G17 Buy Less, Save More: An Investigation in Apple Preservation

Biology
Vito Aiello
Martha's Vineyard Regional H. S.

This project is an investigation in apple preservation, where seven methods (freezing, blanching, refrigerating, use of ethylene gas absorber, use of a humidor, vacuum sealing, and refrigerating with vacuum sealing) were tested to see which was most effective in preserving apple freshness. The purpose in finding the most effective way to preserve apples, is to prevent the waste of money and produce as a result of rotten apples.
Initially I tested four of the methods (freezing, refrigerating, blanching, and refrigerating with vacuum sealing) on a single brand of apples (Gala). After interpreting the results of my first experiment, I repeated it on multiple apple brands. In the second experiment I introduced the preservation methods of vacuum sealing (without refrigeration), use of an ethylene gas absorber, and use of a humidor; I did not test blanching or freezing in my second experiment because they proved ineffective in my original tests. The humidor was used in order to test how apples would perform in a moderate humidity environment (humidity averaged 55%), as refrigeration proved to be a high humidity (avg 70%) environment, and household air a low humidity (avg 31%) environment. In both experiments an unaltered apple was observed over the time period for comparison.
Following a 20-day period, I performed an analysis of the apples and determined the most effective method to be refrigeration and refrigeration with vacuum sealing. All of the sample apples that utilized these preservation techniques were nearly on par with the quality of a fresh apple. Interior quality of all samples were also recorded and compared, with the same results being found.
The findings of this project are applicable to retailers, purchasers, and consumers of apples.

G18 How Much "Invisible" Fats Are in Common Snack Foods

Biology
Henning Anderson
Joseph Case High School

How much Fat is in common snack foods? Some foods such as meat or butter, you can literally see the fat within. But most foods you can’t do this so you can’t just estimate how much fat is in it. My experiment is to test the amounts of fats in common snack foods that have invisible fats in them such as chips, cookies, or crackers. I will do this by separating the fats (if any) from the food by using a method called solvent extraction. My hypothesis is if I add the solvent solution to common snack foods that cheese crackers will leave behind less fats than those of normal snacks, and anything fried or more greasy or a dessert item will produce more fats. I found that the Lorna Doones, a buttery shortbread cookie, was the snack with the most amount of fats within and the Vanilla Wafers were the snack with the least amount of fat. There is some uncertainty to my results which is recorded in the appendix because I added an extraction efficiency chart with comparisons of my percentages to the percentages on the nutrition label. To continue this I could use the same experiment but use low fat and regular versions of snacks to see really how different the two are.

G23 Analysis of the Ebola Glycoprotein from the 2014 Outbreak

Biology
Lauren Jiang
Boston Latin School

During the most recent (2014) Ebola outbreak, a mutation from alanine to valine in residue 82 of the Ebolavirus (EboV) glycoprotein (GP) became fixed in the population. Preliminary data suggests that this mutation makes the GP more resistant to 3.47, a small molecule inhibitor of EboV GP-mediated entry, and that this resistance to 3.47 is correlated with either increased binding to NPC1 (EboV receptor) or decreased stability of the GP. It is hypothesized that the size of the side chain at residue 82 affects the infectivity of EboV as well as its resistance to 3.47. Mutagenesis was performed to produce EboV GP-pseudotyped murine leukemia virus (MLV) particles with a mutation to phenylalanine (A82F). Three experiments were performed; two ELISA's to test for binding to NPC1 and GP stability and a 3.47 dose response to test for inhibition. A titre was also performed to gauge infectivity. Infectivity of the A82F mutant was tenfold that of the wild type in the titre. It was found that NPC1 binding is not a contributor to this but the GP of A82F is less stable than that of the wild type. The 3.47 dose response showed that A82F is also more resistant to 3.47 than the wild type.

G24 The Effect of Heat Indices on Dermestid Beetle's Decaying of Carcasses

Biology
Nikhil Khandekar
Acton-Boxboro Reg. H.S.

Museum curators and archaeologists have been investigating for years on efficient ways to remove flesh from dead bodies that they collect in order to have a skeleton for display. The most commonly used method is the application of Dermestid beetles, a species of insects which are known to be used for removing the skin off of dead organisms. However, in what conditions do these insects thrive the best is unknown to many. From my experiment, I am investigating on which heat indices, a term of measuring temperature and humidity, suits best for these beetles in order for them to decay their carcasses at a faster rate. Different methods were taken into account for measuring the success of each of the conditions given to the Dermestid beetles. Knowing this information, it can be of great help to curators and archaeologists in collecting skeletons in a more efficient way based on the beetle's rate of removing the flesh off a carcass when given a specific environment.

G25 How Sweet It Is!

Biology
Rania Benouannane, Anny Lemus, Illiani Plaza
East Boston High School

Carbohydrate consumption can be a big factor in maintaining peak performance during physical exercise. In fact, carbohydrates consumed in the form of glucose, from sports drinks, are easily broken down and enter the bloodstream to provide the exercising body with energy. Taking into account these facts, we wondered if commercially available sports drinks varied in the amount of glucose contained within. As a result, we designed an experiment that measures the variance of glucose concentration in various sports drinks.
The goal of this study is to investigate which sports drink Gatorade, Powerade, BodyArmor or Vitaminwater will have the highest glucose concentration level after three trials. If 2.5 mL of Gatorade has the highest glucose concentration when compared to 2.5 mL of Powerade, BodyArmor and Vitaminwater sports drinks, and the glucose concentration is measured by placing one Diastix urinalysis test strip into each drink for 60 seconds, waiting 10 seconds after each withdrawal, and observing any possible color change, using a color chart created by the Bayer pharmaceutical company, and prepared glucose concentrations of 0%, 2%, 1%, 0.5%, 0.25%, 0.125%, and 0.0625%, then Gatorade will have the highest glucose concentration of 20 % after three trials. The glucose concentration of each sports drink was calculated by comparing the volume of solute to volume of solvent (v/v).
Conclusion: It was found that after calculating the glucose concentration by using the sports drink Powerade had the highest glucose concentration of 4%. Gatorade came in second place with a calculated 1% glucose concentration. BodyArmor came in third place with 0.25 % glucose. Our hypothesis was incorrect that Gatorade would have the highest concentration of glucose.

G28 Myths of Multitasking

Biology
Abby Egan
Plymouth North High School

Multitasking is the performance of two tasks at once while still being effective and efficient at both.What if someone told you multitasking makes you less productive and more likely to make mistakes?Studies have shown that multitasking isn’t the most productive or effective way to do things.Stereotypically, women are considered the better gender at multitasking.But, if this is true, shouldn't women be getting the higher status jobs to make sure they run more effectively and effieciently?This experiment tested which gender is better at multitasking.Boys and girls from grades 3-8 were asked to copy an excerpt from a book and the number of words written in two minutes was recorded.Each trial had various distractions added and their effects on the words written were recorded.The results for grades 3,4,7, and 8 supported the hypothesis that girls are better at multitasking than boys.In grade 3, there was an average increase of 34% in girls and 13.6% in boys.In grade 4, there was an average increase of 25.5% in girls and 19.2% in boys.In grade 7, there was an average increase of 23.5% in girls and 16.1% in boys.In grade 8, there was an average increase of 24.8% in girls and 24.4% in boys.In grade 5, however, the hypothesis was rejected because the girls only averaged 17.7% increase, while the boys averaged 18.2%.By testing 3-8 grade boys and girls, it showed that girls were better at multitasking.As age increased, the gap between the boys and girls ability to multitask decreased because the brain development between genders got closer as they got older.This project was done to see what gender is better at multitasking and also to see what gender could handle things better in a greater setting.When you are looking for people to run multiple things, they should hire a woman.

H2 Effect of Microbiota on the Thermal and Lead Tolerance of Nematostella

Biology
Violet Xiao
Falmouth Academy

The purpose of this study was to find out the effect of marsh microorganisms in marsh area on Nematostella vectensis at extreme temperatures and when exposed to lead nitrate (Pb(NO3)2). It was hypothesized that the anemones cultured with marsh microbes would exhibit both a stronger tolerance to temperature extremes and to lead nitrate than those cultured without marsh mud in lab culture. There were three trials in the experiment, each containing a lab condition group and a marsh-condition group. The first temperature trial had 30 anemones in each group, tested at 40.2-38.2 ºC for six hours in a thermostat. The second temperature trial had 30 anemones in each group, tested at 39.0ºC-35.0ºC. The toxicity trial had 40 in each group tested at 0, 100, 1000, 2500, 5000 µg/L lead nitrate at 37ºC.The result shows that the lab cultured anemones had a higher average survival rates at extreme temperature which is 28.34%, and marsh group anemones had a higher average survival rates with lead nitrate which is 40%. The hypothesis was partially supported because the anemones exposed to mud conditions had a higher tolerance to lead nitrate, but they had a lower tolerance to extreme temperatures. Using a model animal to test the effect of marsh microbiota can be helpful because determining the nature of interactions between microorganisms and Nematostella vectensis (the starlet sea anemone) will advance people's understanding of how microorganism contribute to the physiology and ecology of the anemone holobiont.

H5 What are the Effects of Artificial Sweeteners and Sugar on Plant Life?

Biology
Christopher Landry
Calvary Chapel Academy

The purpose of this project was to find out the effect of different sweeteners on plant life. The question was, what are the effects of various sweeteners on plant life? The hypothesis was that the Equal sweetener and the Sweet'n Low will be the most harmful to the plants, while the Stevia and the coconut sugar will not be harmful to the plants. The independent variable is the different sweetener the plant is being exposed to. The dependent variable is the growth of the plants, measured in height. The control variables are the types of plants, I used ferns, the amount of water given to each of the plants, and the location the plants were put in. During the experiment, four plants were planted in a mixture of soil and a sweetener, and one was left with just soil to serve as a control group. The sweeteners were Equal sweetener, Sweet'n Low, coconut sugar, and Stevia. Over the next few weeks the height of the plants were monitored to see how quickly they would die. The results of the experiment were that the Sweet'n Low caused the decline of the plant most quickly, followed by the Equal Sweetener, then after that was the Stevia, and finally the coconut sugar. The hypothesis that the Equal Sweetener and Sweet'n Low would cause the plant's health to decline the fastest while the coconut sugar and the Stevia would be the least detrimental was supported by the research, as the Equal and Sweet'n Low caused the plant's health to decline the most quickly, while the Stevia and the coconut sugar were not harmful to the plants.

H11 Calcium Carbonate Vent Influence on Aspects of a Meiofaunal Community

Biology
Emma Keeler
Falmouth Academy

The purpose of this experiment was to assess the ability of a simulated serpentinization vent to support a diverse meiofaunal community over 6 weeks, and to assess the spatial patterns of a that community at varying vent proximities. With a focus on six different calcareous or agglutinated foraminiferal species. Also, to determine if the presence of a hydrothermal vent affects the physical composition of the surrounding hemipelagic marine mud and foraminiferal species, on a microscopic level. Foraminifera form an important link between bacteria and macrobenthos in benthic food webs and thereby play a major role in biogeochemical cycling. 1.5 liters of sediment containing a meiofaunal community were collected and divided up into the two tanks (Control and Vent). After the vent exposure period, a CellHunt Green incubation stained their cytoplasm, permitting live individuals to be detected and analyzed. The vent proximity promoting the highest diversity of forams was Zone 2, where all 6 species appeared. The lowest diversity was from the Control, which also had the highest number of individuals (all Miliammina fusca). Agglutinated species were much more populous throughout the experiment, while calcareous species were only present in the two zones closest to the vent. There were striking microscopic differences in density and calcium carbonate precipitation or vegetation content in sediment samples from each zone. In conclusion, a hydrothermal vents possesses the ability to host a meiofaunal community and has significant effects on the test building processes of the both agglutinated and calcareous species of foraminifera.

H17 Fixing Oxidative Damage: The Effect of Antioxidants on Telomere Length

Biology
Nicole Tanenbaum
Taunton High School

Poor lifestyle choices can cause an excess of free radicals that shorten telomeres, the end caps of chromosomes that have been linked to cellular senescence and premature aging. Since antioxidants can donate electrons to free radicals, this experiment is testing whether the antioxidant green tea can repair telomere damage in the organism Daphnia pulex. Based on the research collected, it was hypothesized that Daphnia pulex exposed to oxidative stress and given an antioxidant treatment would have longer telomeres than those exposed to only oxidative stress. To test this, four cultures were exposed to oxidative stress via hydrogen peroxide, four were exposed oxidative stress and given antioxidants, and the other four cultures received neither to serve as a control. DNA was then extracted from the Daphnia and examined using gel electrophoresis. Calculating the distance the dye in the gels moved and the distance the bands moved and finding their ratio (the RF value) allowed for the lengths of the fragments to be compared. However, the fragments could not be measured in base pairs because the DNA reference ladder moved off the gel. Based on the data that was collected, the RF values of the telomeres exposed to hydrogen peroxide and antioxidants were the highest with mean RF values of 0.90 opposed to 0.83 in the 1.25 mg/ L solution and 0.86 opposed to 0.82 in the 2.50 mg/L solution ($p<0.0001$), meaning they had the shortest telomeres, rejecting the proposed hypothesis. This is most likely because green tea has also been shown to have oxidative properties. To address this discrepancy, a different antioxidant could be tested or the tea could be altered to insure that it is not oxidizing. Additionally, a thicker gel could be made so smaller fragments of DNA could be viewed.

H22 Analysis of Favorable Environments for Growth of Probiotic Bacteria

Biology
Shefali Singh
Falmouth High School

Probiotics in yogurt are widely accepted as a beneficial agent in cleansing gut bacteria along with other health benefits. But which environment promotes the most increase in probiotic growth? To answer this question, milk was boiled and then different substances were added in an effort to aid probiotic growth. An equal amount of samples received inulin, a prebiotic, starter culture, which contained probiotics of Lactobacillus casei, Bifidobacterium longum, Lactobacillus bulgaricus, Streptococcus thermophilus, and Lactobacillus acidophilus, both, or neither. An equal amount of samples were incubated in either 37 degrees celsius or at room temperature, as well as in a Gas Pak with a controlled CO2 environment, and air. These samples were then observed micro and macroscopically. Looking at the samples after they were left overnight showed that the cultures with no starter had not formed yogurt, showing that it was in fact the starter that made yogurt, not another factor. Each culture that had been left in room temperature did not make yogurt. Using fluorescent probes, it was revealed that microscopically, both in the cultures with no starter and starter, Streptococcus was the most abundant, but inulin did not foster as much bacteria. The no starter culture also fluoresced under the firmicute and universal probe, showing that there were bacteria even in the culture with no starter. However, it was 100% a firmicute, because there were no bacteria that responded to the Streptococcus probe. The bacteria could be lactobacilli, but it cannot be confirmed. In conclusion, the environment that promotes the most bacteria is one with air, 37 degrees, no inulin, and starter culture. The type of bacterium that flourishes in these conditions most is the Streptococcus.

H23 The Effects of Huperzine A and Memantine on Hermissenda Crassicornis

Biology
Helena Weare, Isabelle Stewart
Falmouth Academy

The purpose of this experiment was to test the effects of different enhancers on Hermissenda crassicornis, to observe their benefits on the animal’s learning and memory. It was hypothesized that Huperzine A and Memantine, enhancers used as possible treatments for Alzheimer's Disease, would improve learning and memory, and that Huperzine A would enhance memory better than Memantine. The Hermissenda crassicornis were exposed to either natural seawater (control), Bryostatin (the positive control group), Memantine, or Huperzine A, and conditioned using the Pavlovian technique, by using the stimulus light and the unconditioned stimulus of orbital shaking. This elicited a conditioned response in the animals, a contraction of the foot. 24 and 48 hours later the learning and memory were tested by using only the neutral stimulus light to stimulate the conditioned response. During both weeks of experimentation, both enhancers elicited a learned response in the H. crassicornis, shown by foot contraction. 24 hours after training, in both the first and second test Memantine exhibited a greater learned response than Huperzine A. 48 hours after training, Memantine exhibited a greater learned response than Huperzine A in the first test, in the second test Huperzine retained memory better than Memantine. Both Memantine HCl and Huperzine A were beneficial to learning and memory, but Memantine HCl showed a slightly better memory improvement than Huperzine A. The positive results of the enhancers on H. crassicornis could be translated to possible treatments of Alzheimer’s Disease and other forms of impaired memory.

H26 Characterizing the Biomechanics of Runners

Biology
Aman Saiju, Lucas DiCerbo
Lexington High School

What does a runner's ideal stride look like? This fundamental question has been asked countless times in the world of athletics, with each study seeming to create a new "perfect way" to run. The problem, however, is that not all runners are created equal. While previous studies attempted to analyze the stride of individual runners, we focused on establishing relative trends in sprinters as compared to those of distance runners in our experiements. Additionally, we developed an economical and portable pressure sensor technology to perform our research. We hypothesized that sprinters stepped more on the front (ball) of their foot, while distance runners stepped more on the back (heel) of their foot. We also hypothesized that a trained runner will maintain his/her running style irrespective of the distance. We built the "A-RUN", an Arduino based unit that uses pressure sensors in the shoes of test subjects to measure relative pressure exerted by the runners on the ball versus the heel of their foot. We also wrote the software to capture the data from A-RUN remotely while the subject was running. Our results show that sprinters exert more force on the ball of their foot than their heel, while distance runners exert more force on the heel than on the ball. This holds true no matter the distance, as these patterns persist when sprinters run distance events and distance runners run sprinting events. These findings could potentially be used to characterize or identify the natural style of a new runner or to provide a baseline against which to measure a runner recovering from injuries. Our technology - due to its low cost, portability, and ease of use - can be universally applied in the athletic world, no matter the budget, location, or circumstance.

J3 The Value of Plants in Our Soil

Biology
Lauren Menzel
Westfield High School

The purpose of my experiment was to see which soil medium would purify the purest and least amount of groundwater. The initial idea was that soil with plants and organic material growing in it would strain less groundwater that would be more pure then soil without plants or organic material because of a process known as phototechnology and its subgroup photoremediation. This process uses plants to purify the water and the overall environment. The two different soil mediums, one that included an organic material mixture along with plants and the other that was just plants, created the basis for the experiment that was compared to the control of plain dirt. After 2 hours of allowing the water to seep through the soil mediums and into a container, the filtered groundwater was measured and recorded. 1 cup of water seemed to be enough but as the experiment went on the plants needed to be watered with 2 cups of water to output any groundwater. The groundwater itself was different shades of brown therefore the pureness of the groundwater was determined by color. The plants in plain soil had the least amounts of groundwater output over the entire experiment. It also had the lightest shade of brown throughout the experiment. This means the soil medium with plants and the organic material did not do as good as originally thought. The soil produced average color and amounts of groundwater. The plain dirt had the highest and darkest amounts of groundwater. Overall the project demonstrated the effects of different soil mediums in relation to the groundwater and the importance of photoremediation. In turn the plants and their deep roots purified the water best.

J6 Candida Communities:Comparing Biofilm Growth on Catheter Surfaces

Biology
Janelle Carmichael
St. Mark's School

Candida is a genus of yeast that has been known to cause fungal infections in humans. While most Candida species are nonpathogenic, over twenty species of Candida are the source of Candidiasis, an invasive fungal infection that occurs when fungi enter the bloodstream or penetrate the mucous membranes that line the body's cavities and organs (CDC, 2016). Many cases of Candidiasis are associated with biofilms on indwelling medical devices ,e.g. catheters or prosthetic heart valves (Kojic, 2004). Candida biofilms are colonies of yeast that are embedded within a polymeric matrix (Mukherjee, 2005). To form a biofilm, Candida must adhere to a surface, which in hospitals is often an indwelling medical device. If the infected device is not taken out, a patient can develop an infection. Consequently, Candida infections of medical devices are associated with an increase in cost of care and length of hospital stays (Pfaller, 2007). This research focuses on the ability of Candida albicans to form a biofilm on different materials that are commonly used in catheters. These materials are squares of rubber, silicone, and polyvinyl chloride (PVC). To each square, Candida cells were applied in well-plates. After an incubation of 72 hours, the biofilm on each square was measured by taking the dry weight. The dry weights were averaged to form a conclusion about the catheter material that is less likely to be colonized by Candida.
Data is yet inconclusive, but results from this investigation can help assess the risk of Candidiasis that come with inserting a certain catheter in a hospital patient.

J9 On the Prediction of HIV-1 Drug Resistance to Integrase Inhibitors

Biology
Vivek Bhupatiraju
Lexington High School

The human immunodeficiency virus, or HIV, is responsible for causing the AIDS pandemic and killing millions of people around the world. To combat the virus, a variety of drugs have been developed to inhibit enzymes in key steps of HIV's life cycle. This project seeks to test the viability of new machine learning methods in the prediction of drug resistance to integrase inhibitors. Past studies have not used important physicochemical properties as features or tried various neural network architectures to obtain better accuracies.
HIV drug resistance data, in the form of amino acid sequences and fold resistance values, was taken from Stanford HIVdb. Processing of the data was done in Excel and Python, after which a variety of machine learning algorithms were run. The first set of algorithms was run using scikit-learn, which included support for SVMs, KNN and decision trees, while the second set was run using TensorFlow, which included the multi-layer perceptron and the recurrent neural network.
After tuning hyperparameters, the algorithms showed good accuracy (75%), on par with those in previous works. In addition, the work provides the first machine learning classifier for integrase inhibitors and strong support for the use of new physicochemical properties in drug prediction algorithms and for incorporating structural information into training neural networks. These results can be used to better design treatment regimens for HIV patients and to develop more powerful predictive algorithms for general drug resistance.

J13 Yeast Lab: Antifungals

Biology
Caitlin Terpak
Berkshire Arts & Technology Charter Public School

Fungi grow by releasing digestive enzymes to absorb carbohydrates and the antifungals prevent the growth by blocking the enzymes from being released. Athlete's foot medicine will prevent the most yeast growth because it heals infections faster than ringworm medicine. The solutions were made, the baker's yeast was added, and the growth was measured over the course of a little over 2 hours. After a little over 2 hours the control with no antifungal was at a height of 4.3 cm, the Cinnamon Oil was at 3.3 cm, the Tea Tree Oil was at 3.5 cm, the Athletes Foot Medicine was at 6.5 cm, and the Ringworm Medicine was at 6.3 cm. The hypothesis was incorrect and the yeast with the two medicines overflowed over the cups they were in. Another experiment that could be done is seeing which substances would promote yeast growth.

J14 Automated Plant Monitoring System

Biology
Mya Cohen, Mary Schmitt
Bourne High School

Many plants die each year due to poor care by owners because of forgetting to water their plants, watering them too much or too little. Our goal is to build a water pump that waters plants and regulates the levels of moisture in soil to correct how much water is needed for plants to survive using microprocessors.
Our Engineering Design Process Included:
1.) Research water needs for plants, how to build a pump, the materials needed for building and coding of pump (the part that measures moisture levels).
2.) Build prototypes (light only, moisture senor and LCD screen)
3.) Test our project
4.) Improve any problems/Fix them
5.) Test Again
6.) Communicate/Share our results at the Science Fair

J15 Inhibition of the GPD Genes in C.elegans Due to the Presence of Sugar

Biology
Connor Casey
Leominster High School

Diabetes is an epidemic that affects the United States. As of 2012, 21 million Americans have been diagnosed with diabetes. Type 2 diabetes is the most common form of diabetes. This type of diabetes is also preventable.Caenorhabditis elegans is a model organism in genetics and microbiology because they have a short life-span, are inexpensive to maintain, and they have their whole genome mapped out. Wild-Type and mutant gpd-2 Caenorhabditis elegans were grown in sucrose environments, glucose environments and the normal environments. To see the effects of the sugar on the nematodes, a rtPCR was run to determine the gene expression of the targeted genes. The rtPCR was testing for the gene expression of the gpd-1 and the gpd-2 genes. These genes code for the proteins Glyceraldehyde-3-phosphate dehydrogenase 1(gpd-1) and Glyceraldehyde-3-phosphate dehydrogenase 2 (gpd-2). These proteins are essential in the process of glycolysis because they synthesize pyruvate from D-glyceraldehyde 3-phosphate. Pyruvate is an organic acid that can be formed into the coenzyme acetyl-CoA or the amino acid alanine. Based on the results of my experiment, glucose inhibited gpd-1 and gpd-2 gene function, while sucrose made these genes function better. This discovery suggests that humans consuming glucose can lead to inadequate gpd-1 and gpd-2 gene function. This could lead to the development of Type 2 diabetes. The amino acid alanine is an essential part of the Cahill cycle (also, called the Alanine cycle). In the Cahill Cycle, pyruvate is first produced through glycolysis. Pyruvate is then transaminated into alanine. The reaction is catalyzed by alanine transaminase. An excess of alanine transaminase had been contributed to the formation of Type 2 diabetes in humans.

J18 The Best Bend

Biology
Haylee Hartung
Taunton High School

The main point of this project is to figure out which position as a catcher, in either baseball or softball, is the most ergonomically correct for the knee. With the research gathered, the hypothesis that was developed is that the larger the angle the knee is at, the less tension put on the knee. To test this experiment a homemade knee model is used the spring, to measure the tension put on to the knee. If the catcher squats repetitively, but incorrectly or in a position that puts a lot of tension on the knee it can cause minor or severe injuries to knee.The four angles measured were when the knee was at rest (120 degrees), 90 degrees, 65 degrees, and 45 degrees. The knee model was put at each of these angles and then the spring was measured for each angle to see the difference in extension, which would represent tension.The data supports that the greater the angle the knee is at the less tension that is put onto the knee. This experiment was done to give catchers from softball or baseball, a better way to be in the squat position and with less risk of causing injury.

J21 The Effects of Global Warming on the Bourne Community Sea Level

Biology
Michael Bonito, Foster Rubinstein
Bourne High School

The problem we are addressing is how sea level rise is affecting Cape Cod due to global warming and the causes on wildlife. Much of the lower parts in elevation of the Cape will soon be affected by rising sea levels and will have a major effect on habitat and the environment for animals and people of Cape Cod.
-Design laser cut topographic map with laser cutter
-Place the cut outline in sandbox
-Analyze future /predicted sea level rise in elevation, the change of global warming in 10 years difference
-Conclude with overall affects of life/habitats/environments of people and animals due to the ongoing ride in sea level

J25 Investigating Lung Toxicity in Breast Cancer Patients

Biology
Rhedise Bass
Somerville High School

Current radiotherapy practice uses a scaling factor of 1.1 to transfer between proton and X-ray prescription doses. If the scaling factor is valid then we would expect the radiation-induced lung damage to be the same for breast cancer patients treated using either protons or X-rays. We studied CT scans for 9 pairs of proton/X-ray patients, with each pair carefully matched in terms of age, chemotherapy protocol and which breast was treated. In order to compare each patient's pre- and post-treatment CTs we performed a deformable registration where we masked the lungs to ensure that the normal tissue in the pre-treatment CT was not warped to match the radiation-induced lung injury. Across both CTs we extracted dose and CT density values for every voxel in the irradiated lung, so we could investigate the relationship between the change in CT density and dose. Follow-up time points for the x-ray and proton cohorts were well-matched (mean difference =56 days) relative to the long-term timescale of radiation-induced damage. For both cohorts we applied a one-tailed Spearman's rank order test to test for correlations between dose and change in CT density. 9/9 proton patients exhibited correlations statistically significant at the 5% level while only 6/9 x-ray patients did so. For the patients with significant correlations the mean changes in CT density were 0.61 HU/Gy (range 0.19-1.35) and 1.82 HU/Gy (range 1.08-3.31) for the x-ray and proton cohorts respectively, with inter-pair differences statistically significant at the 5% level (Wilcoxon signed-rank test). Our findings suggest that the scaling factor of 1.1 underestimates the radiation-induced lung damage caused by protons as they slow down and stop.

J26 Understanding FUS Mutation Mechanisms in the Cells of ALS Patients

Biology
Snigdha Allaparthi
Lexington High School

Amyotrophic Lateral Sclerosis (ALS) is a neurodegenerative disease that leads to motor neuron degradation, and in many cases, paralysis and eventual death. Fused in sarcoma (FUS) mutations have been specific to familial cases of ALS and have been noted to interfere with RNA (ribonucleic acid) processes within the cell. In this project, the main focus was to find significant RNA expression changes between the wild-type and mutant FUS cells from ALS patients. This project was completed by taking the fibroblasts from control and mutant FUS-ALS patients, which were then converted into neurons through protein and gene expression changes. Then, immunofluorescence was used to visualize the mislocalization of the FUS protein in fibroblasts and to confirm the presence of certain neuronal markers in the neurons to ensure proper conversion. Through the use of RASL-sequencing, two exons within neuronal RNA, GOLPH3L exon 4 and BBX exon 14, were found to be misregulated in almost all of the converted mutant neurons. By performing RT-PCR, the results clearly demonstrated that the mutant FUS cells have a higher inclusion of GOLPH3L exon 4 and BBX exon 14, thus showing that there is an RNA splicing misregulation between mutant FUS and control FUS RNA. This project gives a conclusive answer to the hypothesis, suggesting that there is a link between FUS mutations and RNA alterations. The future applications based on this project are immense as the RNA splicing readouts can be used as a method of testing for specific drugs in order to reverse mutant FUS effects and alleviate disease symptoms.

J27 Quantitatively Comparing cECM Protein in Different Scenarios

Biology
Anders Knudsen
Cambridge Rindge & Latin High School

The damage surrounding the area of a myocardial infarction has lasting negative effects on the heart tissue.The purpose of the project is to investigate the effects of fractionated cardiac extracellular matrix (cECM) peptides on cardiac fibroblasts (CFs), in an attempt to simulate the in vitro environment post myocardial infarction. The peptides were fractionated by size and tested for their ability to stimulate cell proliferation and activation.
The peptides were generated by pepsin digestion, and separated by SDS-PAGE. The proteins were then eluted from the gel and purified using methanol precipitation. CFs were plated at 20,000 cells/cm2 and supplemented with transforming growth factor β1 to initiate fibroblast activation, as would occur after myocardial infarction. The CF's were fed on days 0 and 2 with serum-free media supplemented with the fractionated cECM.
On days 2 and 5 the CFs were fixed, stained with antibodies of Ki-67 for proliferation and alpha-smooth muscle actin for activation, and imaged. The images were analyzed using a custom CellProfiler pipeline. Initially the CF's decreased proliferation at day 2, but gradually increased beyond the baseline at day 5. In initial experiments, fraction 1, the largest subset of peptides, had a statistically significant reduction in proliferation at day 2 based on the Holm-Bonferroni method.
In summary, the reduced cell proliferation on day 2 with fraction 1 showed potential for limiting scar tissue expansion. The increased cell proliferation on day 5 indicates that there may be ways to increase CF proliferation using cECM peptides. Furthermore a method for separating protein and eluting protein using SDS-PAGE gel was developed in the course of these experiments.

J28 Eliminating E. coli

Biology
Jocelyn Botelho
Taunton High School

In this experiment, different hand cleansing products were tested to see which killed the most bacteria. Four hand cleansers were tested: liquid hand soap, foam hand soap, scented hand sanitizer, and unscented hand sanitizer. The hypothesis is "The most effective product to remove bacteria is liquid hand soap because it has a higher concentration of active ingredients, therefore more bacteria will be removed." For this experiment, the bacterial strain E. coli K-12 was grown on petri dishes. Filter paper disks were dipped into each hand washing product and placed in the middle of each petri dish containing E. coli. The clearing around the filter paper disk which indicated no bacteria were present was measured in millimeters every 24 hours over 72 hours. This was measured by holding the plate up to a bright light and measuring through the widest part of the ring around the filter paper disk. Liquid hand soap killed the most bacteria after the first 24 hours with an average of 11.25mm. Foam hand soap killed the most bacteria after 48 hours with an average of 19.25mm. Liquid hand soap killed the most bacteria after 72 hours with an average of 24.1 millimeters. In conclusion, the liquid hand soap killed the most bacteria, offering the most protection against disease.

K1 How Do Circulatory Diseases Affect the Rate of Blood Flow?

Biology
Madyson Medeiros
Joseph Case High School

The objective of this experiment is to research and discover how different circulatory diseases, including atherosclerosis, arteriosclerosis, and an aneurysm, affect the rate at which blood flows through a blood vessel. The hypothesis stated that if a circulatory disease, such as atherosclerosis, arteriosclerosis, or an aneurysm, has infected the blood vessels needed to transport oxygen and nutrients throughout the body, then the rate of blood flow will decrease because the buildup of plaque will narrow and harden the vessel itself. Four different types of tubes were used to represent the blood vessels: a healthy blood vessel, atherosclerosis, arteriosclerosis, and an aneurysm. The results of the experiment concluded that as the plaque builds up within the blood vessel, the rate of blood flow decreases significantly. The healthy blood vessel test had the quickest average rate of flow, while the arteriosclerosis and atherosclerosis tests had the slowest average rate of flows. The aneurysm test had fast times as well, but there was also a loss of water after some tests. To conduct this experiment, a large wooden structure was constructed to hold pipes and tubing in which the water was placed and released out of until all the water had returned into a beaker placed at the bottom of the tube. Each tube was tested seven times and a stopwatch was used to measure the time. The uncertainty of this project is that the viscosity of water is lower than that of blood so the flow of real blood would produce different results. Also some water may have been lost throughout each test. In order to continue experimenting, it would be best to make the tubes longer so that the distance the water traveled would be more realistic to the human body's blood flow.

K2 What Antibiotic is E.Coli Susceptible to?

Biology
Peter Nguyen
Taunton High School

The most commonly used antibiotic to treat bacterial infections are penicillin and gentamicin. They are both from different antibiotic families therefore different kinds of antibiotics will be tested on bacterial infections. These antibiotics are used to treat individuals infected with a form of bacterial infection. The hypothesis for this experiment is if E. Coli is susceptible to the drug Penicillin, then the zone of inhibition will be larger compared to gentamicin because penicillin treats illnesses whose symptoms are closely related to E. coli such as pneumonia. The purpose of the experiment was to note what antibiotic is E. coli, or any other bacterial infections, is most susceptible. This experiment is designed for patients who are infected with E. coli. The procedure of this experiment was to first pour agar on bacterial plates, streak the E. coli on the agar plate using aseptic technique, and distribute the bacteria evenly around the plate, finally embed the antibiotic disk on the streaked plate. After testing the variables in the experiment, it is evident that the hypothesis was incorrect based on the data; gentamicin records a larger zone of inhibition thus E. coli is more susceptible to gentamicin than penicillin. Gentamicin recorded growth on the first day for all trials while penicillin had no effect. The data collected proves that gentamicin is more effective than penicillin in treating patients with E. coli infections.

K10 The Role of Autophagy and Signaling Pathways on Cancer Cell Growth

Biology
Ryan Han
Winchester High School

Autophagy is the intracellular degradation system by which materials in the cytoplasm are degraded in lysosomes. This system supplies nutrients to cells and allows for metabolism in conditions of starvation and nutrient deficiency. While autophagy suppresses cancer cell proliferation in some cases, it promotes tumorigenesis in the majority of situations. The hypothesis is that the dual treatment of autophagy inhibitors and various inhibitors for cell proliferation pathways would prove the most effective in the inhibition of several cancer cell lines. The target proliferation pathways include ERK (Extracellular signal-regulated kinases), mTOR (Mechanistic target of rapamycin), and PI3K (Phosphoinositide 3-kinase). Various cancer cell lines will be tested, including breast cancer, prostate cancer, and glioma cancer cells. The effects of autophagy inhibitors/activators and signaling pathway inhibitors on the cancer cell proliferation and cellular signaling pathways will be evaluated. At the conclusion of my experiment, I will determine which combination treatment is most effective in inhibiting cancer cell proliferation.

K12 How Much Bacteria Is on Your Toothbrush?

Biology
Halimo Ali
Madison Park Tech Voc HS

Bacteria can easily develop on your toothbrush because you use it so often to clean your teeth. The purpose of this project was to see how much bacteria my toothbrush accumulates within a week. I used two toothbrush to see the difference in bacterial growth. I compared the bacteria on my old toothbrush to my new toothbrush before and after use by growing the bacteria on petri dishes. All three samples of my old toothbrush formed bacteria. All three samples of my new unused toothbrush formed mold but no bacteria. Two samples of my new toothbrush on day one of use formed bacteria, and on day two there was no bacteria found all three samples. To conclude, my data shows that the longer you use a toothbrush the more bacteria it accumulates because my old toothbrush formed bacteria rapidly.

K13 Capping Cancer: Cancer Prognosis through Telomere Length

Biology
Rohit Chopra
Community Charter School of Cambridge

In order to confirm the relationship between telomere length and cancer prognosis, we performed a Meta-analysis, which is a statistical procedure to combine the data from multiple studies to a gain understanding about the true effect size. Our meta analysis showed that cancer patients with shorter telomere length had a significantly worse prognosis for overall cancer survival.

K14 Designing Guide RNAs for CRISPR Genome Editing

Biology
Katherine Lim
Lexington High School

The Clustered Regularly Interspaced Palindromic Repeats/CRISPR associated protein (CRISPR/Cas) genome editing system can generate double-strand breaks (DSBs) at target sites in DNA and introduce desired genetic changes at those sites. CRISPR/Cas can genetically alter organisms such as Escherichia coli (E. coli), and in cancer therapy may be used to block PD-L1, a protein that can promote immune evasion and tumor cell growth. To investigate the efficacy of CRISPR/Cas9 in making a K43T mutation to the gene coding for the 30S ribosomal protein S12 (rpsL) in E. coli HME63, thus conferring resistance to the antibiotic streptomycin (strep), eight samples of E. coli HME63 (7 controls, 1 experimental group) were grown on strep media. Only the experimental group contained all CRISPR/Cas9 components, and it was predicted that the E. coli would grow only in this group. However, similar E. coli growth occurred in all groups. Troubleshooting experiments were conducted, and the second experiment's results were consistent with the original hypothesis. This shows that CRISPR/Cas9 is effective in making a K43T mutation in E. coli HME63, and by extension may be effective in producing other types of genome mutations. Various guide RNAs were then designed for making the same mutation in E. coli HME63 and for editing the CD274 gene coding for PD-L1 in humans. Their computational on-target and off-target effects were compared to determine which ones would be optimal to test in a laboratory setting. Future research will focus on experimentally testing, if possible, the selected guide RNAs for their cutting efficiency (ability to produce DSBs) at the target sites, and testing the effects of editing the CD274 gene on tumor cell growth.

K16 The Effects of Turmeric and Bovine Collagen on the Regeneration of Dug

Biology
Imane Bouzit
Pioneer Charter School of Science II

Infection and other factors that inhibit tissue regeneration pose a major challenge in medicine. However, research about regeneration capabilities, particularly in the model organism of the planarian, has the potential to resolve such medical concerns. In this project, Dugesia dorotocephala was exposed to turmeric (a natural antibacterial and antioxidant) and bovine collagen (a structural protein) solutions of 600ppm, 400ppm, and 200ppm after decapitation to determine the effects of the two compounds on tissue regeneration. It was hypothesized that both collagen and turmeric would increase regeneration rates, with higher turmeric levels being the most effective. Planaria were decapitated below the eyespots and randomly assigned a treatment type with Poland Spring water as the control. Images under 4X magnification were taken every two days for two 9-day trials and tissue areas were measured using ImageJ software. Statistical analysis revealed that only the 200ppm collagen sample planaria in the second trial had significantly greater regeneration rates compared to the controls, with an average blastemal size increase of 0.76mm² by the final trial day (based on a Student's t-test with a p-value of 0.07 and alpha level of 0.1). Therefore, the hypothesis was rejected, although the goal of determining impacts of the two compounds was still reached. Additional research must be conducted with a larger sample size and combinations of both collagen and turmeric for maximum regeneration.

K17 Battle of the Bandages

Biology
Daisha Joseph
Bishop Feehan High School

No matter how the size or depth, one tends to bandage their wound. One would wonder which wound dressing is the right one for their injury with the array of choices available. The objective of this research is to determine how effective different types of bandages are when protecting the human body as it repairs. The hypothesis states that bandages with Manuka honey would be the most effective in protecting a small incision compared to regular bandages and liquid bandages. There were expectations that there would be no penetration for the solid bandages, some for the liquid bandage and complete penetration for the control group in for all three experiments. For the procedure, there were four groups tested: the bandages with Manuka honey, regular bandages, liquid bandages, and the control group. The closest thing that could mimic a cut on human skin was pig skin. To test the effectiveness of the bandages, there was a set of three mini trials that stimulated dirt/sand, airborne particles, and measured how waterproof they were. To stimulate dirt, sea salt was sprinkled over the wound and each group was compared to see which the most sea salt in the water. To stimulate airborne particles, dyed water was sprayed over the groups to see which one would have the most water penetrate the the dressings. To measure how waterproof the bandages were, water was sprayed over the bandages for a set amount of time to see if any went through. These mimic some of the most common things bandages are made to withstand. The results of the experiment shows that the hypothesis was incorrect as all three bandages withstood the three mini trials. The data from the three experiments were consistent, meaning all three bandages are effective enough to withstand water, dirt, and airborne particles.

K23 miRNA Targets for the Prevention of Drug Resistance in Cancer Cells

Biology
Seo-Hyun Yoo
Lexington High School

Chemotherapy is one of the major approaches to treat cancer patients, especially those who have progressed into a late stage. However, chemotherapy treatment suffers seriously from multidrug resistance (MDR), which is the pumping out of anticancer therapeutics from cancer cells by transmembrane MDR proteins. Currently, there is no way to stop multidrug resistance from occurring. Recent discoveries thrust miRNAs into the spotlight as a potential method for preventing drug resistance. MiRNAs are recognized to show systemic effects on cell survival, and are able to affect many proteins simultaneously, including MDR proteins. This project focuses on finding miRNAs that can regulate MDR proteins by managing their corresponding mRNAs levels (post-transcriptional regulation). ABCB1/MDR1, ABCC1/MRP1, ABCG2/BCRP, and MGMT are the representative MDR proteins for this project. Overall, 27 miRNAs showed correspondence with ABCB1, 79 miRNAs showed correspondence with ABCC1, 101 miRNAs showed correspondence with ABCG2/BCRP, and 18 miRNAs showed correspondence with MGMT. These miRNAs were found using their correspondence with the translated and untranslated regions of the mRNAs. Out of these miRNAs, only four miRNAs for ABCB1, nine for ABCC1, seven for ABCG2, and two for MGMT showed high enough sequence matching with the target mRNAs to pass the criteria determined in this project. Comparison with information from prior scientific papers was used to determine miRNAs with a higher chance than those currently researched of effectively regulating the protein expression levels. The screened miRNAs found in this project have not yet been reported in scientific literature.They pose high potential for future endeavors into overcoming multidrug resistance by regulating MDR proteins in divers.

K27 The Effect of Microwave Radiation on Living Organisms

Biology
Caitlin Neary
Bishop Feehan High School

This experiment tested how microwave radiation from a microwave oven affects organisms. This research can help people better understand microwaves and their effects. The hypothesis formed was that microwave radiation would present an effect of destruction on living samples.
To test radish seeds and Lima Beans, a control sample was created for each which was never exposed to microwave radiation. Three more samples for both plant varieties were exposed to radiation for 5 seconds, 15 seconds, and 30 seconds. The radish seed and Lima Bean samples were planted in individual containers to observe their growth. Each sample was watered daily, and their growth was recorded in weekly photographs. To test living yeast samples, a control sample was created with yeast that had not been exposed to microwave radiation. 3 more yeast samples were created. These were exposed to 5 seconds, 15 seconds, and 30 seconds of microwave radiation. The yeast samples were mixed with warm water and their reactions were observed and recorded with photographs.
It was expected that the data from these experiments would show that microwave radiation affects the living cells of organisms like radishes, Lima Beans, and yeast. The data contradicted this thought and showed inconclusive results, as every plant sample grew and every yeast sample produced a foaming reaction. Plant growth and yeast reactions did not seem to correspond with radiation exposure, and for some organisms, the samples exposed to the greatest amount of radiation grew the tallest, appeared the healthiest, or produced the greatest reaction. The known information about radiation suggests that the microwaves were too weak to affect the samples.

N1 The Effectiveness of Garlic on Bacteria

Biology
Kamryn Li
Taunton High School

In experimenting whether garlic efficiently kills bacteria, the hypothesis was if the garlic sufficiently kills that bacteria, then the Escherichia coli, will form circular disks illuminating bacterial growth. this hypothesis was formed after doing much research about the effectiveness of spaces on bacteria and what factors affect the speed of bacterial growth. The Petri dishes were split into three quadrants and poured E. coli specimen on and put different size garlic pieces on top. After experimenting there were clear signs of circular shapes in my Petri dishes. 's from smallest medium to large pieces the largest size pieces killed the most bacteria. After researching extensively on why garlic has affected bacteria it has shown that it is a benefit that helps with antimicrobial activities. One thing that could've been changed in this experiment is to have changed from the garlic pieces to liquid so it's spread across each quadrant evenly. From the graphs and charts it was clear that the more garlic you use, the more efficiently it kills. Between Day 1 and Day 2, there weren't many drastic differences. This can be used in the real-life for scientists and chefs who are concerned and in overgrowth of bacteria in their food. Curiosity spreads almost as fast as bacteria does so the more you know about it the safer it will be for people's health. Even though the experiment did have a trial error it still proves to show the small chunks of garlic didn't even kill the bacteria as much as the larger chunks did. Going through such a tedious procedure it has taught others the importance of the dangers of growing of bacteria and how quickly it can affect your body.

N6 Effect of Martian Soil Simulant on Pseudomonas putida

Biology
Albert Farah
Medford High School

Soil bacteria play a vital role in the development of a self-sustaining ecosystem among plants involved in said ecosystem. Some of the most important of these soil bacteria are plant growth-promoting rhizobacteria (PGPR), a group that consists of many different species, whose influences on plant growth range from nutrient intake in plants, to molecular synthesis for plants, to plant protection from diseases and pathogens. Understanding the relationship between these bacteria and plants, and that bacteria would be required for any hope of a self-sustaining human colony on Mars, the three-week experiment that forms the basis of this report was designed to test the effect of a Martian soil simulant on the growth of a specific PGPR, Pseudomonas putida, and how those effects influenced the growth of green onion plants. Over the course of the three weeks of observing plant growth, all external/environmental factors were kept controlled in order to attribute any changes in growth to the tested variables.
At the conclusion of the experiment, the objective was not only answered, but new questions for potential experiments arose. Results showed that while devoid of all soil bacteria except for a single strain, the growth of the onion plants was greatly hindered in both soil types, as was expected, and it is very likely that for any hope of growing food for a human colony on the Red Planet, it will be vital that surviving of bacteria be placed in the ecosystem of the plants being grown for the supplies of a Martian colony. The results also introduced new questions into areas of how the conservation of water by each soil type will affect the growth and development of an ecosystem involving a symbiotic relationship between plants and soil bacteria.

N9 The Effects of Organic Food on Drosophila melanogaster

Biology
Juliana Lederman
Marblehead High School

Although organic food has become a popular choice for consumers, it is unclear whether organic food is actually more nutritious and beneficial to health. In order to test this, the effects of organic and conventional diets on the longevity and fertility of Drosophila melanogaster were measured over a 14-day experiment. Flies were fed either organic or conventional gala apples that had been blended in a standard food processor, and data measuring the total numbers of living flies, dead flies, and pupae were recorded every other day. The experiment produced varying results. Organic flies had greater numbers of offspring, yet there was a limited difference between the longevity of organic and conventional flies. Graphing the pupae-per-fly data from each day in the experiment revealed interesting results, as the organic graph had a large spike in the middle of the graph while the change in the conventional graph was relatively gradual. In order to determine the validity of these results and therefore confirm that organic food is slightly more beneficial, it would be necessary to run a second experiment that is both longer and consists of more trials.

N14 The Effect of Spinacia oleracea and Lactuca sativa on Oxygen Productio

Biology
Meriam Nouri
Pioneer Charter School of Science II

According to Stanford University, levels of atmospheric oxygen have substantially decreased, and have rapidly declining in Earth's 800,000 years existence (The Hill Reaction of Photosynthesis, N/A). Stolper et al speculate that this is caused by a multitude of factors including the burning of fossil fuels and the outside environment (Princeton University, 2016). The burning of fossil fuels also leads to the release of carbon dioxide and the intake of oxygen. While it is a preconceived notion to place a burden on the carbon dioxide levels as the preliminary cause to the depleting levels of oxygen, carbon dioxide levels have remained remarkably stable (Institute of Science in Society, 2009). Applying this concept, this experiment explores sources of oxygen that are most efficient in replenishing the significant amounts of oxygen remaining. By comparing spinach and lettuce as two potential producers of oxygen, their efficiency will be compared. Using the Hill Reaction, photosynthesis will be simulated, using DCPIP (2,6-dichlorophenolindolphenol sodium salt), as an artificial electron acceptor. Essentially, it is hypothesized that in this experiment that the spinach will generate the most oxygen because it has the highest concentration of chlorophyll, a pigment that absorbs sunlight. The independent variable being tested is the source of chloroplasts, while the dependent variable is the rate of photosynthesis, in other words the rate of decolorization of DCPIP. If the data supports the hypothesis, it would suggest the use of spinach chloroplasts as a beneficial method to replenish depleting levels of oxygen. The data collected supported my hypothesis, and chlorophyll was found to be the fastest and most efficient.

N17 Solar Powered Water Desalination Device

Biology

MaiLee Daignault
Berkshire Arts & Technology Charter Public School

During my Project I experienced a few difficulties. Such as not having sunlight all the time. The device would not be able to desalinate enough water for a few people, but that's only in a few hours of course. If it was larger scale it probably would have been much more efficient. I also was thinking while doing my project that if it was warmer and the sun was always on it it would work a lot better. The device desalinated a lot less water than I originally planned it would, but the black paper underneath one of the devices desalinated faster than the white. Overall it was an interesting project and I hope to expand on it.

N20 Studies on Preservation of Vision in the Rotifer Brachionus manjavacus

Biology

Anna Metri
Falmouth Academy

The purpose of this experiment was to try to preserve the eyesight of Brachionus manjavacas rotifers over time, using different chemicals and temperatures. It was hypothesized that in the temperature test, neither the rotifers at 16°C, nor at 21°C in a dark environment, would maintain vision better than the 21°C control. It was hypothesized that in the chemical test, glycerol and Trolox would be able to preserve eyesight in rotifers, while Acarbose would show no improvement over the control. To assess phototaxis, a petri dish half-covered in duct tape was placed on the microscope slide, and a 3-well slide with rotifer culture was placed on the petri dish, allowing only half the slide to receive light. A cardboard box was placed over the slide, and the microscope light was turned off for 1 minute, then turned back on for 2 minutes before removing the cardboard box. The percent of rotifers on the light side of the slide was determined. After 12 days, none of the groups reared at different temperatures preserved eyesight better than the control. By day 14 of the chemical experiment, one group, glycerol, proved successful. An average of 55.6%+/-.08 of the rotifers in the control group had swum towards the light, while the glycerol had a significantly higher percentage, 75.1%+/-.08 on average. Over 10 million Americans suffer from age-related macular degeneration, and another 3 million from presbyopia. With no known cure for either, glycerol supplementation, if proven a successful treatment, could help delay vision loss with age.

N26 Wild Type Vs. GMO Plants

Biology

Baleriet M. Zorrilla Santana, Kiana Pol Tejeda
East Boston High School

GMO soybean and corn plants differ from wild type plants in many different ways. At first we thought that all of the GMO plants were going to grow at a faster rate than the wild type plants, and that they were going to be roundup resistant. In order to test this theory, the plants were all measured by rate of growth, photosynthesis rate, and ability to stay alive (GMO vs wild type). First we grew all of our plants while measuring their heights every couple of days, later on we proceeded to measure the rate of photosynthesis, to conclude with using roundup on all the soybean plants. Our results show that the GMO plants grew faster in average than the wild type plants, but when it came to photosynthesis rates the GMO soybeans had a higher rate than Wild Type, the monsanto soybeans displayed the opposite results, for the round up test the GMO soybeans survived but the rest of the plants died. Overall we wanted to conduct this experiment because we wanted to know if the theory about GMO plants being the better option to plant was true or false, next we would love to check out the differences in the DNA of each plant.

N27 pH in Algae Balls

Biology

Leslie Oliva, Michael Santos, Carlos Moran Sanchez
East Boston High School

The major goal of this project was to create a model using algae balls that could be used to test different questions about photosynthesis and cellular respiration in the future. We were able to grow the algae for two and half months. We selected three indicators and then made the algae balls using sodium alginate. We tested the algae balls using 3 indicators: cabbage juice, phenol red, and the bromothymol blue. We discovered that the amount of algae balls changed the pH of the indicators. However, the pH became more acidic in both the light and dark conditions. Perhaps the algae balls are contaminated with more than just algae and degree of cellular respiration was too great to see the effects of photosynthesis. In the future, we will grow more concentrated and purer algae, analyze the algae balls we have with the microscope, and then use our system to test different questions about photosynthesis and cellular respiration.
After our negative results we did the experiment again. This time, our algae was more concentrated, and the experiment worked. We concluded that in our first experiment the algae was not contaminated, but the algae was not concentrated enough to do photosynthesis. In the first experiment the algae did only cellular respiration. After both experiments, we can say that our hypothesis was correct. Our experiment was complete, and our results supported our hypothesis.

N28 What Factors Trigger Seizures in Fruit Flies?

Biology

Kristen McCormick
Newton Country Day School

What factors trigger seizures in fruit flies? There are many types of seizures and factors that can trigger them, including dehydration. Seizures may include convulsions, short absences of consciousness, general muscle jerks and loss of muscle tone, as well as being tired and confused after the episode. One in ten (1/10) Americans have had a seizure in their lifetime, and 1-2% (approximately 2.7 million) of the United States population has epilepsy. Since there are so many ways and causes that a person could have epilepsy, 50-70% of cases have an unknown origin or explanation. In this experiment, it is hypothesized that if fruit flies are exposed to dehydration, seizures will be induced. Dehydration has been shown to trigger seizures in mammals. For the experiment, fruit flies were acquired with and without a bang-sensitive mutation and raised in two groups: one with the zydeco genetic mutation and one without it. Then both types of flies were divided into two more groups: one of these to test with water, one without water. Afterward, the four groups were set up with proper materials and the experiment was continued by leaving the flies overnight. The next morning, the flies were tested to see if they had seizures by banging the vial on the table 10 times at a consistent force. After testing, data was recorded and analyzed. The hypothesis was supported by the z-test that was run, showing that the results were extremely significant (the p-value was less than 0.0001). The results indicate that dehydration is highly connected to increased seizure activity in the mutant flies and not due to pure coincidence. For future studies, researchers could use this data to show how dehydration is a trigger for seizures in fruit flies.

P1 How Effective is Your Virtual Reality Experience?

Biology
Kevin Turcios, Cristian Figueroa
East Boston High School

Although virtual reality (VR) is most commonly associated with gaming, it is being used in many more capacities. In fact, VR technology is currently being used for education and training purposes, healthcare applications, automotive, aviation simulations, advertising, and tourism. Taking into account these facts, we wondered if the GoogleCardboard could be a simple and effective way to immerse into the virtual world. As a result, we designed an experiment that tests the effectiveness of the platform by measuring the degree of change in three physiological responses as participants were viewing different virtual reality environments. The effectiveness of the was determined based on any measurable change in heart rate, oxygen saturation level, and skin temperature between the control and experimental values. Thirty test subjects watched a fifteen minute video using GoogleCardboard that displayed three-minute segments of a beach sunrise, a non-graphic horror scene and a surprise party simulation. The control was a three-minute black screen. Each test subject was measured using a Nonin GO2 Achieve Oximeter and a Non-Touch Thermometer. During immersion it was found that the subjects heart rate ranged from -2.12 (bpm) to +1.93 (bpm), giving us a range of 4.05 (bpm) . The SpO2 level measured a 3% increase during the beach sunrise environment. It was also found that skin temperature registered a value of +.19 °C, with a range that included the control, being the min, and the range was from 35.48 °C - 35.86 °C, with a range of +.38°C. Our observations and data indicate that Google Cardboard® is effective and the quality of the virtual experience elicits measurable changes in heart rate, oxygen saturation level, and skin temperature between the control and experimental values.

P2 Natural Antibiotics Vs. Pharmaceutical Antibiotics

Biology
Sadie Jude
West Boylston High School

My science fair project looked to compare the effectiveness of pharmaceutical and natural antibiotics. In my experiment, I created e.coli colonies in agar plates and tested half against ampicillin disks, and the other half was tested by turmeric soaked disks. I wanted to see the effectiveness of each antibiotic in regards to its ability to fight antibiotic resistance. I originally predicted that the natural turmeric would end in better result because most pharmaceutical antibiotics are susceptible to resistance. In the end, the pharmaceutical antibiotics did appear to be much more beneficial against bacteria but if you were to look closer at the agar plates you could see the resistance among a few bacteria colonies. These same colonies were not visible in the agar plates of the turmeric antibiotics. This could allude to natural antibiotics being a new options to consider against bacteria.

P8 Deprivation Dilemma

Biology
Ambika Nair
Newton Country Day Sch/Sacred Heart

This literary review studied the effects and results of drug and natural treatments in order to find a more effective treatment to help insomnia and sleep deprivation. Some of the natural treatments included various forms of relaxation such as sleep restriction, cognitive behavioral therapy, muscle relaxation, and lavender aroma therapy. Drug treatments observed were Z-drugs (zaleplon, zolpidem, zopiclone), tryptophan, and secobarbital. 20 different studies on either drug treatments, natural treatments, or of both for Insomnia on either chronic or short term patients. Results showed that all 16 studies for natural treatments were effective in helping with insomnia. Out of the 11 drug treatments, 1 treatment was not effective while the other 10 were. There is not much of a significant difference but in other aspects such as long-term effects and improvement on quality of life, natural treatments seemed to be more helpful. This could infer that in general, natural treatments are more reliable yet a Z-score test was conducted to see if there was any difference in effectiveness of Natural and Drug Treatments. She found that the P value for the effectiveness of natural versus drug was not substantial and therefore there is not much of a difference in effectiveness of drug and natural treatments for Insomnia. Also, another Z-score test proved that there was again no difference in the effectiveness of long term natural treatments versus short term treatments. The hypothesis was not supported but this review but it was realize that one treatment is not better than the other and it may be better to use natural treatments to cure sleep deprivation than unnecessary using harmful drugs. Also, the study proves that further research must be done for finding an effective treatment.

P9 The Effect of Sound on the Respiratory Rate of the House Cricket

Biology
Tam Nguyen, Eileen Chen, Huy Phan
Boston Latin Academy

The purpose of this lab was to find the effect of different frequencies on the respiratory rate of crickets. In our lab, we used female house crickets (Acheta domesticus) to test how their respiration rates changed when they are exposed to 5Hz, 10Hz, and 15Hz frequencies.
In order to measure the amount of carbon dioxide in the respiration chamber, we used a CO2 sensor which is measured in parts per million (ppm). We expect the respiration rate to increase because the crickets may be undergoing stress which fluctuates their respiration rate. Since it is known that sound pollution has a harmful effect on marine organisms, such as Beaked whales, similar effects may affect terrestrial organisms.
Due to our economic advancements, humans play a huge role where planes, constructions, and technologies can affect these organisms on a daily basis. Based on our data, we saw that these frequencies had an effect on the crickets where the respiration was lower compared to when they were in a silent room; which didn't support our hypothesis.

P11 Prevalence of Penicillin Allergies

Biology
Elizabeth Weiss
Newton Country Day Sch/Sacred Heart

Penicillin allergies are a very common allergy. Many people do not test positive when given a skin test or challenged with penicillin. It was hypothesized that only some percentage of the self-reported allergies represent true allergies. A meta-analysis of 21 studies in the literature review was conducted. A total number of 27,646 subjects were tested: The observed positive was 7340, and the negative was 15,730. The null hypothesis the expected 22,829 of positive confirmed allergies (99%), 157 negative tests (1%). The chi square value of the experiment was 1,553,228, the chi square was much larger than the critical value of 3.84 (for P=0.05, 1 degree of freedom). 99% of reported allergies did not test positive, the statistical null hypothesis was rejected. The studies tested the general population, the populations had a mean percentage of 25% positive allergy tests, and 75% negative allergy tests. For the subjects who previously self-reported penicillin allergies the means were 20% positive tests and 80% negative tests. Comparing the two, show that whether an allergy is self-reported or not, the confirmed prevalence of penicillin allergies was low. The mean percentage of positive allergies for the self-reported studies was 20%, and the general populations was 26%. The self-reported allergy mean and the general population's mean were so close, that is very hard to predict if someone has or does not have a penicillin allergy. After running a T-Test on the self-reported studies and the general population studies, the P-Value was found to be .62. Since the P-Value is significantly greater than .05, shows that the two series have little difference. The original hypothesis was supported. The prevalence of penicillin allergies is most likely near 20% to 26%.

P12 Testing Cellular Function with Fluorouracil

Biology
Celeste Torra, Abike Beke
Somerville High School

In this experiment, the cellular function of both prokaryotes and eukaryotes was tested with a cancer killing cream, Fluorouracil. We first tested the effect of varying concentrations of Fluorouracil on yeast, while it was performing cellular respiration. Then, we tested the effect of varying concentrations of Fluorouracil on the cellular reproduction of E. coli. The results concluded that the Fluorouracil cream did work by lowering the rates of CO2 production by the yeast and an increasing inhibition zone for the E. coli when higher concentrations of Fluorouracil were introduced.

P14 How Many Germs Are Really on Your Cellphone?

Biology
Courtney Adams, Karenna Downs
Westfield High School

As human beings, we are constantly attached to our cell phones. With the whole world easily accessible at our fingertips, we are tempted to bring the little handheld devices with us everywhere we go. From our hands, to our ears, from the bedroom to the bathroom, our phones go with us no matter the destination. Throughout recent experiments performed by professionals, they found that on 82% of phone screens live bacteria. Of that 82%, 16% contain germs such as E.coli, the flu, and MRSA. Now as for the bathroom, the splash radius of the toilet is up to 7 feet, so whether or not you're using your phone while on the toilet, you can get the bacteria living in it. There are also findings that cell phone screens have 18 times more bacteria and germs on it than a public toilet seat, which clearly indicates that as human beings we are awful at cleaning. Now for our project we conducted an experiment that would test to see if bacteria grew on your cell phone screen in different amounts each day. To being, we created a hypothesis saying If you are using your cellular device frequently and do not clean it properly, then the bacteria on your cellular device will increase each day. We began by collecting the very vital materials such as multiple cell phones, Clorox Disinfectant Wipes, Q- Tips, Petri Dishes, agar (bacteria food), graph paper, pencil, light table, science notebook, goggles, gloves, incubator, and a fume hood. To conduct this experiment, we cleaned three phones, two to be carried around like normal and one control.After a day we took the q- tips, rubbed our phone screens, and rubbed them onto the agar in the petri dishes and placed them in the incubator. We repeated this every couple of days for a total of 7 swabs in 30 days.When bacteria grew, we put in the petri dish.

P17 The Capability of Trypan Blue as a Viability Dye in Pond Water

Biology
Grace Kelliher
North Quincy High School

An experiment was conducted to determine the capability of trypan blue as a viability dye in a heterogenous population. Trypan blue is a stain that is able to penetrate the membrane of dead cells. The cells stained by trypan blue emit fluorescence that can be detected and measured by a flow cytometer, an instrument used for cell-counting and cell-sorting by means of a laser and a series of sensors. It was predicted that if the concentration of trypan blue in a pond water and trypan blue solution was increased, then the mean fluorescence channel detected by the instrument will increase. Serial dilutions were performed to prepare samples with different concentrations of trypan blue. Fluorescence emitted by trypan blue binded to nonviable cells in the sample were measured by sensors on the Accuri C6 Flow Cytometer and reported using fluorescence channels. It was found that the more concentrated samples caused a greater shift in fluorescence in comparison to the control. The results of this experiment are valuable to research in water quality and can aid in determining the viability of organisms in water.

P18 Impact of Genomic Alterations on TADs in Breast Cancer

Biology
Deepa Nandan
Westborough High School

Breast cancer, a significant cause of death among American women, is caused by copy number alterations (CNAs). CNAs are changes in the number of nucleotides in a chromosome. The purpose of this project is to find out whether copy number alterations specifically target the boundaries of Topologically Associated Domains (TADs), which are specific areas in the genome within which looping interactions occur. To test this purpose, I used publicly available, real-life data from the Cancer Genome Atlas on the size and location of TAD boundaries and CNAs. Then, I wrote a program to count how many times the CNAs overlapped with the TAD boundaries, and counted each of these overlaps as a direct hit. Then, I used an existing program to randomly simulate 1000 permutations of CNAs of the same size and frequency as the real life data. I counted these direct hits as well and compared the number of randomly simulated direct hits to the number of real-life direct hits to see whether the real-life CNAs were targeting the TAD boundaries (in other words, hitting them more than just by chance, because the simulated direct hits were completely by chance). What I found was that indels (CNAs of 100 base pairs or less) were neither enriched or depleted on TAD boundaries, which means that they hit them only by chance. Larger CNAs, however, were enriched for TAD boundaries (which means they target them) and when looking at each individual chromosome, I found that they were either enriched (targeting) or depleted (avoiding) TAD boundaries.

P21 Epigenetic Influences in Cancer

Biology
Hannah Cole
Newton South High School

The American Cancer Society estimates that in 2017 there will be 1.7 million new cases of cancer diagnosed and nearly 600,000 cancer-related deaths in the US. While previous research has focused on gene coding region variants in cancer, the significance of non-coding variants in cancer development and progression has not been fully explored. Here we investigate gene variants in epigenetic, or non-coding regions of DNA, to determine their importance in the development of human cancers using a bioinformatics approach. Our studies employ a global evaluation of cancer-related non-coding single nucleotide polymorphisms, or changes in the DNA sequence, commonly referred to as SNPs, which were obtained from the Genome-Wide Association Studies (GWAS) database containing SNPs that have been found to be associated with a particular trait. Non-coding cancer SNPs were sorted based on their connectivity and influence on gene expression using a variety of analytic software tools. The biological significance of each SNP was further defined using the data analysis programs: Epigenomic Roadmap, RegulomeDB, and GeneTrail. Functionally, cancer SNPs were found to be enriched for various regulatory elements, as well as biological processes related to development and immunity. These findings allow for a greater understanding of the significance of noncoding genetic variants in human cancers, and pave the way for future studies aimed at understanding developmental and immunologic influences in cancer which may ultimately lead to improved methods for diagnosing and treating cancer patients.

Physics & Electronics

Physics & Electronics

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A5 Development of Solar Cells Using Conductive Glass

Physics & Electronics
Bronwyn Pappas-Byers, Parima Sharma
Hopkinton High School

This report investigates the use of solar cells made with titanium dioxide to act as an environmentally friendly energy source. It was hypothesized that the cells will behave in an Ohmic manner (according to Ohm's Law which describes characteristics of a parallel and series circuits) and that they would generate current and voltage in the presence of light. The cells were made from conductive glass slides, a negative slide with titanium dioxide and a positive slide was made with carbon. These slides were clipped together and an electrolyte solution was put in between them. The cells were connected in a series arrangement and the voltage and current was measured using a multimeter. As more cells were added to the series circuit, the current stayed constant, but the voltage increased. These results were graphed and the cells demonstrated Ohmic behavior. Some sources of error with the tests include the solar cells dying over time and the electrolyte solution drying out since it was not in a sealed container.

B14 Lighter Than A Feather?

Physics & Electronics
Hayley Caufield
Berkshire Arts & Technology Charter Public School

I chose this project because it was a question I had during one of our lessons in class on the acceleration due to gravity (g). My hypothesis is that with only force due to gravity affecting a feather, said feather will fall in less time than a feather that is affected by atmosphere. In theory, all objects should fall at the same rate when inside a vacuum, this project was meant to assess the difference between the time it takes for the feather to fall inside and outside the vacuum. I built a vacuum chamber out of plexiglass and strong epoxy and vacuumized it, then I flipped the chamber over so the feather would fall, and I timed each one to get my data. My data showed that the feather inside the vacuum fell almost two times faster than the feather in the ambient chamber. If I could do this experiment again, I would think through the design of the chamber more thoroughly before building and testing it to prevent large scale problems with the experiment.

B17 The Effect of Electromagnetic Forces on Metal Rings

Physics & Electronics
Aidan Pereira
Bishop Feehan High School

This project was chosen to see which metal was launched the highest from an Elihu Thomson apparatus. The apparatus generates an electric field which in turn generates a magnetic field, throwing a metal ring into the air. This project will be determining which metal rings has the best magnetic properties. The inspiration for this project came from a larger version of the apparatus at the Boston Museum of Science. This experiment is also a continuation of the observations and questions about how the apparatus works.
The hypothesis of this experiment was based on previous observations of metals and their magnetic properties. The hypothesis stated that the aluminum rings would launch higher than the copper rings and the stainless steel rings.
The experiment was relatively simple to conduct. First I had to build the apparatus with some PVC pipe, hanging wire, 14 gauge single strand copper wire, an extension cord, and a push button. Next, the rings were placed on the PVC pipe one at a time, the first time room temperature, the second time cold, and the third time warmed up. After the rings were placed, the push button was pressed, and the ring was launched in the air. The height of each ring was measured using a tape measure.
The aluminum ring was expected to launch higher than the copper and stainless steel rings. The aluminum rings did go higher than the other rings in all three trials. The copper rings rings never made it above the top of the PVC pipe, and the steel rings did not move from their original position.

B26 Harp Strings and Humidity

Physics & Electronics
Ava Skogstrom
St. John Paul ll High School

All string musicians will understand the struggle of constantly having to battle out-of-tune strings. From personal experience, I noticed that the string's of my harp seem to go out of tune much faster in the most humid parts of summer and the driest days of winter. It is clear to me that the state of my instrument's strings and sound directly correlate with the environment. This led me to asking the following question: how does humidity affect a harp string's frequency? From this question and previous knowledge my hypothesis was formed; if the level of humidity is above sixty percent and the strings are made out of nylon or gut, then the tension and frequency of the harp strings will change in an allotted period of time. Conducting the experiment entailed building an apparatus that held my strings in place as I exposed the tuned string to a humid climate. With a water vaporizer and a bin, I was able to contain the humidity, while recording the humidity level with a hygrometer, and the string's frequency with a tuner. I tested nine separate strings of three different notes and three different octaves. As a result, the string's frequencies of the third and highest octave out of those tested had the fastest rate of change, as predicted. My hypothesis was based on my data, and my questions involving the fluctuating sound of my harp in winter and summer were answered after conducting my experiment.

C19 DPB - Dimpled Paintball

Physics & Electronics
Tim Curry
Taconic High School

This project was about creating and testing the accuracy of a dimpled paintball vs. a non dimpled paintball. Originally the idea was to create a clay paintball and shoot to measure the distance from the center of the target. Through testing the different materials that could be used, a digital ABS was the best material to use. This then allowed the balls to be created in a 3D printer rather than in a mold.
Accuracy was determined by the distance in inches from the center of the target. The paintballs shot were 60 3D printed dimpled paintballs and 60 non-dimpled paintballs from a distance of 20ft. To eliminate human error and inconsistency, the paintball gun was taped to two boxes to make sure there was no movement between shots.
At the end of the testing the data was collected, calculations were made by using mean, median, mode, T-tests, and standard deviation. These calculations showed that there was no statistical difference proving that one paintball was more accurate than the other.
In conclusion, more testing is required to give a better testing result. Only 120 paintballs being shot is not enough to give a reliable conclusion to this hypothesis. About 250 dimpled and non-dimpled paintballs being shot will give reliable data to conclude whether one paintball is more accurate than the other. As of the data available, one is not more accurate than the other.

D8 An Analysis of HRRGs with Mid-Range Spectral Indices at z ~ 6

Physics & Electronics
Joseph Farah
Medford High School

I use existing Very Large Array observations of high redshift radio galaxies (HRRGs) to create a simulated spectral energy distribution (SED) of early radio sources (z~6). I diagnose the presence of an oscillating model for fluctuations in spectral indices for galaxies at both high and low frequencies by using observed spectral flux densities and calculated luminosity distance to create small portions of radio SEDs for analysis. Spectral indices can be used to hypothesize about the presence of active galactic nuclei and star formation regions in specific galaxies. I find that, at both high and low frequencies, spectral indices in HRRGs that have especially active nuclei tend to oscillate violently over time, signifying concussive galactic change across relatively small time periods and providing an explanation for spectral indices within the 1025 W.GHz-1 bin that seem. Galaxies in this classification that are observed at low frequencies have a gentler spectral index oscillation than those at higher frequencies. This leads to the proposal of a new class of HRRG-- “supernucleic”—and the obviation of the usage of the term “midrange” for these galaxies as grossly inaccurate and wildly misleading.

D9 Surface Vs. Bulk Heating of Ferrofluid in Alternating Magnetic Field

Physics & Electronics
Asiya Karim
Lexington High School

Magnetic Nanoparticles or Ferrofluids are used in several experimental techniques in human medicine. A typical scenario is to have a cancer tumor uptake the ferrofluid and then kill these cells by applying an external alternating (ac) field. In the presence of the field, energy uptake by the fluid causes it to heat up killing the tumor. For obvious reasons, efficiency of the energy uptake is an important parameter, since we want to apply the least possible strength of field and get the maximum benefit. In this experiment we studied how this energy uptake is affected in bulk liquid versus surface films of ferrofluids placed in alternating magnetic fields. Since the surface phenomena involves 2-dimensional physics versus 3-dimensional physics for bulk, some differences might be expected. From the result of the experiment, it is clear that there is actually a huge difference. The temperature rise of the film was over ten times compared to the rise in the bulk liquid. Understanding the underlying physics could have enormous consequences in the practical use of these techniques, and potential for research and development of newer techniques.

D11 ThermoTap: A Thermal Generator Utilizing the Heat of the Desert

Physics & Electronics
Yashasvi Raj
Lexington High School

Over 1.2 billion people around the world don't have access to electricity and therefore rely on other sources of energy. As a rising 11th grade student at Lexington High School, I had an opportunity to visit Barmer district, located in the Thar Desert of Rajasthan, India. The people of Barmer live in dark huts and rely on kerosene lamps for lighting and cooking, instead of electricity. Kerosene is non-renewable resource, produces poor quality light and its fumes and soot are harmful to both health and the environment. Therefore, I thought, of using the heat from both Sun and sand in the desert and convert it to electricity. Upon returning to Boston, I discussed this idea with many engineers and scientists, and have developed an affordable and efficient device called the ThermoTap. It converts thermal energy into electricity, which can then be stored in rechargeable batteries, and used for replacing the kerosene lamps with LED lamps. All of the components in the ThermoTap are common, affordable and durable which facilitates future mass production at a nominal cost. Although the ThermoTap was developed for Barmer, it can be used in other climates with minor modifications as well. The device may be further improved by joining multiple ThermoTaps and LED lights together in order to obtain greater amounts of light. The electricity stored in rechargeable batteries could be used for other purposes, such as charging cellphones and coolers. The brightness of the LED from the current model of ThermoTap is equal to or better than a kerosene lamp. This device can be distributed to households, and this technology could be taught to high school students so that it would enable them to study in cleaner environments and also develop a passion for science and engineering.

D19 The Physics of Video Games

Physics & Electronics
Amelia Herlong
West Boylston High School

Video games have been criticized by many for being unrealistic with their physics and proportions, which inspired a further look at video games and their jumping mechanics. Seven video games were used within the project, and the order of most to least realistic was hypothesized as followed: Portal; Portal Runner; Inside; Alice: Madness Returns; Minecraft; Flying Warriors; then New Super Mario Brothers, Wii. These were predictions based on past experience and observations of video games and their graphics. Using human jump heights as a control, various methods were used to test and scale the video games appropriately. The most frequently used method was by using videos posted online and measuring the screen's pixels, then scaling the character's jump(s). The results showed that six of the seven characters had above average jump height, and that three characters had jump heights above the world record, which meant that they were unrealistic. The hypothesis was partially correct in assuming the majority of characters would have above average, or "unrealistic", vertical jump heights, but the exact order (Portal; Inside; Minecraft; Flying Warriors; New Super Mario Brothers, Wii; Alice: Madness Returns; Portal Runner) differed from the expectation. The data and results found could aid others with further research into the realism of video games and their physics, or help video game designers with their creations and the impact this unrealistic expectation has on young players.

D27 Dynamic Dimples: The Future of Flight

Physics & Electronics
Anshuman Madhukar
Shrewsbury High School

The fuel required for a rocket launch is extremely expensive. A way to reduce this cost is to improve fuel efficiency by minimizing the drag of rockets. Dimples are an effective way to reduce drag on golf balls, and in previous work the dimple design was modified to reduce drag on model rockets. Specifically, an optimal combination of dimple size and spacing was discovered. In this work, this design is further optimized by varying dimple angle and depth. Several model rockets were molded and dimples with various combinations of angle and depth were added to the surfaces. The drag of each rocket was measured in a wind tunnel. The results suggest that the angle which maximizes drag lies towards the middle of the spectrum (around 75° to 105°) and the drag decreases as the angles move away from that value. When the angle is acute, the results suggest that the optimal dimple depth is 0.6 cm, and the drag increases as the depth moves away from 0.6 cm. When the angle is obtuse, however, the trends in the relationship between depth and drag becomes unclear. Further experimentation is required to understand the trends. The implications of this research are that the impact of dimple angle and drag on drag is much more complicated than expected. However, it is clear that the dimple pattern for rockets can be further optimized by changing the depth and angle.

F24 What Material Blocks the Sound the Best?

Physics & Electronics
Jairo Lazo, John Richard OBryant
Edward M. Kennedy Academy for Health Careers

What is the impact of different materials on sound waves? A denser and thicker material will lower the amplitude of sound waves, but leave the frequency unchanged because the molecules in the denser and thicker material will be harder to vibrate and will transfer less of the sound. This is important because we live and work in dense population environments and yet need to maintain boundaries to allow for comfort and privacy. Restriction of noise pollution is key to maintaining these boundaries. We are interested to learn the most efficient way to control noise to best use sound control to enrich our daily lives.

H1 Blunt Force against Medieval Armor

Physics & Electronics
Kaylie Williams
Westfield High School

The project ‘Blunt Force against Medieval Armour’ was planned to test the resilience of both knights’ armours and Celtic armour to the constant force of a hammer on a string-triggered contraption, in order to identify which qualities made armour more valuable to the wearer. In order to test the two armours efficiently with as little mistakes and differences in constants as possible, the contraption was set to a specific point by a nail as to where the hammer would start from before release. Each armour tested was to be hung from the same hook, and the clay resided in the same spot every time, never changing drastically in shape, for it was flattened once more after each test. In this method, the amount of force, angle of release, placement of textile, and placement of clay would all be just about even, aside from a few slight inconsistencies. After three trials for each of the three textiles, one of them being the control test of simple leather, in place of hide used by peasants and vikings often in battles, it was discovered that Celtic armour, the thickest of the three mediums, had the largest width of imprint on the clay, yet its depth was significantly the shallowest. The metal plate used for the knight’s armour showed a slight shortening of the width of the imprint, though its depth had increased in comparison. Finally, the leather seemed to have shown no resistance to the hammer, resulting in the most depth out of the three, as well as the shortest width. In short, as the Celtic armour was discovered to be much more efficient in protecting the wearer against blunt force trauma in comparison to sheet metal used with knights and mere leather worn by lower class soldiers, such as vikings and peasants, it can be seen that thicker materials better protect the wearer.

H6 The Change in Resistance of Metals with Temperature

Physics & Electronics
Benjamin Guerriero
Marian High School

The resistance of an object is a measure of the amount of opposition to the motion of the electrons that flow through it. When an object is cold, the electrons are lined up within the materials so that current can easily flow through. If the object is heated, the electrons begin to vibrate and collide with each other. Each collision causes the electron to lose some energy, and this is the cause of the resistance to motion. The experiment attempted to prove this theory by comparing the resistance of conductors at varying temperatures.
The purpose of this experiment was to determine how the resistance of metals changes with temperature. It was hypothesized that the resistance of metals will increase as temperature increases. To test this theory, a circuit was constructed that included a voltmeter, ammeter, battery, and resistors. The metal would then be used as a second resistor to close the circuit. The voltage and current in the circuit were measured using five different metals at temperatures from 0-100 degrees Celsius, and Ohm’s Law was then used to find the resistance. Once all data was collected, the measurements could be observed in order to form a conclusion.
In this experiment, each metal showed an increase in resistance from 0-100 degrees Celsius. Titanium showed a major increase, copper and aluminum showed minor increases, and steel and tungsten also increased in resistance. Since all five metals increased in resistance from the lowest to highest temperature, the hypothesis that the resistance of metals increases with temperature has been proven correct.

H18 Cymatics: Chladni's Plate

Physics & Electronics
Jordan Bower, Allison Bower
Westfield High School

Cymatics is the study of sound made visible. Ernst Chladni is highly credited for his work with sound and Cymatics. He discovered that if sand was scattered on a metal plate and struck with a violin bow, the sand would create intricate patterns as different frequencies were produced. A mechanical version of a Chladni Plate was made using a circular, square, rectangular, and triangular metal plate. Most experiments involving a Chladni Plate only used a square or circular plate, so this experiment was performed to see how the patterns would differ on a variety of different shaped plates. To construct the Chladni Plate, plywood, a 12-inch diameter speaker, plexiglass, an endcap, metal rods, nuts, and washers were used for the foundation. The speaker was connected to an amplifier, which was then connected to an iPhone for the frequencies. Next, the different shaped metal plates were placed on top and secured to the device using a nut and washer. Salt was scattered all over the plates. Multiple frequencies were tested in order to analyze the measurements between the nodes and antinodes in the patterns that the salt created at each frequency. It was hypothesized that the measurements between the nodes and antinodes would be the same when the same frequency was played on each plate; however, this proved to be false. It was concluded that the measurements between the nodes and antinodes were not be similar due to the fact that the sound waves resonated in a different manner for each plate, thus causing the waves to overlap and cancel out in different places. It was noted that as the frequency increased, the number of nodes increased since frequency and wavelength are inversely proportional, thus creating more opportunities for nodes.

H19 Let 'Em Fly

Physics & Electronics
Will Coty
St. John Paul ll High School

My project compared the accuracy of carbon shaft arrows vs aluminum shaft arrows. The purpose of my research demonstrated to hunters and archery enthusiasts which kind of arrow shafts combination with various lengths of vanes. The importance of my research is assisting hunters and archers with the most accurate arrows they can shoot. My question statement is, will carbon arrow shaft with 2” arrow vanes shoot more accurately than aluminum arrow shafts with 4” arrow vanes. My hypothesis is carbon arrows with 2” vanes will shoot more accurate than aluminum arrows with 4” vanes seeing that most archers have switched from aluminum arrows to carbon arrows. My research on carbon and aluminum properties showed that carbon has more flex than aluminum. I conducted my research in a controlled indoor shooting range. I shot three arrows from each study group from a distance of 18 meters. My hypothesis was supported by my results, because the arrows made out of carbon with 2” vanes had a tighter shot group and shot more consistently than the arrows made out of aluminum with 4” vanes, showing that the carbon shaft with 2” arrow vanes was more accurate.

J1 Finding a Noninvasive Device to Help Reduce Hand Tremors

Physics & Electronics
Emily Taylor
Berkshire Arts & Technology Charter Public School

Hand tremors affects 20% of adults worldwide. It is a constant condition that frequently worsens with age. People with hand tremors find difficulty holding everyday objects such as glasses filled with liquid and/or plates filled with food. This project was completed to help reduce the condition. The hypothesis was, when I create a hand tremors device, it will decrease the severity of the subject's hand tremors because of the materials I use. It will decrease the severity of the subject's hand tremors because the wire and the gyroscope will restrict and balance out the hand tremors. It is incorrect because the pressure of rubber bands proved to be more effective than the gyroscope. To test this, a glove was constructed of wire, rubber bands, and a gyroscope. Using an app on a phone, the subject was asked to lift a glass with a bare hand, with the glove on (gyroscope), and with the glove on (no gyroscope). Multiple versions of the glove were made and tested. The data implies that pressure on the proximal phalanges, metacarpal bones, and carpal bones reduce unwanted hand movement. With this data, a new experiment could be conducted to create a glove for subjects with severe hand tremors.

J11 Electromagnets

Physics & Electronics
Fiona Mannion
Boston Latin Academy

A electromagnet is a type of magnet in which the magnetic field is produced by an electrical current. My experiment was a simple electromagnetic experiment to show how a basic circuit works, with a complete loop from the negative to positive sides of a battery with a copper wire. This is important because how people wire their coil is the connection between the coil and the magnet and that is what causes the electrical current flow. Without this process we would not be able to use MRI's, CAT Scans, Transformers, Television, Earphones/ loudspeakers and electrical motors. These systems are important to our society, because it helps many people in life situations. In my experiment we observed how does the number of coils around the bolt of a magnet affect the magnets power? I believed that if there was more copper coil wrapped around the metal bolt then it was going to have a higher strength of magnetism, because it would raise the electrical currency flow. I investigated by using a wire, varying in length, changing the number of coils; that will be coiled around metal rods. The lengths of wire and number of coils will be my only variable with everything else staying the same. The number of paper clips picked up will determine if there is a difference in the magnetic field created. After doing this experiment I can concluded that the more coils there are wrapped around a bolt, the greater strength the magnet has.

K4 The Power of PSI

Physics & Electronics
Grace Burns, Lenahnia Smith, Rayne Lipscomb
John D. O'Bryant School of Mathematics and Science

Sports are an important aspect of our society because the majority of people love them, and they bring communities together. It is preferred that these games go smoothly and if they don't because of some air pressure issues with the balls no one would like that so we wanted to find out if pressure really has an effect on a ball in play. The hypothesis of this experiment was if there is a larger amount of air inside of a sports ball then the distance it will be able travel will increase. We hit a soccer ball at different pressures repeatedly with the same force to see if the distances varied. We recorded each distance for all 30 trials, 10 for each different pressure level. The results showed us that the more pressure there is present, the farther the ball traveled. We concluded that pressure really can have a negative effect on game play.

N10 The Effect of Heat on the Amount of Static Electricity Gathered

Physics & Electronics
Oulaya Louaddi, Alexa DiPietro
Revere High School

Introduction: Many fires have broken out at gas stations, homes, and facilities due to large amounts of static electricity gathering in one area. Many specific fabrics easily catch fire and can cause unnecessary deaths, because they are made of insulating material that holds in the static. To help avoid danger, this experiment is designed to explain why certain materials can put individuals more at risk of fires because of the common factor of temperature.
Problem Statement: How does temperature affect the amount of static electricity gathered by different fabric materials?
Procedure: We used an electroscope, a tool that measures static electricity, to measure the distance between an aluminum ball on the electroscope and a fabric sample that had been heated with a heating pad and rubbed on a balloon 20 times for a transfer of electrons or the creation of a static charge. We tested satin and cotton because of their popularity with consumers and similar capabilities in terms of collecting and holding onto static electricity based on results from a previous experiment.
Results: Without heat applied, cotton and satin moved the aluminum ball an average of 6.35mm and 16.71mm respectively. With heat applied, cotton and satin moved the aluminum ball an average of 44.48mm and 20.33mm respectively.
Conclusion: The results supported the conclusion, as there was an increase in distance after heat was applied to the cotton and satin. This is because temperature increases the level of conductivity in an atmosphere, so larger amounts of static could be held before a static charge was released.

P5 All That Matters Is The Spatter

Physics & Electronics
Isabella Ferretti
Plymouth South High School

For my project, the problem that I was chose to investigate, expand my knowledge on and question was how does the height of where the blood drop falls from affect the appearance of blood spatter on a given surface and then how does the blood spatter show where the blood-shedding event occurred or how does it help indicate towards other evidence pieces. Early on, my hypothesis was that the higher the blood was dropped from, the wider the spatter will be on the white paper acting as my surface.I did a lot of research prior to my doing of the project itself and I found out how a lot more than height can affect the appearance of blood spatter, given that we have to consider angle,distance, wind and other effects like such. During my actual experimentation, I chose to drop the blood from a distance range of 10cm to 100cm in order to see a wider range of “activity” in the blood spatter and its appearance. Throughout my 10cm-50cm range, my hypothesis was supported as expected. Through my 50cm-100cm, there was a change in the appearance of the blood spatter that I did not expect, therefore I came up with my own hypothesis for this that maybe the air bubbles in the droplet could have affected it, but I was proven wrong by my research. My conclusion came to that yes, the higher the blood was dropped from, the wider the spatter will be on the white paper acting as my surface, but there were a couple of things such as its color pigmentation and satellites that changed throughout my height range, as mentioned before, that was unexpected but later researched and found an answer to.

Biochemistry

Biochemistry

A6 Using siRNAs to Promote Homology-Directed DNA Repair
B12 Effects of Different Sunscreens
C17 Separation of Collagen from Eggshell Membranes as Dietary Supplements
D25 Utilizing Biochemistry of Enzymes to Design Effective Stain Removers
F1 Varying Lipid Production Efficiencies among Microalgae
F12 Molecular Dynamics Simulations of Botulinum Neurotoxin Inhibitor
F25 Do Natural Compounds Have Antibiotic Properties?
F28 Does Bar Soap Damage Your Skin ?
G5 Antimicrobial Copper and Liver of Sulfur
G12 Developing A Pre-Diagnostic for Chemotherapy
G26 Which Fruit or Vegetable Produces the Most DNA Extraction?
G27 Generating Electricity Using Biowaste
H15 The Effects of Mouthwash on Oral Bacteria
H21 pH's Effect on the Oxidation of Apples
H24 The Effect of Meso-tetra Porphyrin on Alzheimer's Disease
J2 The Hemagglutinating Effect of Lectins on Blood of People with PCOS
J19 Building a Better Microbial Fuel Cell
J24 Building a Model For Separation and Migration of DNA
K18 Designing A Thyroid Hormone Detection System
K19 Reducing Methane Emission in Cow Manure
K21 Natural Antiseptic Remedies
N16 Engineering Recombinent Virus To Express tBid Exclusively In Cartilage
P7 Investigating Photosynthesis with Algae Balls

A6 Using siRNAs to Promote Homology-Directed DNA Repair

Biochemistry
Karan Mehta
Bancroft School

Since the discovery of The Clustered Regularly Interspaced Palindromic Repeats (CRISPR)/Cas9 genome editing tool, scientists have pursued research to determine how this tool can be modified to allow for greater accuracy. One proposed approach is to induce the Homologous Recombination (HR) repair pathway by knocking down genes associated with its low-fidelity alternative, Non-homologous End-joining (NHEJ). This theory was tested by knocking down three proteins essential to the NHEJ pathway: Ku70 (encoded by XRCC6), the protein encoded by XRCC4, and DNA-PKcs (encoded by PRKDC). The genes encoding these proteins were knocked down by means of Small (or short) interfering RNAs (siRNAs) in a HEK293 cell line stably integrated with the Traffic-Light Report system. The TLR system allows for the efficient scoring of which repair mechanism was used, HR represented by the expression of GFP (green) and NHEJ by the expression of mCherry (red).
Preliminary results have proven that the Cas9 has cleaved the TLR reporter and shifted the reading frame, as mCherry has been detected. Additionally, the donor has been successfully inserted, as GFP has been detected. However, the experiment has not provided enough insight into whether or not the hypothesis was rejected or supported. In the future, the goal of this experiment will be to conduct replicates and to statistically analyze these replicates by means of a T-Test. Additionally, the following genes, known to be involved with either the HR or NHEJ pathway, will be investigated: Rad51, MRE11, Rad50, XRCC5, and BRCA2.

B12 Effects of Different Sunscreens

Biochemistry
Brigid Moriarty
Westfield High School

The purpose of my experiment was to find out which brand of sunscreen works the best to prevent your skin from the harmful UV rays of the sun, and if price has anything to do with the sunscreen's ability. My hypothesis was that the more expensive sunscreen would do the best job at blocking UV rays, because it would be a better quality. To conduct my experiment, I used UV detecting beads, instead of skin. UV beads go from a clear color to darker shades when they are exposed to UV light. To keeps my variables consistent, I used a UV lamp instead of the sun. Each sunscreen was on its own plate of beads, and then placed under the UV lamp for 2 hours, the recommended time under the sun before reapplying.
Some things that I noticed while conducting my experiment was how different the sunscreens were. Three brands of sunscreens were used in my experiment; Neutrogena, Coppertone, and Banana Boat. If my hypothesis was correct, then the Neutrogena sunscreen should perform better in this experiment because it is much more expensive than the other two brands. The brands differed in color, texture, and odor, making application unique each time. For example Neutrogena sunscreen had the best quality each time; it was a smooth texture and had a low odor. But, it showed a thinner application than the less expensive brands.
The results of my experiment were not a shock, but there were a few little surprises. The lotion sunscreen performed better than the spray sunscreen almost every time, because of its thinner application and consistency. As expected, Neutrogena was a clear winner. In 3/4 sections, Neutrogena tied for first place. The only time that Neutrogena came in 2nd place was with the spray sunscreen with the SPF of 100.

C17 Separation of Collagen from Eggshell Membranes as Dietary Supplements

Biochemistry

Ngoc Tram Nguyen, Amy Qian
Miss Hall's School

Collagen plays a vital role our well-being whether we notice it or not. Those who do can't help but want more in the form of supplements. Little do they know, the collagen that they are drinking is not from the safest source. Collagen on the market is not cheap, therefore not accessible to everyone. Our project aims to address this problem by producing collagen from the safest and organic source, ensuring your health, as well bridging the economic gap, addressing landfills and environmental issues, cutting cost and making collagen accessible to everyone, not just the middle and upper class. We extracted collagen from eggshell membranes, in hopes of greener future.

D25 Utilizing Biochemistry of Enzymes to Design Effective Stain Removers

Biochemistry

Janani Ram
Westborough High School

Biological molecules play a central role in our lives, ranging from curing diseases, monitoring health, and producing drugs, to aiding us in day to day activities like cleaning our clothes and dishes.
However, biological molecules are very complex and are optimally active in specific conditions. Additionally, they are more expensive to manufacture, therefore the amount used is a critical aspect of determining the cost of the product that they are a part of. This is especially true in products such as laundry detergents, stain removers, and dish washing liquids.
Enzymes are a class of biomolecules that are potent catalysts that are prevalent in all life forms, and can be produced in large scales cost effectively using bacterial systems, for use as additives in laundry detergents, stain removers, and dish washing liquids.
Enzymes are effective only under certain conditions and concentrations, and only work on specific substrates. Therefore, in designing products containing them, it is important to optimize the relative proportions and concentrations of these enzymes, as well as conditions such as pH and temperature. Currently, however, the manufacturers take a “one size fits all” approach, and provide no instructions for specific use or make products for specific applications.
This study has provided a very good understanding of the various factors affecting amylase and lipase activity. The study provides the optimal conditions for stain removal using these enzymes. Implementing these conditions when removing a stain containing starch is very feasible,for example,one could make a solution with warm water, a small amount of baking soda, and add a small amount of amylase, with a detergent, as a pre-treatment to completely degrade the stain.

F1 Varying Lipid Production Efficiencies among Microalgae

Biochemistry
Katherine Beadle
Bishop Feehan High School

The concern related to a global energy crisis remains at the forefront of discussion because conventional sources of energy, such as fossil fuels, are finite and innovative methods for production of clean energy are sparse. Microalgae are small organisms that convert sunlight into energy through photosynthesis and have been identified as a clean, renewable alternative source of fuel. However, not all genera of algae produce lipids at the same rate. The purpose of this experiment is to cultivate various genera of algae using a photobioreactor, and through an analysis of lipid content, dissolved oxygen content and water conversion, identify the genus that yields lipids most abundantly and thus represents the best potential source of biofuel production.
A photobioreactor was designed and constructed to provide twelve samples of algae with identical environmental conditions during the photosynthetic process. The dissolved oxygen content of each sample was measured daily to determine the respective carrying capacities, and water volume was measured to compare photosynthetic activity among species. The lipids were then extracted using the "Folch method," a 2:1 chloroform methanol (v/v) mixture, washed with sodium chloride and isolated via centrifugation. The lipid content was then measured and recorded. The results of the experiment indicated that the peak dissolved oxygen content (mg/L) ranged from 5.6 to 4.4. The water (mL) converted through photosynthesis varied from 9.5% to 52%. Finally, the lipid yield per sample ranged from 1% to 31%. The genus of algae that proved to be the most efficient for biofuel production was Ankistrodesmus, a result which runs counter to the literature reflecting Chlorella as one of the most prolific and widely used specimens.

F12 Molecular Dynamics Simulations of Botulinum Neurotoxin Inhibitor

Biochemistry
Katherine Huang
Lowell High School

Botulinum neurotoxin serotype A (BoNT/A), a protein produced by the bacterium Clostridium botulinum, is the most poisonous poison, with a median lethal dose of 0.1 ng/kg. BoNT is composed of a heavy chain and light chain, which cleaves the SNARE protein complex necessary for neurotransmission, causing botulism, a disease characterized by muscle paralysis and autonomic dysfunction. Botulism, typically contracted via consumption of contaminated food, has limited antitoxins and affects the body up to six months; therefore, it is a public health hazard and potential bioterrorist threat. However, miniscule amounts of BoNT are used in cosmetic products, such as Botox, and in effectively treating hyperactive muscle disorders, chronic pain, and clinical depression. This research aims to analyze the binding strengths of potential inhibitors using molecular dynamics simulations, run with GROMACS on high-performance GPUs, of forced unbinding. The results provide atomic-resolution insight into the efficacy of possible drugs and demonstrate the usefulness of computational tools in drug discovery.

F25 Do Natural Compounds Have Antibiotic Properties?

Biochemistry
Ineida Alves, Ngoc Le
Excel High

Antibiotics are group of medicines that are used to treat infections caused by bacteria and are normally prescribed for serious bacterial infections. In addition, natural compounds have antibacterial properties and are used all over the world. Many known antibiotics such as penicillin, erythromycin and streptomycin were all discovered in natural compounds (fungus and bacteria). However, bacteria can change such that antibiotics are less effective.This leads to antibiotic resistance, a condition in which bacteria become immune to antibiotics. Resistance is a concern because it makes treatment difficult and expensive. Our project is important because natural antibiotics could be a useful tool for combating infection and resistance.
Our hypothesis is natural compounds will have equivalent antibiotics properties to synthetic antibiotics. We tested our hypothesis by using six natural compounds: allicin, curcumin, caffeine acid, olive leaf extract, oregano extract, olive leaf extract, cayenne, as our independent variables and kanamycin as our control. By measuring the zone of inhibition, the circles appeared on the Petri dishes if either E.coli or Brevis was killed, we were able to figure out how effective our natural compounds had on the two strains of bacteria. In conclusion, only oregano extract and kanamycin were able to stop Ecoli from growing while five other natural compounds did not show any zone of inhibition on both bacteria.

F28 Does Bar Soap Damage Your Skin ?

Biochemistry
Rayana Gay
Edward M. Kennedy Academy for Health Careers

The purpose of this project is to investigate the different effects bar soap can have on your skin. When testing you can determine if some types of soaps are more damaging than others. Does bar soap damage your skin? My hypothesis is: If I test 6 different types of Dove bar soaps and 1 homemade bar soap, then the homemade bar soap will be less damaging, because all the products used to make the homemade bar soap are natural and good for you. During this experiment, II tested pH levels using litmus paper; and I tested different skin properties using the Hydr8. The homemade soap was more alkaline and the Hydr8 results were inconclusive. The bars of Dove soap showed to be less damaging than the bar soap; therefore, my hypothesis was incorrect.

G5 Antimicrobial Copper and Liver of Sulfur

Biochemistry
Johnna Farnham
Westfield High School

As a handmade jeweler, I often use liver of sulfur, also known as potassium sulfide, to patina or age copper. I knew copper is naturally antimicrobial so then I began to question if the contact property of copper would be changed by the potassium sulfide. My hypothesis was that when copper is treated with liver of sulfur, it will no longer be antimicrobial. Using safety protocols, I worked with my designated supervisor to culture bacteria and then apply regular and treated copper sheets to the dishes of bacteria. After leaving the completed dishes in the 37ºC incubator for a week, I found that a zone of inhibition had formed around two out of the four natural copper sheets and three out of the four treated copper sheets. This disproves my hypothesis that when copper is treated with liver of sulfur, it will no longer be antimicrobial. More trials should be done; however, this proves that copper is still antimicrobial with a patina and can be used as an antimicrobial surface in places such as hospitals and kitchens in the future.

G12 Developing A Pre-Diagnostic for Chemotherapy

Biochemistry
Shivi Maheswaran
Lexington High School

As tumors grow large, its center does not receive adequate oxygen, a condition known as hypoxia. A minor fraction of tumor cells survive this adverse condition. I hypothesized that cells surviving hypoxia would also be resistant to cancer therapeutics and tested this using breast cancer cells treated with chemotherapeutic drugs. I specifically used cells derived from Triple Negative Breast Cancers (TNBCs); a subtype of breast cancer, which is treated predominantly with chemotherapy. The TNBC cell lines, BT459, MDA-MB-468, MBA-MB-157 and MDA-MB-231 were grown under either hypoxic or normoxic conditions and treated with increasing concentrations of chemotherapy drugs, docetaxel and doxorubicin. I used Cell Titer-Glo to quantify cell viability in untreated and drug treated cultures. Data analysis showed that BT549 and MDA-MB-468 cells exposed to hypoxia were resistant to chemotherapeutic drugs whereas MDA-MB-231 and MDA-MB157 were not. Interestingly, both BT549 and MDA-MB-468 harbor PTEN mutations, which are not present in the other two cell lines. Furthermore, comparison of gene expression showed that BT549 and MDA-MB-468 exhibit down regulation of the TGFß pathway compared to the other two cells. Previous publications implicate both PTEN and TGFß in hypoxic responses. Taken together, these findings for the first time identify two classes of TNBCs depending on their drug responsiveness under hypoxic conditions and suggest that PTEN and TGFß signaling might have a role in mediating these effects. I will test this further by combining drugs that target TGFß and PTEN pathways, to determine whether they would enhance the effect of chemotherapy induced cell death of TNBCs grown under hypoxia; The goal being to reverse hypoxia-induced resistance to chemotherapy.

G26 Which Fruit or Vegetable Produces the Most DNA Extraction?

Biochemistry
Madge Piard
Edward M. Kennedy Academy for Health Careers

The purpose of conducting this experiment is to determine the quantity of DNA that each fruit and vegetables carries. My scientific question is among the three fruits and vegetables: onion, kiwi and banana, which one produces the most DNA per gram? I predict that the vegetable (onion) will contain the most DNA because of its cell structure. An onion's cell structure is made up of many layers, so it will contain the most DNA. To obtain DNA from each fruit and vegetable, I will break them down to have access to the inner cell. I will use ethanol to lift up the DNA from the broken down cell, and I will later calculate the amount of DNA in grams, and observe which fruit or vegetable contains the most DNA. After conducting this experiment, i found out that the onion had the most DNA extract. Compared to the extract from the kiwi and the banana, the onion extract was quicker to appear and the amount was abundant. My hypothesis was correct, the onion contained the most DNA.

G27 Generating Electricity Using Biowaste

Biochemistry
Juliana Pereira, Eunnindy Sanon
Edward M. Kennedy Academy for Health Careers

The goal of the project was to construct a working two-chamber microbial fuel cell with a maximum output of 0.4 volts (V) or more. A microbial fuel cell is a fuel cell in which the naturally occurring electrochemical processes of anaerobic bacteria breaking down food, are harnessed to generate electricity but the electrical current created by electrons extracted from those bacteria. On top of that, the goal is to test which type of waste would be suitable for a constant electrical current, whether it is pond water which I will extract from the Jamaica Plain Pond or manure which I will obtain from Home Depot. The whole experiment will be conducted at Northeastern University and I have a partner who will assist me in the process and will be holding a different experiment revolving around the MFC. We have created three prototypes in order to have an MFC that can meet our credentials.

H15 The Effects of Mouthwash on Oral Bacteria

Biochemistry
Chloe Burke
Bishop Feehan High School

There are over 700 different strains of bacteria that can live in the human mouth. People can host 34-72 different types of bacteria in their mouth at a time. Although people can't see, taste, or feel bacteria, it is always present. Bacteria can cause gingivitis and plaque build-up. The only proven way to get rid of oral bacteria is to brush your teeth, floss, and most importantly, use antibacterial mouthwash. Brushing alone misses 70% of the bacteria in a person’s mouth. The problem with this is that people use all different types of mouthwashes, not knowing which one kills the most bacteria. The approach to this experiment was to buy five types of mouthwash, including Listerine, ACT, Crest, CVS brand, and Colgate, then to test each one on four agar plates and incubate them multiple times. The hypothesis for this experiment was that Listerine would kill the most bacteria because of what the company has accomplished and the popularity of this product. The expected outcome was that Listerine would kill the most bacteria because it also has the best ratings. From this process, it was determined that CVS brand mouthwash had the largest zone of inhibition out of all the mouthwashes tested. Even though it is just a store brand, it has mostly natural ingredients which caused the great results. Out of these five mouthwashes, CVS brand killed the most bacteria, which can show people what the difference is between this mouthwash and the mouthwash they are using. Hopefully, these results help improve people’s hygiene and bring people to having a healthier mouth. Mouthwash has been around for hundreds of years and continues to improve people’s mouths by clearing bacteria away.

H21 pH's Effect on the Oxidation of Apples

Biochemistry
Mairead Baker
Boston Latin Academy

When people are cooking with apples, or simply just eating the fruit, they brown after quickly being exposed to the air. To solve this problem and in conclusion, letting apple slices soak in lemon juice for an hour or more can help slow the oxidation process after being exposed to the air. My testable question was, “How do liquids of different pH’s affect the oxidation of a sliced apple?” For research, I figured out that apples contain a high level of water, fructose, and vitamin C. They are acidic, so my hypothesis was that the lemon juice would protect it from browning the most. To test this, I used 6 plastic bags, and each contained ⅓ cup of a different substance with a different pH level. I left 1 apple slice in each for an hour, and documented my observations. I found out that substances with low pHs, on the acidic side, preserve an apple better than do bases.

H24 The Effect of Meso-tetra Porphyrin on Alzheimer's Disease

Biochemistry
James Kim
Phillips Academy

As of today, porphyrins have not seen a large amount of extensive use in practical applications, with their main function being involved in the support of aerobic life. This study delved into examining the effects of porphyrins on several aspects of behavior in Drosophila melanogaster. After examining the properties and chemical structure of meso-tetra porphyrin (or TPPS), it was predicted that Drosophila melanogaster fed media containing varying concentrations of TPPS would see a general increase in locomotion, nociception perception, and neuromuscular system function.

In the Drosophila melanogaster, a simulated version of Alzheimer’s disease was created through the UAS/GAL4 system. Multiple tests were conducted to determine whether the stated hypothesis was supported. To begin, locomotion tests were enacted by placing several groups of larvae in several petri dishes coated with a film of agar gel. The motions of the larvae were observed over a period of about 10 minutes. Nociception tests were also held by using a heated probe from a hot water bath in order to bring about a reaction During this time period, the neuromuscular system function test was also conducted. This involved using a climbing assay with a glass column and Parafilm to accurately determine if the TPPS that was fed to them helped alleviate the symptoms of the simulated Alzheimer’s disease.

It was determined that the previous hypothesis was supported. Flies that were fed the meso-tetra porphyrin showed an increase in physical abilities, pain response, and locmotion. This study concludes that the meso-tetra porphyrin demonstrated very positive effects on the behavior and general health of Drosophila melanogaster with Alzheimer’s disease.

J2 The Hemagglutinating Effect of Lectins on Blood of People with PCOS

Biochemistry
Chloe Byrne
Ursuline Academy

Two years ago, I participated in the Region V Science Fair and MSSEF with my project, Beans For Your Blood Type. The goal was to use the hemagglutinating effect of lectins found in certain beans to determine blood type. While researching, came across an abstract for immunochemical studies on the combining site of the blood group A-specific Lima bean lectin, LBL. The article mentions how a precipitate and agglutination formed only when the LBL was mixed with the A- blood group, which they referred to as the ovarian cyst group. This sparked my interest because my family has been personally affected by Polycystic Ovary Syndrome, a disorder of the endocrine system, which usually results in cysts on the ovaries, due to the body's excessive production of androgens. So, I began wondering if certain foods containing lectins have the ability to reduce or worsen the symptoms of PCOS. To test this, I used presence or lack of agglutination in every blood group with foods (vegetables, fruits, etc.) containing lectins proven to have an hemagglutinating property. The test involved foods that people with PCOS have issues with, and those that actually have been proven to reduce their symptoms. I hypothesized that if the foods that cause health issues specifically in people with PCOS agglutinate the A- blood alone, then obviously there may be a connection between PCOS and lectins that induce hemagglutination in the person with the syndrome. If the foods that help prevent symptoms of PCOS didn't cause agglutination in the A- group, then this could suggest that certain lectins react with the blood in a way that lessen the symptoms, and could lead to easier treatments. The other three main human blood groups B-, AB+, O- were also tested for comparison.

J19 Building a Better Microbial Fuel Cell

Biochemistry
Umar Padela, Patricia Chan
Braintree High School

Microbial Fuel Cells (MFC) make use of the normal metabolic processes of microbes to produce energy and fresh water. The fact that the MFC is able to produce fresh water while simultaneously generating energy makes it of much interest to help third world countries which lack both of these resources. The current problems with MFC are the high costs and low power outputs. This study aims to measure changes in power output caused by changing electrode size, microbe concentration, and glucose concentration in the anode. We predict that, if electrode size is increased, then power output will increase. If microbe concentration is increased, then power output will increase and a biofilm will form. If glucose concentration is increased, then power output will increase.

J24 Building a Model For Separation and Migration of DNA

Biochemistry
Dania Halak
Revere High School

The purpose of this project is to serve as a model of the laboratory method gel electrophoresis and to teach how it works. The problem is to build a gel electrophoresis chamber model and use it to compare molecules in different colors of food coloring dyes. The main procedure is two steps: first, build the chamber, and then the gel that will run the experiment. I expect some macromolecules to separate and run further than others based on size. As a result, the food coloring dyes migrated, moved from one side of the box/chamber to the other. The green migrated 3.3cm, the red 2.9cm, and the blue 2.3cm. Also, 2 of the food coloring dyes showed clear separation into their original pigments: the green dye separated into a blue and a yellow band, while the blue dye into a blue and a faintly small red band. In conclusion, the results met both hypotheses. First, some dyes ran father on the gel than others. This indicates that the gel separated the macromolecules by size, allowing the smaller molecules to travel farther. Second, some food coloring dyes separated into 2 bands, which indicates that the food coloring used was made of different components. When attempting this project, one can learn a lot about gel electrophoresis since it is not an easy project and everything should be done accurately and correctly, thus one can gain experience from failures and earn knowledge about gel electrophoresis and how it works.

K18 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 diseases 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 for patients. As a result, many individuals with hypothyroidism don’t get their 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. Various chemical reactions will separate the iodine from the thyroid hormones and subsequently react it with aluminum to form a salt, creating a proportion between the salt, or a certain vector of the salt, to the original thyroid hormone levels. This project aims to create such a system that will help individuals with thyroid issues receive adequate treatment and better medication through frequent and cost-effective monitoring of their hormone levels in the comfort of their own homes.

K19 Reducing Methane Emission in Cow Manure

Biochemistry
Aneeha Dalal, Kim Wilfong, Chloë Deveney
Grafton Memorial Senior H. S.

Global warming is drastically changing our world day by day. One of the main greenhouse gases contributing to global warming is methane. Ruminants (mammals such as sheep, cows, and deer, that have four compartments that make up their stomachs), emit large amounts of methane gas. These compartments are the reticulum, rumen, omasum and abomasum. All ruminants, specifically cows, heavily contribute towards global methane emissions because they contain a rumen compartment. The rumen compartment is where a ruminant, such as a cow, holds bacteria known as methanogens which help aid in fermentation and create the by-product, methane. Although treatments to reduce methane in humans, such as antibiotics, have been proved effective, using these same treatments in a cow would be detrimental to the animal's overall health. Our goal is to find ways to decrease methane production without using any substances that would be harmful to the cow. To do this, we will modify methanogens in the cow's Protozoa, outside of the cow and then measure amounts of methane.

K21 Natural Antiseptic Remedies

Biochemistry
Jordan LeSage
Berkshire Arts & Technology Charter Public School

Natural antiseptics have been proven to have several health benefits. They work well as remedies on many different types of infections, wounds, and illnesses. Honey, tea tree oil, and ginger are some of the most effective natural antiseptics. They have many enzymes that allow wounds to conserve its viscosity yet it still kills the bacteria. Many studies have proven that some natural antiseptics have been more effective than pharmaceutical antiseptics. Putting drops of honey, tea tree oil, and ginger directly onto yeast has proved that tea tree oil will be the most effective natural antiseptic is tea tree oil. It killed the biggest area of yeast in the petri dishes compared to the honey and ginger water.

N16 Engineering Recombinent Virus To Express tBid Exclusively In Cartilage

Biochemistry
Daniel Gaines
Martha's Vineyard Regional H. S.

This research endeavor explored utilizing recombinant Adeno-Associated Virus (AAV) to induce intrinsic apoptosis (cell death) exclusively in human cartilage cells. Several diseases related to cartilage overgrowth exist, including pectus excavatum, a chest deformity that is estimated to affect 1 in 300-400 children at birth. The vast majority of these overgrowth diseases require invasive surgical operations to remove the excess cartilage. If successful, this form of gene therapy would target only chondrocytes, reducing the risk of collateral damage to other tissues present in current treatments.
Vector Builder, a company dedicated to providing safe viral technologies, was used to construct the AAV vector. The backbone of the AAV vector contained a cartilage tissue specific promoter, the apoptosis inducing gene (tBid), and the gene Enhanced Green Fluorescent Protein (EGFP) to track cellular transfection and cellular death. A transfection kit sold by Cell Applications provided the necessary reagents to create an artificial phospholipid viral envelope with Adenovirus glycoprotein receptors for the viral vectors, allowing them to enter host cells through endocytosis.
The results of this experiment are unclear, due to the severe injury or death of the chondrocytes from a fungal contamination. For future trials, the University of Massachusetts Dartmouth is providing a biological safety cabinet equipped with High Efficiency Particulate Arrestance (HEPA) filters. This piece of equipment will be critical to preventing unintended contaminations to the cell cultures during future trials.

P7 Investigating Photosynthesis with Algae Balls

Biochemistry
Do Mai, Manyeuiris Soriano
John D. O'Bryant School of Mathematics and Science

This experiment is designed to determine how much energy is produced by algae balls when exposed to different intensities of light. By measuring the change in the pH of the water that the algae balls reside in you can determine the relative amounts of CO2 produced from the photosynthetic process. An increase in the production of CO2 correlates directly to energy production from photosynthetic activity. CO2 production was measured by the level of pH in the water. A decrease in the amount of CO2 meant an increase of the pH and vice versa. The result of this experiment showed that algae balls exposed to high intensity light will increase the amount of photosynthetic activity during a given time period and therefore will increase energy production. Lower intensity light correlates to lower energy production.

Chemistry

Chemistry

A13 Brightening At Levels
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H4 Radiating Devices
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J8 Warriors of the Winter
K3 Purifying Salt-Water
K5 Denaturing Proteins: In Which Conditions Do Proteins Denature?
K7 How Safe Are You from Acid Rain?
K20 Novel Method for Removing Contaminants from Surfaces Using Nanobubbles
N4 Salt Bridge (Not an Engineering Project)
N11 What Makes a Good Quality Lip Balm?
N15 Plop Plop, Fizz Fizz
N21 Borax Recrystallization
N22 Novel Biochemical Nanoparticles as Contrast Agents For Bio Imaging
N24 Fruitizymes!
P4 Electrolyte Challenge: Orange Juice Vs. Sports Drinks
P6 Have Your Cake and Eat It Too!
P10 The Geochemistry of Bottled Water
P19 The Effect of Musa Acuminata Ash's Flame Retardancy Compared to NaHCO3

A13 Brightening At Levels

Chemistry
Alice Wong
Taunton High School

The concept of teeth whitening has been around for quite some time now. Having whiter teeth is perceived as better looking and healthier teeth. Some people who want to have whiter teeth for themselves often look for the best choice possible after considering their needs. Options include going to the dentist, teeth whitening kits, whitening toothpaste, etc. But out of all the services out there, finding the right one, no matter what is chosen can possibly lead to the same results. Of course there are slight differences between each product/service but they all use the same ingredient, Hydrogen Peroxide, to get the aimed results. Different levels of hydrogen peroxide will serve either as a strong or weak bleaching agent for teeth whitening. How much difference between one concentration verses another is the goal of this experiment. In this experiment the hypothesis was that there will not be much difference considering that hydrogen peroxide used are not at a high level of concentration. Using the concentrations that I decided to use, it is expected for them to not reach a significant shade difference. Egg shells were used to act as human teeth and different levels of concentrated hydrogen peroxide was placed on them to simulate how teeth whitening works. They were then put into a closed cabinet under UV light for forty-five minutes for each trial tested. The result of this experiment is that none of the levels of Hydrogen Peroxide produced an eight shade difference. So the hypothesis is supported that using the different concentrations of Hydrogen Peroxide, it did not yield a significant shade difference. From the data collected, it can be concluded that a higher level of concentrated Hydrogen Peroxide needs to be used in order for the results to be significant.

A18 Dye Concentration in Naturally and Artificially Colored Drinks

Chemistry
Cameron Davignon
Westfield High School

Multiple studies prove common food dyes to be causes of negative effects on health, most severely brain cancer. This project enabled the determination of these potentially dangerous dye's concentrations in some of the most common naturally and artificially colored juices, of which I hypothesized the artificial to be most concentrated. This information can be used to set healthy standards of dye amounts in processed foods and drinks.
Concentration was determined through a series of dilutions of each drink used and the measuring of their absorbances using a light spectrometer. These values were compared the pure dyes, which were also diluted and analyzed, to determine their reasonability and level of health.
Overall the artificially colored drinks exhibited the highest concentrations over the naturally colored drinks. One drink tested was seen to be cloudier than the rest and was filtered to improve the spectrometer's absorbance testing but received results were unreasonable and consequently ignored. However, each of the other juices were reasonable. The hypothesis was proven to be true through the unanimously higher concentration of dye displayed in artificially colored drinks. These results can be used by the FDA or USDA to make knowledge of the potential dangers of dyes more widespread. Implementing a maximum allowable dye concentration in processed foods and drinks would be very impactful societally because it could increase the overarching level of health within these foods as well as remove any associated dangers that may accompany the dyes contained in these drinks.

B6 Which Fabric is Better Suited to Overall Outdoor Use?

Chemistry
Cameron LaCourse
Taunton High School

People are always concerned with what to wear, but when it comes to going outside, most people just throw on a T-shirt and shorts or jeans, not realizing there could be a smart choice to this. This project studies what some shirts are made of...literally, by testing the fabrics that compose them. First, the shirts were stretched on a homemade rack to evaluate stretchiness through resistance. Second, they were heated up in an average dryer to see how much heat they can hold on to. Finally, people put them on and rated how they felt. Cotton fabric keeps its heat, losing an average of 0.9℃ less than its competition, while polyester put up the least resistance when stretched, at only 0.0831 kg of resistance per percentage of its original length stretched. Ultimately, it was found that a poly-cotton combination can do both and feel great at the same time, with nearly 5 out of 5 comfort ratings in each category. This project shows exactly what a person should wear in the great outdoors.

C1 Which Drinks Contain the Most Blue Food Dye?

Chemistry
Lauren Harrington
Bishop Feehan High School

The topic of this project is trying to find out which common juices, sports drinks, and sodas have the most blue food dye in them, and how much of the drink is made up of food dye. This is being tested and researched because it is important to know what we are consuming, how much of it we are consuming, and how it affects our bodies. My hypothesis is that if a given drink is a bright color, then it will have a higher reading of food dye determined by the spectrophotometer. Also, I predicted that Kool-Aid will have the highest concentration of food dye and Cool Blue Gatorade will have the lowest concentration of food dye, based on their looks. The spectrophotometer will be constructed using a kit and it will test the resistance on a multimeter while a light is being shone through a drink sample. The higher the resistance is, the more concentrated with blue food dye the drink will be. Before the data for the drinks are recorded, known concentrations of food dye must be tested so that the resistance values of the known concentrations can be compared with the drink resistances, revealing their concentrations. Once the concentrations of the drinks have been obtained by their resistance being matched up with their corresponding concentration, the drinks can be compared to see which one has the highest percentage of food dye. The results showed that my expected outcome was wrong for the least amount of food dye, which was the Powerade, but was correct for the most amount of dye, Kool-Aid. They also revealed that most drinks have less than or nearly equal to .1% of food dye in them.

C8 C "No" 2: A Novel Method to Reduce CO2 Emissions from Motor Vehicles

Chemistry
Vishnu Penubarthi
Shrewsbury High School

Excessive amounts of CO2 in the atmosphere have been linked to global warming, climate change, and damage to the human body. Various groups have proposed different solutions on this overarching issue, but many of these solutions have significant flaws. The purpose of this experiment was to find a viable solution to this problem that doesn't have these flaws by finding a chemical which would best react with CO2 and place it in a filter which would be fitted on the end of a model of a tailpipe, as motor vehicles are major contributors to excessive CO2 levels. To do this, a model of a tailpipe was created, and four substances (lithium hydroxide, sodium hydroxide, potassium hydroxide, and calcium oxide) were chosen along with the control (no substance) based on prior research. In each of the 20 trials done for each of the five groups, 12 grams of CO2 passed through a filter containing 10 grams of the substance (nothing for control). The difference in the mass of the filter was used to calculate the amount of CO2 absorption. The results were that lithium hydroxide was the best at absorbing CO2. Even though lithium hydroxide was the best CO2 absorber, due to its high price, calcium oxide, which is much less expensive, might be a more feasible chemical to use within a filter. Overall, these chemicals, and the idea of a filter at the end of a tailpipe, provide a novel solution which can be seamlessly integrated into everyday life.

C20 Temperature Dependent Kinetics of a Self-Healing Polymer

Chemistry
Philip Onffroy
Bancroft School

This laboratory research project involves the synthesis and characterization of a self-healing tetrafuran-bismaleimide polymer that takes advantage of the reversibility of a Diels-Alder reaction. First, the tetrafuran monomer is synthesized with the addition of four furyl-succinic acid arms to a pentaerythritol molecule. Tetrafuran is then polymerized with bismaleimide to form a highly cross-linked, self-healing polymer. Detailed verification of both the synthesized monomer and the final polymer is obtained through the use of Nuclear Magnetic Resonance (NMR). After polymer creation, its ability to self-heal will be tested under different temperatures using creep analysis. This will result in quantitative data that will be analyzed to determine if the polymer's rate of healing changes with temperature. If so, the kinetics order of the reaction will be determined and a rate constant for healing versus temperature will be calculated.

D3 The Effect of Chemicals and pH on Coagulation

Chemistry
Annabelle Mathers
Wachusett Regional High School

The intent of the project was to evaluate effects of variations of chemicals and pH on coagulation. This water treatment method removed water turbidity using polyaluminum chloride (PCH), ferric sulfate and aluminum sulfate (alum) coagulants. Chemical coagulation destabilized particle charges in the water, allowing particle attraction and floc formation through physical flocculation. Heavy metals, trihalomethanes and other contaminants had potential to be removed.
Using industry standards, 0.2 mL coagulant was used per 150 mL water. Coagulants were tested separately using three pH levels (high, medium, low) within individual ranges. A magnetic stirrer created flocculation and a turbidity meter provided results. Clay (0.05 g) was added to increase overall floc formation. Solutions flocculated for eight minutes and rested for fifteen minutes, with a sample of treated water then measured for turbidity. Nine total chemical and pH combinations were each tested ten times.
The PCH yielded the highest quality floc and least average turbidity. Ferric sulfate yielded the second lowest turbidity and alum had the highest turbidity. As pH rose, PCH and alum displayed increasingly lower turbidity. Ferric sulfate was most efficient at a medium pH. Highly polymerized PCH structures and their ability to withstand charge changes created a universal destabilizer. Ferric sulfate and alum underwent pH levels too acidic for their alkaline base and pH too basic for floc structure (restabilization). All results were significant, except four combination pairings. These overlapping averages shared pH workability, inspiring extensions testing coagulant combinations, and potential improvements in polymer and chemical additives.

G1 Which Photo Developer is the Most Effective?

Chemistry
Allison Eldredge
Falmouth Academy

The purpose of this experiment was to discover a more effective alternative to traditional black and white chemical photo developers containing hydroquinone. It was hypothesized that Illford photo developer would have the quickest development time and the best quality followed by, caffenol, beetrootol and the washing soda and vitamin C. Ten test strips were exposed to light and placed in the different developers. The time it took for the test strip to turn black was recorded and the average was used to find the development time for each developer. The development times were then used to print ten prints in the developers. The prints were then compared to The Zone System to observe zones for different sections of the photograph. It was found that caffenol had the fastest average development time of 27.6 seconds, which was faster than the Ilford control which had an average development time of 30.1 seconds, followed by washing soda which had an average development time of 39.6 seconds, followed by beetrootol which had an average of 734 seconds. In terms of contrast of prints washing soda had the same zones as the control. Caffenol was the second best with four out of eleven matches and beetrootol the worst with only one match. The hypothesis was not supported as caffenol was the fastest developer followed by Ilford, washing soda, and beetrootol, and washing soda had the best contrast followed by caffenol and beetrootol. These findings provide useful information for substituting chemical photo developers with safer and cheaper options.

G8 Chemically Curly Hair

Chemistry
Grace Cole
Boston Latin Academy

My objective was to show the effects of popular curly hair taming techniques on the hair cuticle. My research used a product with short chained alcohols and silicones, coconut oil, a straightener, and hair that is simply left alone. The goal was to observe which method caused the most structural damage to the protein scales on the cuticle. Four bags with three unbleached hair stands in each were treated with either heat from a straightener, a coating of coconut oil, a coating of a silicone/alcohol product "Dove" hairspray, or nothing (control). I quantified the damage by counting how many frays on the focused side of the strand there were per .5mm. My data concluded that over a month of twelve treatments the heat strands showed the most significant damage to the hair cuticle with an average of 14 per .5mm.
I had previously thought that the Dove strands would cause damage because it contained a silicone and denatured alcohol (C2H6O) which is a short chained alcohol. Ideally, because short chained alcohols are lightweight they evaporate quickly and steal moisture from the hair. However, in my experiment the Dove product did not display any visible damage due to the silicone sealant. In contrast the hairs treated with heat suffered the most damage. To expand this project one could test the effects of hair cleansing products on the hair strand's cuticle.

G10 Electrifying Fruits and Vegetables

Chemistry
Hurryra Hea
John D. O'Bryant School of Mathematics and Science

This experiment was conducted to see if the acidity of a fruit or vegetable is a factor in conducting electricity. My hypothesis was if the pH of the fruit or vegetable is low, then it will conduct a higher voltage.
To test this question, "How does the pH of fruits/vegetables affect the conductivity of it generating electricity?", different kinds of fruits and vegetables was used. Fruits that I used were, apple, lemon, and tomato. Vegetables that I used were carrot, eggplant, tomato. A penny and galvanized nail was used as the electrodes. The voltage was measured first and the pH was measured second.
The results turned out that the highest pH did conduct electricity better, but the fruit that I expected to have more voltage turned out to be the second fruit with the highest voltage. This can lead to future experimentation by using other vegetables or even testing if temperature has any effect on electricity.

G11 Catalytic Impact of Nickel Nanoparticles on CKD Mineral Carbonation

Chemistry
Nadine Najah
Pioneer Charter School of Science II

To implement the CCU practice (carbon dioxide capture and usage), this project focuses on the catalytic impact of Nickel Nanoparticles (NiNp) on Cement-Kiln Dust (CKD) mineral carbonation at various temperatures. Since mineral carbonation is a fairly slow process, the NiNp will catalyze the reaction to achieve acidic pH values at an earlier time in the duration of the reaction. To determine the impact of NiNp size and temperature on catalysis, round NiNp of distinct diameters (10-30nm, 40-60nm, 60-80nm, 80-110 nm) at room temperature (~16°C), 30°C, 40°C, and 50°C, respectively. Ideally, NiNp of 10-30 nm at 50°C will yield the best results. As a result of pH evolution, NiNp of 40-60 nm diameter at 40°C reached acidic pH values the earliest (4 minutes from start). As a result of IR analysis, the same combination at 4 minutes yielded almost exact wavelengths as that of fully carbonated CKD. For Carbon Elemental Analysis, the same combination yielded 11.04% of Carbon while a sample of CKD that has not undergone carbonation possessed only .13% of Carbon. In conclusion, the hypothesis was not supported by the data, because NiNp of 10-20nm diameter at 50°C was outperformed. However, the results have engendered a novel conclusion regarding the catalytic impact of NiNp on CKD mineral carbonation; with Nickel Nanoparticles magneticity and large surface area, sequestration of excess CO2 in the atmosphere will be efficiently catalyzed.

H4 Radiating Devices

Chemistry
Rukia Nur
Excel High

The objective of this project is to investigate EMR radiation in cell phones and determine whether or not it has potential detriments in humans. Two types of cellphones - iPhone 6S and Samsung 7S were tested by soaking it in water. Temperature change and the amount of radiation were measured using thermometer and Geiger counter, accordingly. Results showed that each cell phone emits little amount of radiation and that Samsung emits more than the iPhone. These results and observations confirmed the hypothesis, even though, the amount of radiation is not detrimental to human health. However, long term exposure of it will eventually result to damage of the frequently exposed tissues that may lead to illness and disorder. This is true to all phones as communication with cell towers use EMR radiation, though some emits more than others.

H7 Does Less Dense Fruits Contain More Vitiamn C?

Chemistry
Saiida Farah, Christine St.Louis-Severe
Edward M. Kennedy Academy for Health Careers

This experiment will focus on the relationship between the amount of vitamin C and the different sizes of fruits. We are testing if the size of the fruits matters in the amount of nutrients and vitamins that you receive after eating it. For example, will a larger apple provide more vitamins than a smaller apple? This experiment is essential and is able to impact society because it can give a better idea as to what is favorable to buy when grocery shopping or what will be more beneficial to eat. If we measure the amount of vitamins C in a larger fruit, it will have a higher amount than that of a much smaller fruit. For our procedure we cut each of the fruits into smaller pieces and then place them in beakers to measure the mass. After measurement we blended the fruits, filtered the pulp and then measured the vitamin C. We concluded that the fruits with the highest density do not alway contain the most amount of vitamin C.

J8 Warriors of the Winter

Chemistry
Bartek Szymanowski, Marcus Babiy
Northbridge Jr.-Sr. H. S.

For our experiment, we tested for the type of salt that could melt ice the fastest. Both of us decided to test for this because it was the winter and we wanted to find the cheapest and most efficient salt to use in melting roads. We tested this experiment by taking three ice cubes, placing them in petri dishes, then adding the 5 grams of salt then timing which ice cubes had melted the fastest. Overall we concluded over a lengthy set of testings that the NaCl (Kitchen Salt) had worked the best for melting ice.

K3 Purifying Salt-Water

Chemistry
Heather Perkins
Berkshire Arts & Technology Charter Public School

Despite the advancements in technology towards purifying salt water methods, many of them are not very effective and are very high in cost. Only 2.5% of the world's water is fresh, resulting in a push towards finding a way to purify water. I chose this topic because purifying water has become an increasingly pressing issue, and performing this experiment helped to open my eyes to the problems the world is facing and all of the problems that come with finding a solution to this problem. The research question being addressed is which method of purifying salt water will be most effective, and the hypothesis I made at the beginning of the experiment was that the boiling method will be most effective in producing pure water. For each method performed, the same amount of salt was added to the same amount of water to make sure that the results would be accurate. The salinity of each salt water mixture was taken before and after the method in order to compare the salinity of the saltwater with the water that had been "purified". The salinity at the end of the boiling method was lower than the baseline measurement, meaning that the result of the boiling method was that any impurities that might conduct electricity were removed from the water through the boiling process. Both salinity tests at the end of the other two experiments showed little change in the amount of salt, confirming that the boiling method was much more successful. Although the boiling method was quite successful, the total loss of water at the end nearly outweighs the benefits. Another experiment that could branch off of this would be freezing the salt into crystals so that more of the salt would be removed from the saltwater resulting in a more purified water.

K5 Denaturing Proteins: In Which Conditions Do Proteins Denature?

Chemistry
Vanessa Bazile, Ky-Auna Joyner
John D. O'Bryant School of Mathematics and Science

Denaturation occurs when protein molecules unravel from their naturally coiled state. This can happen by acid, heat, salt, or other chemicals. pH is used to measure the amount of acid. The highest amount is acidic while the lowest amount is basic, and both are very dangerous. This experiment helps people to know how to get more nutrients from the food, so doing this experiment can help people to see which method is better to denaturalize more efficiently. If we denature proteins with heat and Ph, the way that they will denature will vary due to the fact that they are different foods with different grams of protein and we are using two different ways to do so. We tested how Ph, heat, and both would affect different types of proteins: chicken, fish, eggs, and milk. After we left the proteins in vinegar overnight we cooked it and recorded times and temperatures. We also recorded times and temperatures of the proteins we cooked without Ph and compared results. Our results proved our hypothesis because we got different results with each protein, but the Ph protein and normal protein were very close in results.

K7 How Safe Are You from Acid Rain?

Chemistry
Luana Machado, Kathleen Wong
Methuen High School

In this experiment, the effect of acid rain on varying substances will be tested and analyzed. 6500mL of concentrated nitric acid with a pH of 3.3 will be made in the lab as a substitute for acid rain. A piece of 3in by 3in of rubber, plywood, glass, polyethylene plastic, and aluminum foil will be placed in 200mL of simulated acid rain (concentrated nitric acid with pH of 3.3) for one week. Before experimentation, the materials will be placed on an analytical balance each at a time for their masses to be measured (g). The masses of the substances before experimentation will be recorded. The experimentation will take place under the flame hood. The independent variable is the acid rain (concentrated nitric acid with pH of 3.3) and the dependent variable is the condition in which each substance will be in after one week of being soaked in the concentrated nitric acid with pH of 3.3. At the end of the week, the substances will be taken out and their masses will be re-measured once they are neutralized. The color and texture of the materials before and after experimentation will be recorded for examination. Three trials for each substance will be conducted, including one control trial with distilled water instead of concentrated nitric acid with pH of 3.3.

K20 Novel Method for Removing Contaminants from Surfaces Using Nanobubbles

Chemistry
Sumit De
Foxborough Regional Charter School

Recently, nanobubbles have emerged as an innovation with many potential benefits and applications. The simple application I'm focusing on is the property that water containing nanobubbles can be used as an extremely efficient and effective surface cleaning material. The nanobubbles will be obtained by electrolysis, as when a small voltage is applied between a conductive component and a second electrode in a water bath, bubbles of hydrogen gas form on its surface. Theoretically, if the gas forms directly on the surface, as the bubbles grow they will lift the surface film and carry it off into the water when the bubble leaves the surface. My hypothesis was if electrolyzed water infused with hydrogen nanobubbles is created and used to rinse a surface, then it will be more effective at removing contaminants than ordinary tap water. I used a nickel-plated surface with sulfate ion contaminants as a baseline to test removing contaminants and recreated the conditions of similar experiments and compared how much the partially electrolyzed water weighed after the rinsing the nicked-plated surface compared to other forms of nanobubble water. In conclusion, the data supported the hypothesis, as electrolyzed water infused with hydrogen nanobubbles removed 68% of the target contaminant while tap water removed 43% of the target contaminant. However, it was not as effective as professional nanobubble generators, which removed up to 99% of the target contaminant.

N4 Salt Bridge (Not an Engineering Project)

Chemistry
Gerardo Aguilar
Berkshire Arts & Technology Charter Public School

Electrolysis of water was defined and explained for the first time by Michael Faraday in 1820. From there on, it would become an important industrial process because of the following: the equation of electrolysis yields both pure oxygen gas and hydrogen gas, the latter being important for energy storage. Its growth in industrial use would keep on expanding until natural gas replaced it at being more effective for the production of hydrogen fuel. I picked this project because Michael Faraday is one of the biggest scientist that have ever existed in my opinion, and all his work has been massively important for any advance on science and mechanics in the last two centuries. My hypothesis was, will a solution with table salt and tap water have a major current and thus a better result in the production of these gases, than a solution of distilled water and epsom salts? I prepared two main tests, each with each set of the conditions aforementioned, to see what test had wider gaps between their initial pH's and their final pH's. Then I transmitted a current of 9V through the solutions, using a salt bridge to create a circuit. My hypothesis was proven right: first test finalized with a positive difference (pd) of 3.03 and a negative difference (nd) of 3.64 in the pH, while the second test ended with a pd of 0.44 and an nd of 2.46 in the pH. An alternative to this project could be, could it be used as a renewable source of energy storage if the electricity source is a solar panel and not a battery? Or would it be counterproductive?

N11 What Makes a Good Quality Lip Balm?

Chemistry
Janelle Fuller
Mary Lyon Pilot High School

Your lips are very delicate skin that should be taken care of along with other parts of your body especially if you struggle with chapped lips or licking lips. I decided to put 4 recipes to the test to see which lip balm was the best, and the great part about it is that they all each only have 3 ingredients. The ingredients I decided to test are almond oil, coconut oil, shea butter, cocoa butter, and beeswax. For my hypothesis I believed the if a recipe has almond oil and shea butter combined, then the overall quality of the lip balm will be high. For my materials I used many tubes to pour in the liquid form of the lip balms during the time that they were being made, I also used my refrigerator and oven as part of the experiment to make and test the products. In the end the results were very scattered as many of the experiments led to very different results with the lip balms. Overall, I found that a lot went into creating and testing out these lip products as there never really was a clear definite answer as to finding the absolute best lip balm out of the four recipes.

N15 Plop Plop, Fizz Fizz

Chemistry
Priti Patel
Foxborough Regional Charter School

The purpose of the experiment is to understand how particle size and reaction times are related by testing the hypothesis, if the particle size is small then the reaction time will be faster than the reaction times of the larger particles. The results and data collected supported the hypothesis because the all of the smaller particles had a faster rate of reaction time and a faster rate of how fast the particles dissolved compared to the larger particles. As the particle size had decreased there was an increased amount of exposed surface area because less molecules are trapped inside the body. This increase will cause an quantitative growth in the amount of interactions and in effective collisions.The more effective collisions present, resulted in a faster reaction time. The results obtained were the similar as predicted and can be deemed to be valid due to the pattern presented in all the trials. I was able to learn how as particle size decreases, the reaction time decreases.

N21 Borax Recrystallization

Chemistry

Rina Blanco, Michelle Bui
East Boston High School

We were interested in doing this project because we were always fascinated by the way crystals were formed. It also made us curious as to how laundry detergent can form crystals. The purpose of this project was to purify an organic compound, using only borax and water to test the different conditions that made the purest crystals. Our hypothesis was that the crystals created in room temperature will be the purest and biggest crystals. To do this project we mixed borax and hot water in different temperatures to create a chemical reaction. We found that the crystals made in room temperature were the cleanest while the colder temperature made the heaviest (bigger) crystals, so it didn't fully support our hypothesis. We think this happened because when the temperature of the water is warmer more borax is dissolved than when it is cold. The colder the temperature the fastest the crystals are formed.

N22 Novel Biochemical Nanoparticles as Contrast Agents For Bio Imaging

Chemistry

Si Young Choi
Brooks School

Contrast agents are crucial in medical imaging, effectively improving the clarity and contrast of the targeted body part. Clear differentiation between the body structure and nearby tissue is necessary for accurate clinical examination and diagnosis. Through empirical and computational research, image contrast agents that are higher in stability and safety are examined. Magnetic resonance imaging, a major diagnostic method in modern medicine, is safe due to the absence of damaging ionizing radiation. Researchers have used electrochemical techniques to study aqueous fullerene nanoparticles as not only X-Ray contrast agents, but also MRI contrast agents. This paper uses computational simulations to examine the potential of nanomaterials such as fluorescent functionalized fullerenes, transition metal oxide nanoparticles, and nanoscale metal-organic frameworks to be used as nano-scaled contrast agents in the detection of tumor cells. The paper presents the analysis and comparison of thermodynamic stability of various imaging contrast agents composed of metal oxide a and b by assessing the optimized energy via Avogadro. In addition, the electron properties of contrast agents are examined by Density Functional Theory (DFT).

N24 Fruitizymes!

Chemistry

Sara Wong
North Quincy High School

The purpose of this experiment is to reveal the possible effects fruits in our everyday lives may have after consumption. The hypothesis to this experiment was: "If the strength of proteins (replicated by gelatin) is related to the strength of lemon, lime, orange and pineapple enzymes, then the strength of the gelatin that is exposed to the fruit enzymes will be half as strong as the gelatin that was not exposed to the fruit enzymes." To conduct this experiment you must obtain gelatin, lemons, limes, oranges, and a pineapple. You will then be placing a set amount of each fruit onto the gelatin surface over a span of 3 days to see if there is any deterioration taking place. Record your results as you go and see what happens! After conducting the experiment, the pineapple fruit was the only fruit who was capable of deterioration. The rest of the fruits either had no effect on the gelatin or enhanced its strength. As mentioned before, my hypothesis was not supported. That could have been due to the physical properties of the fruits I have selected for this experiment. This project could potentially inform those who do not know, the effects a fruit really has and what it really does. It may also reveal different properties it may have. Not many people take the time to learn about this information therefore, this is a chance to grasp the concepts.

P4 Electrolyte Challenge: Orange Juice Vs. Sports Drinks

Chemistry
Heidi Thomas
Edward M. Kennedy Academy for Health Careers

Ever get thirsty after a good workout or a good walk? We all do. We all desire something to quench our thirst as well as satisfy our palates. This experiment will let you know the healthiest and most beneficial beverage to drink after your powerful workout. What are electrolytes? Electrolytes are ions that are needed to keep ourselves healthy. Electrolytes are certain nutrients (or chemicals) present in your body that have many important functions — from regulating your heartbeat to allowing your muscles to contract so you can move. Without electrolytes we would not live for long. We would be dehydrated, then we'd pass out, and eventually dry up and die. Orange juice is one of America's most common drinks. Especially in the morning! From this experiment we can all learn that orange juice doesn't have to be just a breakfast drink, it can be an all day drink. This experiment has proved that orange juice is the BEST replenishing energy drink. In comparison to popular energy drinks , Tropicana Orange Juice has the most electrolytes! It is the drink to drink to regulate your lost energy and get you fired up for your next workout. Oranges contain a high level of potassium, which is a key electrolyte for the body. Save some money and don't buy the sports drinks. They false advertise. Orange juice has the greatest number of electrolytes compared to all the energy drinks. No artificial coloring, no artificial flavoring. It's all natural!

P6 Have Your Cake and Eat It Too!

Chemistry
Jayden Reid, Genia Jenkins
John D. O'Bryant School of Mathematics and Science

We chose this project because it seemed interesting to find out if the outcomes of cakes would be different if we changed the important ingredients needed in order to make the cakes. The purpose was to find out whether or not the density, mass, volume, height and length would vary if we were to change the amount of ingredients, or types of ingredients added to each cake. We believed that if we varied the amount and types of ingredients that we added to each cake, then the outcomes would be different.
In this experiment we made 6 cakes in total to test out the differences. Cakes 4-6 were made with self-rising flour instead of all purpose flour. Cake 4 had normal ingredients except for the flour. Cake 5 had self rising flour, and we added baking powder instead of baking soda, and Cake 6 had self rising flour, and we doubled the amount of eggs that we put into the mix. We left cakes 1-3 in the oven for an hour, and when the hour was up, we took them out and put in cakes 4-6 for another hour as well. While we were mixing the cakes we noticed that the mixes were different colors from each changed variable. We then pointed out differences when all the cakes were done. And when we got to school the next day we measured the rest of the observations.

P10 The Geochemistry of Bottled Water

Chemistry
Nick Kania
Falmouth Academy

The purpose of this project was to compare ionic composition of various drinking waters (town waters vs. bottled waters). Drinking water quality is an important topic, especially regarding town vs bottled water, and it was hypothesized that town waters and natural spring waters would be similar in composition to natural river water. Sampled waters were prepared in a clean lab at WHOI. A mass spectrometer was used to analyze the ion concentrations of Duxbury and Falmouth town waters as well as four bottled water brands. The ion counts were converted to micromolar concentrations and compared against each other, as well as against the ionic contents of average river water. The data was then compared against Michel Meybeck's compilation of waters from different sources by plotting molar ratios of Ca/Na against Mg/Na. Interaction of the analyzed waters with different rock types is reflected in the water chemistry. Both municipal waters are similar in composition to average river water. In Ca/Na vs Mg/Na space, Poland Spring and Evian waters fell within the normal range of natural freshwaters, which reflect their origin from natural springs and groundwater. In contrast, Essentia and BigChill bottles waters have very different chemical compositions that reflect the heavily processed nature of these waters. These findings support the initial hypothesis.

P19 The Effect of Musa Acuminata Ash's Flame Retardancy Compared to NaHCO3

Chemistry
Aiman Najah
Pioneer Charter School of Science II

Common flame retardants (Sodium Bicarbonate & Potassium Carbonate) used in fire extinguishers often release harmful toxins to the environment around them. Flame retardants are compounds added to flammable materials to reduce their flammability. This project is designed to find a more economic and cost efficient flame retardant using banana peels. If a tongue depressor is immersed in the Musa Acuminata ash solution, the tongue depressor would have a lower burning time than Sodium Bicarbonate. Second, if placed under titration, Musa Acuminata would have an abundance of bicarbonate compared to other common anions.
An ash solution with 10g of Ash and 500 ml of water was first made. After a quick qualitative analysis testing for common active anions, the most active anions in the ash solution where chloride, carbonate, and bicarbonate. Each test gave off a different color which confirms their presence. After the quick ion test, three different titrations were conducted, Mohr titration for chloride and two required titrations for bicarbonate and carbonate. When titrated with AgNO3, chloride results in 6.2% of the ash solution. When titrated with HCl, bicarbonate and carbonate result in 14.23% and 13.3% respectively of the ash solution. After conducting a flame test, the wood soaked in the ash solution burnt for only 6 seconds compared to the one minute regular wood and 45 seconds' sodium bicarbonate soaked wood. Finally, after an elemental analysis, there is a large presence of Potassium (217,000 PPM). In conclusion, Musa Acuminata is an effective flame retardant compared to Sodium Bicarbonate.

Behavioral Science

Behavioral Science

A15 The Effects of Clothing on Observer Projection of Perceived Threat
A16 Caffeine's Effect on Learning and Memory in Drosophila
B1 Consumption Preferences of the Coenobita clypeatus
C13 Mitigating Congestion through Map Design: A Case Study of DC Subway
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A15 The Effects of Clothing on Observer Projection of Perceived Threat

Behavioral Science
Tiana Brote
Bancroft School

The purpose of this research was to assess projection levels onto images after the sympathetic nervous system (SNS) was activated. Specifically, how projection levels differ when subjects sees an image of an out-group minority, and the effects that clothing has on projections onto minorities. Subjects first watched a two minute suspenseful video, and were then shown a series of ten emotionless images specific to the one of four sets assigned to them. Both control, white images and variable, out-group images were shown. Set contains three images of Middle Eastern or Black men in traditional wear or casual American clothing. Each image was shown for one second. Subjects were then asked to interpret the photo by selecting either “angry,” “afraid,” “tired,” or “happy.” Subjects were asked to complete the Belief in a Dangerous World survey, which assigns a score corresponding to a subjects belief that the world is an inherently dangerous place.
Despite all pictures showing neutral facial expressions, subjects perceived minority out-group images as angry more frequently than white control images. Minority images were frequently ranked as either angry or tired. White images were most frequently ranked as tired, representing a lack of negative projection. White images were perceived as angry or afraid nearly equally as often. Anger was projected more frequently than fear onto Middle Eastern faces, regardless of the dress of those Middle Eastern men pictured. Black men were perceived as all four emotions relatively equally, regardless of dress. No significant changes were seen when the same minority faces were seen in alternative clothing. No significant correlation was found between subjects’ BDW scores and frequency with which anger was projected.

A16 Caffeine's Effect on Learning and Memory in Drosophila

Behavioral Science
Harry Kuperstein
St. Mark's School

Caffeine is a central nervous system stimulant known to promote wakefulness in the brain. It is commonly consumed for making one feel alert, awake and focused. It is often used in conjunction with activities demanding learning and memory. While caffeine has been the focus of many studies and its cognitive effects are understood to an extent, there remains uncertainty on how caffeine affects learning and memory. It is possible that caffeine, while it is known that through its inhibition of adenosine receptors promotes alertness, may have other interactions in the brain that better permit learning and memory consolidation.
This study used Drosophila melanogaster as a model organism by which caffeine’s effects on associative learning can be isolated and studied. Drosophila is a suitable model organism for exploring learning as it closely models the human brain. This was measured by running trials utilizing a T-maze assay, a procedure in which a T-maze with an elevator is used for transporting flies to two arms which are used to collect flies. A functional T-maze and complementary odor air flow system was designed, machined and configured to conduct the aforementioned tests. This T-maze will be iterated upon continually to improve workflow, ease of usability and effectiveness.

B1 Consumption Preferences of the Coenobita clypeatus

Behavioral Science
Aiden Chisholm, Brendan Morrissey
Westfield High School

This project is designed to test the consumption preferences of the Coenobita clypeatus in order to help pet owners and society understand their predilection. The Coenobita clypeatus does not select their food randomly as they prefer food they have not encountered in over 24 hours. Hermit crabs with single item diets were noticeably growing less than the crabs with multiple item diets.
Six Ceonobita clypeatus were ordered from Connecticut Valley Biology Supply, in order to keep track of each crab they were painted pink, black, red, blue, yellow and purple. Until the experiment the Coenobita clypeatus were kept in a holding tank that contained food, water, and sand; there was also a heat lamp used to keep the Coenobita clypeatus warm. The experiments were conducted in a twenty-eight quart under bed box that contained sand and a cardboard divider, splitting the area into halves. About five grams of each type of food were placed into a corner: banana, orange, Florida Marine Research Hermit Crab Food, and ZooMed Hermit Crab Food. Two hermit crabs were experimented on at a time for thirty minutes each. After the test was completed the food samples were measured to calculate the amount ate.
There were a total of 24 experiments conducted; 20.83% of the experiments run, a Coenobita clypeatus ate food. Out of this 20.83% ZooMed was eaten 100% of the time and Florida Marine Research was eaten 40% of the time. The Coenobita clypeatus ate .183 grams of FMR and .739 grams of ZooMed. The Coenobita clypeatus preferred store bought food, specifically ZooMed, to native food.
Our original hypothesis “The hermit crabs will be more attracted to the native food versus store bought food,” was not supported.The hermit crabs eating more of the store bought food than the nat.

C13 Mitigating Congestion through Map Design: A Case Study of DC Subway

Behavioral Science
John Xu
Deerfield Academy

This paper discusses the potential of using schematic transit maps as a powerful behavioral tool to influence passengers’ choice and to mitigate congestion, using the Washington DC metro map as a case study. Seven maps and 30 Origin-Destination (O-D) pairs were presented to participants during two experiments conducted between August and December 2016. The first experiment targets metro riders and was conducted through advertisements on the Express, a free daily newspaper available at DC metro stations. The second targets residents in the Washington metropolitan area and was conducted on Amazon Mechanical Turk, an online crowdsourcing platform.
The results show that, as expected, infrequent users are more conducive to schematic map. However, contrary to conventional beliefs, frequent riders are actually more responsive to the changes in schematic map design. For instance, a 12% decrease in Yellow Line’s length causes 7.1% of passengers to switch to this underutilized line, about 10, 408 riders per day, at almost zero cost. This ridership switch contributes significantly to solving capacity constraints, and for DC, to alleviating congestion at the Rosslyn Tunnel, chokepoint of the entire metro system. Using prospect theory, this paper also discusses and accounts for behavioral differences among different ridership groups. With six new stations due in service in 2020, redrawing the DC metro map is an impending necessity. This paper encourages consideration of schematic maps as an influential means to shift passenger behavior and to improve system efficiency.

C14 Light Based Emotions

Behavioral Science
Saida Abdi, Ardo Ali, Portia Bocage
Madison Park Tech Voc HS

The goal of our experiment was to find out how people's emotions vary based on the lighting of their environment and whether bright light makes people happy, sad or nervous. During our background research we found Amparo Berenice and Luis Eduardo Falcon Morales' experiment on lighting called "Emotions and the Urban Lighting Environment." The experiment showed that people most like feel happy and calm in bright lighting and feel gloomy in the absence of light. The project is important or useful to the society because the awareness of the impact of lighting on people can make the interview process and photo shoot process easier. Our hypothesis was that people would feel more comfortable under dim lighting than bright lighting because bright light puts pressure on them when they're in the spotlight, they can't even see what's in front of them. In experiment we put test subjects under different lighting and asked their emotions. The majority of the test subjects felt the happiest under bright lighting and the majority of them felt the most nervous and sad under no light. In the end, people felt happier and more comfortable when they are under bright light and spotlight and a lot of people felt very nervous when they are in the absence of light.

C24 Utilizing Brain Wave Analysis in Enhancing STEM Education

Behavioral Science
Sanjana Puri
Lexington High School

Problem: In many classrooms, the teaching method most often used is the "sage on the stage" approach, where a teacher stands in the front of the classroom and lectures students. This system has proved to be ineffective in maximizing each student's attention. Learning does not only consist of memorizing and recalling facts and a more individualized approach to teaching could improve educational processes and performance.
Our Brains and the Learning Process: Brain activity happens at three levels. The first level is where sensory information is collected, the second level is where this information is analyzed, and the tertiary region is where actions are created and memory is created for either short term or long term function. Long term memory is the main function of the hippocampus.
Hypothesis: The learning strategy of a particular student can be determined through changes in brain activity on exposure to various learning strategies. Brain wave pattern analysis will help us identify which learning strategy is most suited to an individual student, as the student goes through course material in Introductory Physics.
The Study: EEG research has led to the identification of different frequency bands such as theta (4 – 8Hz), alpha (8 – 14 Hz), beta (14 –30Hz), or gamma (30Hz) and their relationship to cognitive functions including attention and concentration.
In this study, brain wave activity will be tracked using headbands with inbuilt (EEG) recorders. The headband records composite band values of alpha, beta and gamma rhythms. The learning strategy that is associated with the most attention and engagement would be the one best suited for the student, and will be determined by mapping to brain wave activity during a practice quiz.

F4 Psychosocial Turmoil

Behavioral Science
Meredith Blaise
Bishop Feehan High School

The purpose of this study is to isolate biomarkers of psychosocial stress by means of presenting scenarios with increasing stakes and observing changes in blood pressure, blood oxygen, and pulse, as well as a questionnaire pertaining to quantitative, cognitive, sensorial and influential demands. The hypothesis of this study states that if a psychosocially stressful situation is induced, then an increasing change in blood pressure, blood and oxygen and pulse will be observed. The procedure is to be executed as follows; first gather the materials, following this, sit the test subject in a controlled environment. Record the subjects' age and gender for personal reference. Wrap the electronic blood pressure monitor around the subject's arm and take starting blood pressure (systolic/diastolic) reading, as well as pulse and blood oxygen level. Ask the questions, and record any changes in blood pressure (systolic/diastolic) reading, as well as pulse and blood oxygen level in the chart. Following experimentation, the hypothesis was partially disproved. An increasing change in blood pressure and pulse were frequently observed during the second variation of the transplant dilemma and the implied consent scenario, however blood oxygen remained constant with nearly all the subjects included in the data. In conclusion, blood oxygen is not a valid identifier for psychosocial stress.

F9 Does Listening to Music Help to Do Homework?

Behavioral Science
Rory Geraghty
Bishop Feehan High School

The purpose for this project is to see what is the best method for a student to complete their homework. Many students debate with themselves trying to decide whether or not they should listen to music while completing their homework. Some people say that listening to music does help to get homework done, while others say that it is a hindrance to a student’s performance on homework. The predicted outcome based off of extensive research is that the listening to music will allow the music to be completed quicker, but with less accuracy. To test this, 100 volunteers were collected and each completed three different basic, generic, math worksheets. The first was completed while listening to classical music, the second pop music, and the third was completed in silence. All times were recorded, in addition to the percentage of correct answers. The expected outcome was that the two worksheets completed while listening to music will have faster times than the one completed in silence, but the percentage of correct answers will be lower. After extensive testing, it was found that the hypothesis was rejected and that in fact, listening to music does not help a student to complete homework. The average time to complete the worksheet in silence was lower than the two worksheets completed while listening to music. The average percent correct for the worksheet completed in silence was significantly higher than that of the two worksheets completed in silence.

F17 Long Term Impacts on War Affected Population: Study Using Planaria

Behavioral Science
Anvitha Addanki
Canton High School

War like conditions have a catastrophic effect on the health of humans and wellbeing of nations. They destroy communities and families and cause significant long-term physical and psychological harm to children and adults [1]. The short and medium term effects of war like conditions on population health have been studied reasonably well. However, their long term effects across generations have not been studied thoroughly [2].
To study the effect of war like conditions on multiple generations of humans, Planaria, an invertebrate which can retain memory and can reproduce rapidly, is chosen as the experimental model. Planarian brain, despite its simplicity, is structurally and molecularly similar to mammalian brain. NASA sent Planaria to space to model human behavior [3].
By studying the effect of simulated war like conditions on Planaria and observing its behavior may help to estimate the effect on humans. Studying their next generation behavior may also help determine if war conditions would have any impact on the future generations of humans and if so, the number of generations that will be affected. Experiments concluded that all war stimuli (except sound in the absence of electric shock) decreased the speed of both the original Planaria and regenerated Planaria. We can interpolate this behavior to humans and conclude that war conditions have long term effects on humans and they also have an impact on future generations.

G9 Music on Plant Growth

Behavioral Science
Jacqueline Tran
John D. O'Bryant School of Mathematics and Science

How does music will affect the plant growth? I want to learn and use what I know to research the relationship between music and plant growth, which can be related to real life since a high percent of the population owns a plant at home and/or at work. To carry out the experiment, I gathered a variety of music and one type of seed, and I prepared different pots and placed them in different rooms, with a specific type of music playing. According to research, it said that only classical music would make a plant grow the fastest. When doing the experiment, I found it is not only classical, but also rock. By doing this experiment, I obtained a data that I never expected on how an aspect of life can affect another. It shows that the rate in the plant growth was somewhat stable, and that each day, it grew little by little; but what interested me is that in the result, two types of music made plants grow the same within the five days, even though the heights grown per day were different. All plants were exposed to the same amount of water, light, and temperature, so I believe the wavelengths of the sound had an effect on how plants would grow. Even though the time of music exposure was the same, the wavelengths were different because each sound has areas of different frequencies. In the future, I would take different types of plants and see how they react to the same music that I chose keeping in mind the frequency of each type of music. In order to improve my experiment I will have to learn more about wavelength and sound to help me answer a question that I have in mind is: What is the effect of the sound waves of any type of sound have on plants. Last but not least, I am also curious to go beyond music and see how plants react to the noises that take place in everyday life.

G13 Interactions with the Enviornment by Captive White Cheeked Gibbons

Behavioral Science
Margaret Ingmanson
Silver Lake Reg. H. S.

Primates are highly intellectual animals with large brains that need mental stimulation. In the wild, primates have a multitude of different ways to entertain their intelligence, from trees to other individuals. This can be hard to replicate when they are brought into a captive situation. The size of apes and their high intelligence causes keepers to be constantly replacing toys and structures. A lack of diversity in environment can cause these apes to waste their intelligence. Zoo keepers routinely change supplemental environment pieces, but the animals are still in the same small enclosure, which does not reflect the expansive territories of individuals in the wild. The appropriate mental stimulation of the primates is important to good health for the animals. This project, conducted at the Roger Williams Zoo, involved observing two White-Cheeked Gibbons, who had been paired together the previous fall. Using focal samples for 3 consecutive 5 minute periods and alternating between the two individuals, the object manipulation and use of environment for each animal will be recorded. Questions being addressed include if the gibbons do use the provided environment, to what degree, and whether they truly manipulate the object or just brush over it. The results of this study may help understand and improve the living conditions for these individuals, as well as other primates in captivity.

G20 Semantic Representations of Emotional and Social Concepts in Autism

Behavioral Science
Siyi Cao
St. Mark's School

Autism Spectrum Disorders (ASD) are a set of neurodevelopmental disorders as shown through difficulties in social interaction and communication as well as repetitive behaviors. Symptoms of ASD manifest at an early age and become most prominent between the ages two to three years old. One major area of defect common among ASD individuals is language and communication, especially the ability to comprehend language and make inferences based on social and emotional context. Recent linguistics studies have shown that there is an association between the ability of individuals with autism to attribute mental states (to themselves and others) and verbal skills. It is found that high-functioning ASD individuals have a less coherent representation of emotional experiences and tend to avoid using emotional terminology. The goal of this study was to examine the relationship between social competence and semantic representation of social and emotional concepts. Knowing that lexical co-occurrences are useful measurements of semantic knowledge, participants of this study were asked to rate pairs of verbs in terms of similarity on a scale from 1 to 5, 1 being very similar and 5 being very dissimilar. Data collected from the typically developing (TD) participants indicates that there is a correlation between social competence and accuracy of similarity ratings of verbs containing social and emotional content. The less socially competent, the less accurate the ratings are. Moreover, such a correlation is not present in verbs of no social or emotional content. The study of ASD individuals is currently ongoing, and results regarding the semantic representation of social and emotional concepts in autism will be collected in the following weeks.

H13 Which Musical Genre Prompts the Greatest Recall of Information?

Behavioral Science
Rachel Sussman, Katarina Bulovic
Lexington High School

This experiment tested whether the lyrics of original songs would be remembered at different rates depending on the song's genre: either pop, country, or jazz. The control was spoken words. We hypothesized that pop music would lead to the greatest information recall.
We tested 5-11 year old children at a local aftercare by asking participants to listen to two word lists: one spoken and one sung (in any aforementioned genre). Participants then wrote down words they remembered. The words were of similar difficulty, there were twelve unique words per list, and the lists were repeated twice per song.
Of the 44 participants, we found a statistically significant difference between retention of spoken words and lyrics, with participants remembering spoken words at a much higher rate. Music retention appears to be independent of genre, genre preference, gender, familiarity, and instrument bias.
Experimental problems include that we tested a cluster sample of one elementary school, with voluntary response, nonresponse, and undercoverage bias, as well as convenience sampling. Extraneous variables include testing in a distraction-prone hallway, tired children, and varied song diction. A follow-up experiment would be a longitudinal study exposing children to the same music multiple times and comparing those retention rates.
Thank you to the volunteers who helped us administer the experiment: Robin Armstrong, Emily Kaye, Ivy Gao, Nora Bulovic, Jane Lawrence, and Annie Zhu. We would also like to thank Dr. Lisa Freed, Dr. Vladimir Bulovic, and Mrs. Bonnie Peletier for their analytical guidance. We would like to extend a special thank you to Mrs. Grinder, Mrs. Sine, and the rest of Lextended day for providing space and a forum to test.

N2 Interaction of Mechanisms for Cooperation in Small-Scale Societies

Behavioral Science
Michael Isakov
Lincoln-Sudbury Reg. H. S.

Recent behavioral experiments have shown that religiosity and market integration are two key factors for the evolutionary foundations of human cooperation. However, these experiments are limited in their ability to show the mechanisms for this cultural evolution. Recent studies have focused on creating mathematical models to simulate human behavior, supplementing hard-to-get data from remote areas. This project focuses on improving existing models for human cooperation to better understand this phenomenon. I simulate a structured (multi-tiered) society and consider two methods of enforcement coupled together – "religious" and "state". I also provide theoretical results for a simplified version of the model and consider several extensions, including the case of probabilistic punishment. In the probabilistic model, uncertainty and "lucky defectors" allow oscillating strategies at the society level. I compare these models to real data and find support for (and extensions to) observed qualitative trends identified in the current literature. Finally, I propose several extensions for future work, including a multi-state model and variable learning rates in ruler-subject interactions.

P16 Accuracy of Eyewitness Testimony

Behavioral Science
Madison McAloon
Taunton High School

Eyewitness Testimony is a legal term describing an account given by the people, of an event they have witnessed. This is especially important to legal cases and the research of cognitive psychology and human memory. The only thing is, it is very unreliable. The purpose of this study is to test the accuracy of eyewitness testimony. The hypotheses for this project were: If subjects are shown the “False Memories” video, then 50% of subjects will write down sleep due to false memories because of association and the misinformation effect,if subjects are shown the video “Test your Awareness” video, 25% of subjects will guess the correct number of passes but will miss the moonwalking bear, and if a car honking noise is played during one of the experiments, the group will do worse than the group that memorized without the car honking noises. To test eyewitness testimony, two control groups and two experimental groups observe two videos both testing important factors of memory and selective attention. For the two experimental groups, car honking was played to create a distraction. The results supported all three of my hypotheses. This data is important to the real world because it proves eyewitness testimony is unreliable and should be less depended on in today’s legal system.

Environmental Science

Environmental Science

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B5 Toxicity of Titanium Dioxide and Zinc Oxide Nanoparticles
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B20 Freshwater Oil Spills: Effects on Daphnia Magna
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N3 The Effect of Antacids on Soil Damaged by Acid Rain

N8 The Effect of Mycorrhizal Fungi on the Growth of Tomatoes
N12 Reducing Ocean Acidification
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P22 Effect of the Species of Wood on the Heat Produced by a Biomass Pellet

B3 Hydroponics is Growing and the Future Should Too

Environmental Science
Lorna Li
Taunton High School

Oftentimes in developing countries or even inner cities in first world countries, the importance of nutrition is overlooked since the hustle and bustle of everyday life consumes people. Other times, some people may even realize the essential foods they should eat for a healthy diet but just unfortunately do not have the means to finance such a diet. This is where the future of hydroponics becomes the present solution. Hydroponics is a compact gardening technique that does not require soil, space, or extensive agricultural knowledge. This experiment's purpose was to prove that vegetables grown hydroponically have just as much if not more nutrients as store bought plants. If this were to be true, people could start eating healthy for less money than ever before. The approach for this project was entirely hands on. The four hydroponics systems were built by hand and the lettuce and kale seeds, for the most part, sprouted successfully. After using a spectrophotometer to test the absorbency of each plant, the results were clear. Hydroponic plants are stockier and contain more concentration to them than store bought vegetables. This completely changes the way that people should think about food. Eating healthy is not a mindset but a lifestyle that can be achieved through some air pumps, buckets, seeds and lots and lots of sunlight.

B5 Toxicity of Titanium Dioxide and Zinc Oxide Nanoparticles

Environmental Science
Christine Schremp
Bishop Feehan High School

The purpose of this research was to determine the effects of titanium dioxide (TiO2) and zinc oxide (ZnO) nanoparticles on the health of Dugesia tigrina. Due to the various novel applications of nanoparticles, their production and prevalence in consumer products has increased exponentially. While their entry into the environment is inevitable, little is known about the ecotoxicological effects of nanoparticles. The freshwater flatworm Dugesia tigrina was chosen as the model organism for this experiment due to its prevalence in toxicology research. It was hypothesized that if Dugesia tigrina were exposed to ZnO and TiO2 nanoparticles, then they would exhibit an increased mortality rate as well as a deterioration in health as seen by a decreased regeneration rate and abnormal behavioral patterns. An acute toxicity test was conducted with ZnO (18 nm) and TiO2 (18 nm) nanoparticles at concentrations of .01 mg/L, .1 mg/L. 1 mg/L, 10 mg/L, and 100 mg/L. To assess the chronic effects of nanoparticle exposure on growth and development, a regeneration study was conducted. Dugesia were exposed to sublethal concentrations of nanoparticles, and their regeneration rates were monitored. Overall, the results of this experiment supported the hypothesis; it was found that the 48 hour LC50s for nano-ZnO and nano-TiO2 were .41 mg/L and 8.05 mg/L, respectively. The results of the regeneration study followed a similar trend, with those exposed to nano-ZnO exhibiting the largest delay in regeneration time, with nano-TiO2 causing a similar effect. In addition, abnormal swimming patterns were observed in the organisms exposed to ZnO nanoparticles, an indication of neurotoxicity. Future studies will assess the effects of nanoparticle exposure on learning and memory of planaria.

B18 Starch Vs. Cellulosic Derived Ethanol

Environmental Science
Mahika Gupta
North Attleboro High School

In 2016 carbon dioxide levels were 400 parts per million which has greatly started to impact the world. An increase in carbon dioxide will not only have an impact on the global climate but a profound effect on the growth, physiology, and chemistry plants. Without plants many ecosystems can have devastating ends. Biofuel can be the answer to solving the problem. Biofuel is made through the process of fermentation. Fermentation results in the production of Ethanol. The experiment conducted shows if either a starch or cellulosic source is better for the environment. In the experiment eight substances, four with starch and four with cellulose were fermented. According to the polysaccharide the substance was pretreated. After fermentation, the newspaper made the most while the potato made the least amount of ethanol. The newspaper made about twice the amount than corn. Cellulose is a more complex and condensed than starch. In the cellulose solutions, the extra enzyme helped break down the cellulose into smaller monosaccharides helping the yeast in not working as hard to ferment. In the end cellulose, substances made the most amount of ethanol. The solutions were burned in a controlled environment to measure the amount of carbon dioxide released. From the data collected newspaper released the least. In the end using newspaper to make biofuel would benefit the environment by reducing the carbon footprint and providing the largest energy source. A way to enhance the project would be to find an alternate way to break down the cellulose in the cellulosic substances. The ultimate benefit of this project would directly impact the environment in a positive way. Having a fuel source that completes the needs and doesn't harm the environment will only improve the global climate.

B20 Freshwater Oil Spills: Effects on Daphnia Magna

Environmental Science
Cheaheon Lim
Northfield-Mt.Hermon School

To gain insight into the effect that gasoline contamination and ethanol flushing (a means of counteracting gasoline contamination) have on freshwater microorganisms, research on the physiological stress indicators—heart rate change and jerking rate—that Daphnia magna show in response to exposure to these contaminants have been conducted. It was hypothesised that the physiological stress indicators of Daphnia magna will change in proportion to the volume of spilled gasoline, and that adding equivalent amounts of ethanol and inducing the flushing effect will minimise disturbances caused by gasoline contamination. A series of tests were created to examine the cardiac disturbance in Daphnia magna after 30 minutes of exposure to various concentrations of gasoline and ethanol. Environmental factors were also included to simulate real freshwater habitats. After initial experimentation, the Daphnia magna samples were relocated to the original culturing water and their jerking rates and the recovery of their cardiac conditions were observed for 30 minutes to quantify their ability to recover after exposure to contaminants.
The hypothesis was proved partially correct. Physiological stress indicators of Daphnia magna did indeed change in proportion to the volume of spilled gasoline. However, tests in which Daphnia magna were exposed to gasoline contaminated mixtures with ethanol flushing induced yielded that ethanol only deteriorated the damage done by gasoline contamination, rather than ameliorating it. Thus, it can be concluded that the volume of spilled gasoline is proportional to the damage done on Daphnia magna populations. However, the use of ethanol flushing as a means of contamination remediation requires further study.

B24 Trash the Ash: The Effect of Smoke on Stomatal Behavior

Environmental Science
Lida Johansen
Assabet Valley Voc. H. S.

Clean air is made up of nitrogen, oxygen and argon, with traces of other gases like carbon dioxide. Air pollutants mainly come from the discharges of gases, particles, and smoke. A large cause of air pollution is the smoke that comes from cigarettes. In this project, Chlorophytum comosum (spider plants) were chosen to be the test subject. Ten spider plants will be utilized throughout the process of the experiment. Five spider plants will be intoxicated by Marlboro Cigarettes, and five spider plants will be placed in a healthy environment. The plants in both conditions were compared based on stomatal pore length and coloration indicating photosynthesis rates. The recorded data does support the hypothesis. The data created clear trends, proving that the smoke intoxication did lead to the decrease in photosynthesis activity, leading to discoloration in the leaves of the spider plant. Going forward, testing should be continued. Possibilities of removing chemicals of most harm should be researched.

C5 Hydroponics Vs. Aquaponics

Environmental Science
Alisa Feilhauer
Joseph Case High School

The objective of this project was to determine whether radish sprouts and wheatgrass grow better in a hydroponics or an aquaponics system. This procedure is conducted by creating a hydroponics tank and an aquaponics tank which allow for the roots of the plants to extend into the water of the tank. The next step of the procedure is to plant seeds for wheatgrass and radish sprouts in a hydroponics system (the system with RapidStart) and planting seeds for wheatgrass and radish sprouts in an aquaponics system (the system with the Betta fish) . The growth of the plants is measured and recorded daily. After testing both the wheatgrass and the radish sprouts in each system, data concluded that both plants grew taller and thicker in the aquaponics system than the hydroponics system. This was because the waste that the Betta fish produced, created an ecosystem which had a stronger impact on the growth of both plants than the RapidStart nutrient additive. The Betta fish created a natural ecosystem which allowed the plants to thrive in the aquaponics system. The results of this experiment were very accurate due to the measurements taken strictly everyday. Although the measurements were accurate, the plants grew a lot each day, therefore for even more accurate results, the plants could be measured two or three times each day. This could conclude whether the plants grew better in the morning or at night and it would help to show exactly how quickly the plants grew. An extension on this project would be to grow fruit in both a hydroponics and an aquaponics system and compare the results to determine whether the fruit would grow bigger and taste better in a hydroponics or aquaponics system. This could allow for farmers to grow crops more efficiently and possibly even save money.

C15 Enhancing Biodegradability in Polymers Using Silane Chemistry

Environmental Science

John Ta
Mass. Academy of Math & Science

Plastics are one of mankind's most important inventions; their value is seen in everyday life and in the economy. However, many plastics have a variety of problems. About 33 million tons of plastic are produced each year, but only about 7% of it is recycled. Over time, the amount of plastic waste will accumulate rapidly. Additionally, this problem is further exacerbated by the poor biodegradation of polymers. As a result of these issues, it was determined that combating the problem where it was most concentrated — the environment — would help reduce future waste. The goal was to enhance biodegradability in existing polymers. Using alkoxysilanes, various polymeric surfaces were surface derivatized in order to examine their properties as a result of bonding. Silicone rubber was surface derivatized in order to examine the effects of the alkoxysilanes. Then, PLA was surface derivatized with the same alkoxysilanes and was tensile tested and subjected to contact angle goniometry in order to determine success of reaction. Extra specimens were created for use in biodegradability testing, where they were immersed in cultures of S. epidermidis at 30 °C for a one week period. After some time, the specimens were removed and tensile tested in order to determine the effects of the bacteria and alkoxysilanes. The result suggested that the alkoxysilanes had been successfully bonded through the use of one way ANOVA tests and T-Tests. Additionally, the results implied that the alkoxysilanes had an influence on the rate of biodegradation: APDMS increased the rate of biodegradation. This procedure could be applied on a mass scale in plastic production plants to shorten biodegradation time of waste that is deposited into the environment, which will effectively minimize future waste.

C25 A Community Connection: Nodal LoRa Modulation for Environmental Data

Environmental Science

Curtis Fisher, Annika Schmidt
Martha's Vineyard Regional H. S.

This project recognizes the growing need for data as a result of complex developments in information technology. The overall goal of this research endeavor is to create a low-cost, efficient, and readily deployable sensor network that leverages LoRa modulation to provide real-time data. This data can be used for visualization, statistical analysis, historical record-keeping, public information, predictive environmental studies, and correlative studies. In an attempt to fill the shrinking void of access to information, and improve currently insufficient data collection methods, we have integrated existing sensor technologies with an implementation of LoRa transmission. The greatest challenges in implementing this technology are calibration and waterproofing. In order to reduce upfront cost, we have used affordable sensors which require yearly calibration. In humid climates, waterproofing is essential. Initially, we used an IP 65 enclosure which is rated as “dust tight” and protected against water projected from a nozzle. We found that this was insufficient as rain-storms affected the humidity within the enclosure which fouled equipment calibration. After installing an IP 68 enclosure—rated as "dust tight" and protected against complete, continuous submersion in water—we found that the equipment was no longer fouled by humidity. Connected sensors enable people to inhabit, respond to and manage built environments. Organizations win because they receive real-time data from a network of inexpensive sensors; the community wins because new knowledge and data, point to potential social and economic innovation; and the environment wins because we can predict and monitor variance in ecological phenomenon and initiate preventative action to protect our ecosystem.

C26 The Study of H. sanguineus Population Density and Genetic Variation

Environmental Science
Margaret Slein
Archbishop Williams H.S.

I expect to find that the number of Asian Shore Crabs are vast in both Scituate and Nut Island and to discover that the populations are not evolving due of their geographic proximity and lack of geographic isolation.
Two standard traps will be deployed at each location. The traps will be removed from the water and each crab caught will be marked with a waterproof, nontoxic paint and returned to the water, at various times depending on sunrise and tides. Each time the trap is retrieved, a ratio will be recorded of marked crabs and unmarked crabs to determine the population density. For population density, the ratio between the number of total crabs caught and crabs previously caught will be compiled and averaged to create an average ratio. A number of crab DNA will be taken from the legs of the crabs from each location and studied by me, for genetic mutations and variations at Northeastern University. The samples will be analyzed at specific DNA locations to search for genetic markers that could indicate genetic variation. This data will be compared from location to location and to the DNA sequence of the Asian Shore Crab that Northeastern University possesses.

C28 From Farm to Cable: The New Forefront of Energy Harvesting

Environmental Science
Mei Collins, Brittney Gedeon, Saja EL-Saudi
Somerville High School

Dye sensitized solar cells (DSSCs) are a type of photovoltaic technology that can be made from easily obtainable materials, such as dyes from natural sources like dark pigmented berries or leaves, to convert solar energy to electricity. Even though these cells are very environmentally friendly, the average DSSC can only absorb about 10% of light, and does not convert much of this light into usable electric energy. In our project, we sought to figure out how to create the optimal solar cell, using different organic dyes, such as blackberries, blueberries, and raspberries, as well as utilizing different layers comprised of either titanium dioxide (TiO_2) or zinc oxide (ZnO). To test the efficiency of the cells, a multimeter was used to measure how many millivolts and milliamps each cell produced when placed under an artificial light source. The average voltage and amperage for each cell were multiplied to determine the average wattage, or power output of each cell. The hypothesis was that the cell dyed with blackberry extract would generate the greatest number of watts because darker dyes are able to absorb a larger range of wavelengths from light sources, thus increasing the excitation of electrons and the power produced. The experimental results proved to primarily suggest different problems in creating the cells, which caused a wide range of raw data and inconclusive results. The deviation from expectations in this experimental data can be integrated seamlessly into the analysis of the composition of an ideal cell, through the use of different methods to create a more stable photovoltaic device.

D6 Finding Better Fuel: Optimizing Algae Biofuel

Environmental Science
Julia Danko
Wachusett Regional High School

The consumption of fossil fuels as an energy source for transportation and industrial power is increasing at a rate that cannot be sustained environmentally. Biofuels offer a novel solution for this energy crisis. As renewable sources of fuel, they are made through the growth and processing of plants and other photosynthetic organisms. Many organisms are used to make biofuel, but green microalgae, a photosynthetic, aquatic, unicellular, Protist produces far more oil per acre than the other crops. Although microalgae have a naturally high fat content, it must be increased by implementing environmental stress in order to make algae biofuel economically feasible. The purpose of this experiment was to determine the optimal concentration of sodium chloride to stress freshwater algae to produce the most internal oil.
The algae were grown at at varying concentrations of sodium chloride and then the optimal salt level that produced the most lipid when compared to chlorophyll amounts was determined. It was hypothesized that as the salt levels increased the lipid would also increase, while the chlorophyll content would decrease. The results of both tests did support this hypothesis although the highest concentration was not found to be most successful. In fact, the 0.01-0.013 g/mL of salt was optimal for lipid accumulation in the Chlorella algae. It was found that salinity stress can in fact be implemented for the production for algae biofuel increasing the potential for algae to be used as an alternative fuel source.

D26 Are Alkenone Paleoclimate Proxies Influenced by Ocean Acidification?

Environmental Science
Charles Xu
Falmouth High School

The phytoplankton Emiliania huxleyi is known to produce long chain methyl and ethyl unsaturated ketones, or alkenones. Because of the global distribution of Emiliania huxleyi and how resistant alkenones are to degradation, alkenones can commonly be found in sediments all over the world. The UK’37 index is calculated by comparing the unsaturation of alkenones, and varies linearly with past sea surface temperature, making it a useful paleoclimate proxy. However, because CO2 has been a driving force of changing temperature, it is possible that there may be a systemic difference where UK’37 based temperature records may be affected by CO2 levels and do not only reflect past sea surface temperature. In order to test this, CO2 levels representing pre-industrial and historic, current day, end of century, and future levels were bubbled into batch cultures. Alkenone data was collected during day 7 and 14 of growth from cultures. Temperatures calculated from UK’37 were always lower than actual temperature, but this has also been noticed in numerous studies involving laboratory cell cultures. There is no statistical difference in UK’37 caused by the simulated CO2 in samples at one time point. However, there are significant differences between bubbling and non-bubbling samples in UK’37 and the amount of alkenones produced. Bubbling samples had higher UK’37 values and higher quantities of alkenones per mL and per cell. Additionally, there appeared to be differences between time point 1 and time point 2 samples, with time point 1 producing lower UK’37 values. This data suggests possible impacts of growth phase on UK’37 values and differences between bubbling and non-bubbling. Based on the data from this study, CO2 levels do not appear to have a direct impact on UK'37.

D28 The Effect of Pile Driving Noise on Alpheus angulosus

Environmental Science
Grace Kwon
Falmouth High School

The purpose of this experiment was to determine if the noise produced by pile driving is significantly harmful to shrimp living on the seafloor. Although many studies have focused on vertebrates, invertebrates are just as important to the ecosystem, as they create the bottom of many food chains and can affect many other creatures, including humans. The hypothesis was that pile driving would indeed be harmful to the shrimp, as it creates a large amount of artificial noise and vibrations. Alpheus angulosus, a species of snapping shrimp, was used for this experiment. They were placed in a small tank, one meter away from a speaker which played sound samples of pile driving noise taken from work being done off the coast of Block Island. The shrimp were observed for 15 minutes before the recording was played, 15 minutes during, and 15 minutes afterward. Other than the sound being played, all other environmental factors were kept constant. When results were analyzed, it was determined that a majority of the shrimp grew less active as the pile driving was being played. They stayed in one place for a majority of the time, whereas before, they were running around the edges of the holding cup or burrowing in the sand. This demonstrates how artificial noises like pile driving could desensitize the shrimp to real threats such as predators, and could be dangerous not only to snapping shrimp, but to other similar creatures as well. Due to this, pile driving and other undersea construction must be carefully regulated, not only for fish and mammals, but also for small invertebrates and other creatures that are often passed by.

F5 Controlling Phragmites by Depleting Stored Nutrients

Environmental Science
Rachel Shen
Quincy High School

Phragmites australis, an invasive marsh grass, threatens native species with its rapid growth rate, allowing it to overtake native plant communities. Current control methods such as mowing and burning remove aboveground biomass but neglect underground rhizomes, from which the plant can regrow and reproduce from its energy stores. A 0.0009% (by mass) gibberellic acid spray treatment, combined with weekly mowing was investigated as a method to deplete rhizome starch content. This treatment was hypothesized to reduce Phragmites rhizomes by increasing growth rate, converting stored energy to aboveground and easily removable biomass. Phragmites australis rhizome fragments were grown hydroponically for 16 days, and the starch concentration from ground dry material was determined spectrophotometrically with iodine.
Mowing without gibberellic acid reduced starch concentration of the rhizomes, with starch concentration decreasing from from 0.130 mg/DW(g) to 0.0685mg/DW(g) and 0.0488mg/DW(g) with one and two mowings, respectively. Without mowing, gibberellic acid decreased starch content from 0.109 mg/g to 0.0625 mg/g. However, the gibberellic acid treatment combined with mowing increased the rhizome starch concentration. With mowing, gibberellic acid increased starch content from 0.0685 mg/g to 0.109 mg/g and 0.0488mg/g to 0.0625 mg/g with one and two mowings, respectively. This suggests that mowing is effective in both reducing aboveground biomass and the energy stores of the plant. A gibberellic acid treatment is not recommended as a way to deplete rhizome resources. Other ways of indirectly affecting Phragmites rhizomes should be investigated.

F11 Biodegreadable Plastics: A Worthy Successor?

Environmental Science
Derek Hunter
North Quincy High School

The purpose of this experiment was to find alternative materials to harmful and non degradable petroleum based plastics, that are both renewable and sustainable, the material being biodegradable plastic. Before testing, the hypothesis, if two kinds of biodegradable plastics maximum weight capacities are compared to that of a common plastic bag, then the corn starch plastic's maximum weight capacity will average out to be higher than that of the common plastic bag, was proposed. To test this, each plastic was made from its basic ingredients. Two kinds of plastic were made, one that was based upon corn starch and the other based upon gelatin. Once they were made, they both were then tested against a common plastic bag in order to test their effectiveness. All three types of plastic were tested to find the total amount of weight they could hold, or their maximum weight capacity. After testing, in all sets of data, the common plastic bag held the most amount of weight, thereby not supporting my hypothesis. The overall averages for the common plastic, corn starch plastic, and gelatin plastic were 10.1 lbs., 6.5 lbs., and 8.3 lbs., respectively. The overall averages show that the common plastic performed better than the other two plastics, rejecting the hypothesis. This project is relevant to the scientific community as it gives a renewable alternative to harmful petroleum plastics. It also gives a basis into two kinds of potentially useful bioplastics and their effectiveness.

G19 Are These Plants GMO?

Environmental Science
Luis Pires
Excel High

This study purposely aimed to determine the effects of substances on the growth of plants. The researcher hypothesized that adding substances into the growing medium will alter the genetic make-up of the plants thereby is considered as Genetically Modified Organism. Using the normal condition on planting means Non-genetically Modified Organisms are produced.
Using standard protocols in hydroponics systems - 15 set-ups with 5 seeds on each were treated with distilled water, Vitamin D (25%, 50% and 75%) and Miracle Gro - NPK were applied.
Based on the data collected after 14 days from planting, results showed that both Vitamin D and Miracle Gro - NPK enhanced faster growth by reducing the germination period to 3 days instead of 5 and produced healthier leaves and stem structures as shown on the number of leaves produced compared to pure water only. Of the two test substances, NPK showed more promising results as all plants bloomed and looked robust compared to Vitamin D and water-only plants. As for Vitamin D, the 25% provides better results compared to 50% and 75% Vitamin D content.
Therefore, the researcher conclude that the addition of Vitamin D and the Miracle Gro - NPK enhanced the growth of plants and thus confirmed the hypotheses of the study. However, to claim the produced plants as Genetically Modified Organisms is not conclusive as this study was not able to do genetic screening on the plants. Thereby, it is highly recommended for the next researchers to do the process in order to determine whether it is GMO or Non-GMO at all.

G21 Effect of S. pasteurii and Calcium Alginate on Increasing Soil Cohesion

Environmental Science
Sang Yoon Park
Deerfield Academy

S.pasteurii is a non-pathogenic spore-forming bacteria that promotes CaCO3 production through Urease and reinforces cement. This experiment investigated whether S.pasteurii's such biomineralization capability could increase soil cohesion and what conditions were necessary to optimize the process. First, in order to find the best condition for plant growth, the amount of S.pasteurii and Urea were varied from 2% to 10% and cabbage growth was observed. As a result, the absorbance of chlorophyll a and b at 2% concentration were 1.444A and 0.602A respectively, while that of 4% concentration were 1.462A and 0.6A respectively. Moreover, observation of S.pasteurii depending on different Urea concentration showed 2% and 4% was decreased less than that from 6% ~ 10%. Also, treating S.pasteurii at 2% Urea and 4% Urea allowed better separation of Urea at 60uL and 80 uL. Thus, the soil was treated with calcium alginate in combination with 4% Urea in 100 uL and 200uL S.pasteurii. Furthermore, in order to confirm soil aggregation, the weight change of soil particles was observed via 500um filter and the soil's capability of conserving water. As a result, soil particle weight was 0.18g and had the most water evaporation where 0.47g out of 1g of soil was water, when the 4% Urea and 200uL S. pasteurii was used. Also, measurement of calcium ions in the soil solution indicated the control group, not treated with S.pasteurii, contained calcium ion concentration of 489ppm, while the sample treated with S.pasteurii had 25% lower concentration. After treating the soil solution in the calcium medium, production of CaCO3 from S.pasteurii was observed by treating the collected bacterial colonies formed adjacent to the CaCO3 crystals with distilled water.

H8 The Food For Our Food

Environmental Science
Bradley Marcosa, Bailey Nance
Upper Cape Cod Voc-Tec. H. S.

Black soldier flies are beneficial to the Earth. At about 42% protein during the larval stage, other organisms can benefit from them. By consuming BSFL, the organisms gain protein, which they could be lacking. Black soldier flies have no mouth parts, no stingers, do not transmit disease, and do not create a "buzz" sound. The Environmental Science and Technology Shop at Upper Cape Tech raises black soldier flies in the greenhouse. There, they are used as research, viewing, and a protein source for the Tilapia.
Due to the fact that black soldier flies prefer food with protein and a pH of 7, clam waste can be consumed in large quantities. The hypothesis of this experiment states, "If the black soldier flies are fed the clam waste and cranberry waste, the clam waste will be consumed more." It is important to investigate this topic because black soldier flies have the potential to replace fish food. The experiment was conducted by placing 50 grams of black soldier fly larvae in a bin with 300 grams of clam waste and 50 grams of black soldier fly larva in a bin with 300 grams of cranberry waste. There was a third bin with 50 grams of black soldier fly larva with 300 grams of lettuce, as the control group. The bins were checked daily for 3 days, then left over the weekend, and checked on that Monday for the final weight of the bins. This allows direct comparison between all the food sources.
The black soldier fly larvae consumed clam waste the most, then cranberry waste, and lettuce the least. There was a total of 233 grams of clam waste, 179 grams of cranberry waste, and 51 grams of lettuce consumed throughout the entire experiment. The black soldier flies were moving actively throughout the experiment. There was a strong odor from the clam waste in each trial.

H9 The Effect of Toxins in Dirt on the Lifespan of Daphnia Magna

Environmental Science
Olivia Sears
Revere High School

The purpose of this experiment is to test which location (Revere High School Garden, Veterans of Fallen War parking lot, or the Belle Isle Marsh) has dirt that has a greater effect on the lifespan of Daphnia Magna. Daphnia Magna are water fleas that are used for scientific testing because they react quickly to changes in their environment. Some of the substances that could possibly be in dirt are gasoline, brake fluid, antifreeze, rock salt, lead, chemical sealants, and discarded cigarettes, all of which would have an effect on the lifespan of the Daphnia.
First, I collected the dirt samples from each of the locations and put them in plastic bags. Next, I put 0.5 grams of one of the samples in 3 different containers and repeated this for each of the dirt samples. I left 3 containers empty as a control group. Then I put 4.1 grams of spring water in all of the containers and added 5 Daphnia to each of the containers. I counted how many were left after every 8 hours, stopping at 32 hours. After the 32 hours were over, I tested the pH of each container.
The dirt from the VFW parking lot caused the Daphnia to die the fastest. Other than the control group, the Daphnia in the containers with the dirt from the Belle Isle Marsh survived the longest. On average, 3.6666 Daphnia from the Belle Isle Marsh containers survived and only 2 survived from the VFW containers.
The Daphnia died the fastest in the containers with dirt from the VFW because I obtained the sample from a parking lot. There could be toxic substances in this parking lot such as gasoline, brake dust, brake fluid, antifreeze, rock salt, lead, chemical sealants, discarded cigarettes, etc. The Daphnia in the containers with dirt from the Belle Isle Marsh lived the longest because there were no cars allowed.

H12 The Growth of Plants In a Hydroponic System

Environmental Science
Jillian Taylor
Upper Cape Cod Voc-Tec. H. S.

The purpose of this experiment was inspired to help hydroponic novices as well as gardeners who feel they can improve their methods. The use of hydroponic systems has become growingly popular. The hypothesis created states that a herb will grow the fastest in a hydroponic system. After researching, basil was predicted to grow the fastest. The data gathered from this experiment will help novices and gardeners better understand hydroponic system, as well as help guide them when it comes to making decisions. In order to test the hypothesis, an experiment was formed.
The experiment was conducted over a series of six weeks, in which four subjects of each type of plant was given time to grow. Once every week the designated 500 mL of ORGANIC ACTIVATOR and VIGOR was added. After the trials were completed, the biomass of the the surviving plants was measured. This allowed the results of the individual plant to be compared. During the experiment, the water quality of the reservoir was taken three times over the course of the experiment as a way to try and help understand why certain plants grew better than others.
Out of the four basil trials, only one plant survived and weighed at 0.39 grams. The type of plant that grew the fastest was strawberries. The strawberry plant that weighed the most was 12.9 grams. Marigolds grew the second best with two plants surviving, weighing at 4.3 grams and 4.2 grams. The amount of nitrate and nitrite in the water never changed, while the ammonia slowly decreased and the alkalinity increased at the end of the experiment.
After analyzing the results of this experiment it can be concluded that the hypothesis was not supported. These results can be used in the future and in long term when planning large scale and commercial hydroponic growing.

H28 How Does Carbon Dioxide Affect Plant Growth

Environmental Science
Hasna Iqbal
Boston Latin Academy

My objective is to identify the relationship carbon dioxide has on plant growth. This information is key into researching the topic of climate change and to finding ways to prevent it or lessen it because it is a critical problem. Not to mention it also helps in the way of solving controversies on whether climate change is an actual problem and/or how critical it is to take steps into preventing or lessening it.
My experiment uses the process of fermentation in order to create the carbon dioxide as a primary source. During the experiment multiple factors had to be controlled such as placement and amount of water they received.
My hypothesis was proven correct through this experiment. I predicted that the plants that received extra co2 wouldn't grow as well as the plants that didn't receive extra co2 and it according to the results was confirmed.

J4 Bioplastic: An Alternative for Environmentally Destructive Polymers

Environmental Science
Kimberly Konar, Amanda Cameron
Marlborough High School

Plastic consumption has increased drastically in the last century. The Great Pacific Garbage Patch, just one of the plastic landfills, is 50 feet long and stretches all the way to the sea floor. As a solution to the problem, bioplastics were created. As opposed to the petroleum used in common plastic, bioplastic is created using all natural ingredients, building long polymer chains with starches and glucose. The problem tested was whether corn starch plastic or milk plastic would create the most readily biodegradable plastic while also resembling the most realistic plastic consistency. It was hypothesized that corn starch would make the most durable and biodegradable plastic due to its chemical composition of long polymer chains. However, the starch is not a recycled material like the curdled milk, thus, the spoiled milk plastic would have a more positive environmental impact. Starch plastic was created from vinegar, glycerol, water and starch; whereas the milk plastic combined milk and vinegar to separate out the curds. Once the pieces were dried, they were left to biodegrade for 4 weeks. Based on the data collected, it was determined that the milk plastic biodegraded more efficiently, since the starch plastic increased in mass by absorbing water. When physically observed though, it was determined that although the data was accurate, based on the initial problem that was trying to be solved, the starch plastic was the most durable and useful, while still following the biodegradability guidelines, although it did not biodegrade as quickly as the milk plastic.

J5 Lichen: Bio-Indicators of Air Quality

Environmental Science
Driss Bourzgui
Berkshire Arts & Technology Charter Public School

Lichen has been known to be very sensitive to fluctuations of air pollutants. The hypothesis is that air quality can be determined by the composition of an area's lichen population. I was able to test this by observing different areas of air quality and rating them each on a SO_2 scale. My results showed that my urban area of study had the lowest scale rating of 4 (highest pollutants), the suburban second highest with a rating of 6, and the wooded area with the highest scale rating of 8 (least pollutants). My hypothesis was proven by my data since the area with the lowest air quality had a low amount and variety of lichen showing that lichen can be used as a biomonitor. Another experiment that could be conducted is going to to more areas of increasing air quality.

J10 Salinity's Effect on Brine Shrimp

Environmental Science
Juliana Vazquez
East Boston High School

I chose this project to see how various concentrations of salt in a solution affect the ability of brine shrimp to successfully hatch. This project was very complex. I had to find the exact measurements in order for the eggs to hatch, it wasn't easy. After a failed attempt, I decided to try again and this time I stepped up my game. I got a heat lamp, epsom salt, hatching salt, a water pump and yeast (to feed them). This really helped my experiment. Before I had those things, I had water, salt, and the brine shrimp eggs. My results were successful! Christmas morning I woke up to over a hundred brine shrimp swimming around (probably the best christmas gift ever!) My project reached all the goals I wanted to and I am very happy with the results.

J12 Using Calcium to Protect Forest Plants from Nitric Acid Rain.

Environmental Science
Karla Gomez
Edward M. Kennedy Academy for Health Careers

Nitric acid rain is harmful to forest plants, my experiment was to determine which Calcium sources when added to the soil are best to protect plants from Nitric acid rain. Plants were grown in soil that contains Calcium source such as Oyster Shells, Eggshells, Milk or Limestone by watering the plants with a 10 mM of nitric acid solution we tested the effect of the Calcium Source. When I did the experiment it proved that the Calcium source did actually helped the plants by increasing their height and changing the color to adapt to their environment and the plants that only had Nitric acid died off which shows that the plants are usually being damaged by the Acid rain and it will be a terrible impact in the future if Nitric acid falls into the plants consistently.

J22 Determining Micro-Plastic Pollution in Bivalves by Species and Region

Environmental Science
Michael Dello Russo
Revere High School

Plastic pollution is very ubiquitous in today's marine ecosystems and can have harmful effects on the inhabitants of these ecosystems. Since these plastics are in the ecosystem, organisms are constantly coming in contact with them and possibly ingesting them through either mistaken identity or accidental consumption through active feeding. Harmful chemicals have been found on their surface, such as PCB's, DDT, and carcinogens. If micro-plastics are consumed, then these chemicals could transfer from the surface of the plastic to the tissues of the organism. If a base level organism in the food chain consumes micro-plastics, then predatory organisms who eat a number of these base level organisms will come in contact with micro-plastics and any chemicals that may have been on the surface of these micro-plastics. This process is called biomagnification and as you go up in the food chain, the concentration of chemicals will increase. Humans are avid consumers of seafood, so the possible presence of harmful chemicals in the marine food chain may mean that chemicals could possibly permeate the human food chain. If bivalves are collected from various locations along the north shore of Massachusetts, then those that are collected closer to effluent sources, both from water treatment and storm drains, will have a higher concentration of micro-plastics in their system than those which are farther away from these sources, because water treatment plants and storm drains contribute micro-plastics to the marine ecosystem. Also if wild bivalves and store bought bivalves are collected, then the store bought bivalves will most likely have a lower concentration of micro-plastics when compared with the wild caught bivalves, because of the processing that bivalves go through before sale.

J23 Neutralizing the Effects of Ocean Acidification on Bivalves

Environmental Science
Samantha Trattel, Emily Kitsock, Mei Marks
Nantucket High School

Our experiment investigated neutralizing the effects of ocean acidification. In the last 200 years, 550 billion tons of carbon dioxide has been absorbed into the ocean. The pollution of carbon dioxide into the earth's ocean is the key factor in ocean acidification. Ocean acidification is affecting the ocean water at a concerning rate, and without researching ways to slow this rate, it may end up with unfortunate consequences. Methods of preventing further acidification are necessary in order to bring the pH levels down. The buildup of carbon dioxide (CO2) in the water is what causes ocean acidification. Ocean acidification is the main factor in deteriorating oyster shells as well as other organism with calcium carbonate shells.

K6 The Effect of Global Climate Change on Spider Silk Proteins

Environmental Science
Emma Beale, Kate Woelflein
Hopkinton High School

According to NASA, temperatures could rise by 4.5°F in the coming century because of increasing carbon emissions. In order to determine the impact of global warming on an international scale, spiders were analyzed in 3 different terrariums set at 3 different temperatures. Spiders are ectothermic animals, meaning that both their metabolic rates and activity levels vary with temperature. Being that they are sensitive to temperature, the activity level of a spider can be monitored through the amount, structure, and strength of the silk produced in varying temperatures to simulate global warming. 3 terrariums set up with the same conditions (water cup, 12 sticks, one package of sphagnum moss) at 3 different temperatures were used to model projected global warming rises. One spider was placed in each terrarium. After 4 day trials, the mass of the silk produced, size/structure of the web, and elevation of the web was analyzed and recorded. Silk samples from the web were also taken to measure the width of each strand, as well as to observe the internal makeup of the proteins in the silk fibers. The sum of data indicates that there are smaller webs that are less efficient in capturing prey being produced in the terrariums set at higher temperatures.

K8 Microplastics in the Coastal Ocean Over Time

Environmental Science
Bishakha Oli
Falmouth Academy

Since the early 1970s, demand for plastics has risen among consumers due to its versatile nature. However, partially disintegrated plastics known as microplastics can cause serious damage to the marine ecosystem. Their size makes them available to a greater degree of marine animals. If ingested, microplastics can cause blockages of digestive tracks, toxic reaction and even death. The purpose of this experiment was to determine how the size and relative composition of plastic types in ocean debris have changed over the course of the past twenty years. Near shore microplastic samples of microplastics from the years 1990-95 and 2010-15 were analyzed. These samples were taken from tows that were collected off the coast of Martha's Vineyard. It was hypothesized that the size of microplastics would have decreased over the last twenty years, and that there would be more polypropylene present today than before, less polyethylene, and the same amount of polystyrene. The experiment was conducted by first determining the 2D surface area of each particle from the tows using a high definition scanner. Next, a Raman Spectrometer was used to determine the polymer type of the particles. At the end of the experiment it was determined that the size of microplastic particles has decreased over the past twenty years, that the relative amount of polypropylene has increased by 25%, that the amount of polyethylene have increased by 8%, and that the amount of polystyrene has increased by 5%. The hypothesis was supported. These results are relevant because they provide new information about the particle size and composition of microplastic debris.

K9 The Effects of Caffeine on the Environment

Environmental Science
Michael Falcao, Aoguzi Muhameiti
Pioneer Charter School of Science II

It has become apparent to me that caffeine has become the most widely consumed drug in the world and it has made its way into many cultures. Due to such a large amount of caffeine being used world wide, we wished to test how caffeine would affect the marigold flower, due to its wide availability and fast rate of growth. We hypothesized that caffeine would have a positive effect on the growth rate of the plants. We hypothesized this after cross referencing research conducted by universities, each came up with a unique conclusion that the caffeine in coffee assists in the growth of their tested plants. So we conducted our experiment that was conducted of 2 control groups which consisted of a pot, soil, seeds and water. Then there were 6 other groups that had the same components as the control, but they had various amounts of caffeine. After, 5 weeks, we were able to come up with a solid conclusion. The groups that had the most caffeine either had their growth stunted or they did not grow at all. In comparison to the other 6 groups that all grew equally healthy and in an equal abundance. With this information, we were able to conclude that plants have limitations to the amount of caffeine they can take in, and when caffeine is administered in high concentration, there are side effects on the plants. In conclusion, we disproved the research presented by universities, and proved that caffeine can have a serious effect on the environment when it is introduced in large quantities to the soil. The effect on the calcium content was confirmed with the measurement of calcium before and after growth using litmus strips.

K24 Filtering with Titanium Dioxide

Environmental Science
Starleene Thou, Erin Holmgren
Brockton High School

If titanium dioxide is coated on the outside of a building, then the amount of air pollution in the surrounding environment will decrease because titanium dioxide uses the process of photocatalysis to chemically change the air pollutants into substances that are safer for the population and the environment. The expected outcome of this experiment is to use titanium dioxide as an effective filter for air pollutants consistently. The outcome should show a higher level of oxygen during the trials with model buildings covered in titanium dioxide, while the control buildings should be in an environment with less overall oxygen. The data will be acquired by an oxygen probe. This data will then be analyzed and formed into line graphs for each trial with two lines on each. One line will represent the test without titanium dioxide and the other will represent the test with titanium dioxide for that particular trial. Conclusions can be drawn based on the amount of oxygen measured for each trial. The data will be showcased on the graphs where analysis will take place based on the validity of the graphs and trials. If the amount of oxygen is overall consistently higher for the trials with titanium dioxide, then the conclusion can be drawn that the titanium dioxide did indeed filter the air pollutants.

N3 The Effect of Antacids on Soil Damaged by Acid Rain

Environmental Science
Elizabeth Parkinson
Bishop Feehan High School

Acid rain damages the earth in many ways. This experiment tested whether antacids can reverse the effects of acid rain on soil. The hypothesis of this experiment was that if bush beans growing in soil contaminated by acid rain are treated with the antacid TUMS, then they will grow taller and their soil will have a higher pH level than the plants growing in soil contaminated by acid rain with no antacids. This was tested by growing bush bean plants in soil affected by an acid rain substitute, which was group A, in soil affected an acid rain substitute and the antacid TUMS, which was group B, and in regular soil, which was group C. After three weeks the plant's height and the pH level of its soil was measured. The results of this experiment were that the plants in group A had an average height of 14.5 centimeters and their soil had a pH of 4.0. The plants in group B had an average height of 13.2125 centimeters and their soil had a pH of 8.0. The plants in group C had an average height of 22.0625 centimeters and their soil had a pH of 5.5. The results did not support the hypothesis because the plants in group B did not grow taller that the plants in group A. This experiment did show that antacids can reverse the effects of acid rain on soil because the soil in group B had a higher pH than the soil in group A.

N8 The Effect of Mycorrhizal Fungi on the Growth of Tomatoes

Environmental Science
Andrew Paradis, Rashawn Shaw
Excel High

Plants and certain types of fungi have the potential to have a symbiotic relationship, which is referred to as a mycorrhiza. Through research we identified that, the presence of mycorrhizal fungi has been shown to improve the growth of trees. The goal of this project is to determine whether arbuscular mycorrhizal fungi can have a positive effect on the growth of tomato plants and in turn, if they have the potential to improve agricultural yields, and act as a substitute for synthetic fertilizers. We hypothesized arbuscular mycorrhizal fungi will have a positive effect on tomato plant growth. To test this, we took 16 pots which contained 2 tomato seeds each in potting soil. 4 of the pots were watered with mycorrhizal mushroom spores, 4 were watered with Miracle-Gro, 4 were watered with both mycorrhizal mushroom spores and Miracle-Gro, and 4 were watered with potable water. Once a week we watered and measured height and widths. From our data, you can clearly see that the miracle grow impacted our plants over the course of 7 weeks having an exponential growth curve which was far greater than our mycorrhizal fungi growth curve. However, after 6 weeks we began to see an increase in the mycorrhizal fungi's growth curve. Which makes it difficult to say, based on the findings, that the mycorrhizal fungi did not have positive effect on the growth of tomato plants because it can be argued that it can be a substitute over growing plants in just regular potting soil.

N12 Reducing Ocean Acidification

Environmental Science
Brian Thompson
Mary Lyon Pilot High School

Can algae reduce ocean acidification and can plants reduce the carbon footprint produced by fossil fuels? An algae platform on the ocean could absorb CO2 gas before entering the water preventing more ocean acidification. I built a CO2 reactor to simulate the greenhouse gas in the atmosphere and an algae plantation that I hypothesized would absorb the CO2. I tested the pH of the water samples and after 10 days the pH of the saltwater with no algae dropped to approximately 7, while the pH of the algae water remained at a level of 8.1 After a successful experiment the test shows that placing an algae plantation on the ocean will reduce the amount of CO2 going into the ocean and prevent further damage to the ecosystem of the ocean.

P20 The Effect of Biodegradable Plastics on Pea Plants: Friends or Foes

Environmental Science
Isha Chug
Shrewsbury High School

Plastic is everywhere! Wherever one goes, there will be plastic litter found on the ground! Every year, over 300 million metric tons of plastic is produced. At least 50% is thrown away and discarded within a year of their purchase, and only 9% is recycled. Once the plastics have been discarded into the environment, it is believed that it can take up to 1000 years for the bag to biodegrade. However, the petroleum-based plastics barely degrade at all. During the degradation process, harmful gases are released, similar to those released when plastic is produced, not only harming the environment, but people as well. A solution is needed for this problem. If more organic matter is added to a plastic bag, will the bag degrade faster and increase the total growth of the plants, such as peas? I hypothesized that yes, biodegradable plastics, with increased amounts of cornstarch, between 5 g and 20 g, would be able to degrade faster with living microorganisms, like bacteria, in the soil. They break down material into organic biomass, leveraging decomposed biomass to help the total growth of pea plants, improving the overall environment. With this, I buried 2 samples of plastic shopping bags (degradable plastics) and SunChips bags (biodegradable bags), and 4 samples of the cornstarch bags, and planted peas. The total growth of the pea plants was monitored over the course of about a month. I concluded that biodegradable plastics are most beneficial to an environment, as the total growth of pea plants in that box was the highest. However, the results collected are not statistically significant, and additional time is required for further experiment. So, when you use a plastic product next time, remember to recycle it, as it will contribute to a safer environment.

P22 Effect of the Species of Wood on the Heat Produced by a Biomass Pellet

Environmental Science
Sierra Little-Gill
Hanover High School

The purpose of the experiment was to determine which combination of four woods, bound with a soy-based biological wax, would produce the most heat and burn for the longest amount of time. Approximately 0.200 g. of each type of wood was placed in the pellet and covered with a constant amount of wax. The pellets were ignited and the amount of heat produced was measured using a coffee-cup calorimeter. After two trials it was determined that a pellet containing (layered bottom to top): maple, poplar, jatoba and cherry burned on average for 2 minutes longer and produced 40 J more energy than the other three pellets.

Mathematics

Mathematics

F27 Graph-Theoretic Implications on Graphs Composed of Complete Bijections

Mathematics
Max Abrams
Falmouth High School

This project explored results from previous years' research, in which an algorithm to generate M-graphs was created. M-graphs are composed of smaller graphs, which are generated by plotting all possible mappings from a between two sets (equal in cardinality) of numbers. Each mapping from a number in one set to a number in the other set creates a vertex. Each bijection yields a set of vertices, which are completely connected to one another. Each mapping is referred to as a bijection, and the M-graph is finished once all bijections are plotted.
For M-graphs generated from sets whose cardinality is greater than or equal to 4, it was found that multiple edges were present. It was found that for every single pair of vertices in an M-graph (cardinality greater than or equal to 4), both vertices will be mapped to each other at least twice, because each vertex in every pair of vertices is contained in at least two bijections. As the cardinality of the sets increases, the number of multiple edges between every pair of vertices increases, making the M-graph more complex.
M-graphs are Eulerian. For all cardinal values greater than or equal to 3, M-graphs are connected, and the degree of every single vertex in an M-graph is even.
As the cardinality of the sets increases, the graphs become more complex. However, the graphs remain Eulerian. Mathematically, this is interesting because there will always be order as complexity increases.

H27 Solving a Rubik's Cube for a Beginner

Mathematics
Kevin AuDuong
Plymouth North High School

The rubik's cube is a 3D 6 faced color puzzle with over 43 quintillion ways to scramble the 6 faces. To many beginners it would seem almost impossible to solve a Rubik's cube easily, thus leading to many people giving up on ever solving one. There are many ways or methods however in which someone can memorize it's algorithms to successfully solve a Rubik's Cube. However there are many ways out there for a person to learn and some are much more complex or difficult to execute than others. The aim of this experiment is to see compare if the differences between 2 of the most commonly referred to methods to beginners. Then there will be an optimal method that is both easy to learn and efficient enough for a beginner. Through testing of both methods in time it takes to solve and how many moves it takes. CFOP was shown to have a better average moves count and time overall than the beginner method with 1:33 seconds and 101 moves. The beginner method had an average time of 2:16 seconds and 125 moves on average. Showing from this it is ok to conclude that CFOP is a better method to use than the 7-step for a beginner. Showing for a much more simple way to solve a Rubik's cube alongside faster times and moves count being much smaller.

K11 Maximum Size of a Family of Pairwise Graph-Different Permutations

Mathematics
Richard Zhou, Louis Golowich
Lexington High School

Two permutations of the vertices of a graph G are called G-different if there exists an index i such that i-th entry of the two permutations form an edge in G. We bound or determine the maximum size of a family of pairwise G-different permutations for various graphs G. This problem is motivated by its relation to the Shannon capacity of a graph. We show that for all balanced bipartite graphs G of order n with minimum degree n/2 - o(n), the maximum number of pairwise G-different permutations is grows on the exponential order of 2^n. We also present examples of bipartite graphs G with maximum degree O(log n) that have this property. We explore the problem of bounding the maximum size of a family of pairwise M(n)-different permutations, where M(n) denotes the graph of n/2 independent edges; we determine the exact value for M(4), and present some asymptotic bounds relating to pairwise M(n)-different families of permutations.

K25 End Behavior of Discrete Curve Shortening Flow

Mathematics
Peter Rowley, Sam Cohen
Lexington High School

In this project, we analyze the results of triangles under discrete curve shortening flow, specifically isosceles triangles with top angle greater than pi/3 and scalene triangles. By considering the locations of the three vertices after some small time epsilon, we use the definition of the derivative to calculate a system of differential equations involving parameters that can describe the triangle. Constructing phase plane diagrams and analyzing them, we find that the singular behavior of discrete curve shortening flow on isosceles triangles with top angle greater than pi/3 is a point and on scalene triangles is a line segment.

N19 Music Math: Does Music Follow a Zipfian Distribution?

Mathematics
Brian Best
Hopkinton High School

Zipf's law is a mathematical distribution based in proportions that originated as a theory as to how language formed in early human history. Many functions of the human body and brain also fall into a Zipfian distribution. In last year's project, the driving question was whether or not music fits into a Zipfian distribution. If it did, it would explain why humans enjoy music because it would fit into the natural math of the human body and brain. However, the results showed that music does not fit into a Zipfian distribution, but rather it seems to follow its own specific pattern, indicating that there may be some innate pattern different from Zipf's law that composers follow when writing music. This year, the goal was to study outside the realm of western music and find the underlying pattern in music from different cultures, as music from different cultures sounds very different. The hypothesis was that each culture would have a unique pattern for their music. Note distribution was analyzed in traditional music from five cultures, being Judaic, Irish, Polish, Brazilian, and Japanese. The notes were ordered by rank from highest to lowest number of occurrences, and their respective number of occurrences were graphed on logarithmic axes along with the ideal Zipfian distribution for each song. Despite how different the music from each culture sounds, each song followed the same distribution on the graph cross-culturally, matching the same distribution found in western music in last year's project. This suggests that this unknown pattern is a universal, innate distribution that composers across the world unintentionally follow when writing music.

Earth & Space Science

Earth & Space Science

K28 The Accuracy of Weather Applications
P23 Catching Stellar Dust

K28 The Accuracy of Weather Applications

Earth & Space Science
Joseph Rotondo
Upper Cape Cod Voc-Tec. H. S.

The project that has been completed was inspired by the need for an accurate weather application that predicts the weather without variations from actual weather data. The hypothesis that was created states that the effect of different weather applications on the accuracy of weather predictions proves that NOAA's (The National Oceanographic and Atmospheric Administration's) predictions are the most accurate. Being curious about the weather, research was gathered on the accuracy of different weather applications, and a hypothesis was created predicting the best one. This project was created to help other people find the best weather application for the Cape Cod area and help plan their days with accordance to the weather predictions made. The data gathered shows the result of predictions made over a week to determine the analysis and conclusion.
The independent variables in this investigation were the weather applications. The dependent variable was the accuracy of the weather application's predictions. The control group was the weather that was measured daily. The experimental groups were the weather predictions from the weather applications. There was 7 trials over 8 days, where predictions were gathered at 12pm over the first seven days and weather data measurements were made at 6am, 12pm, and 6pm to determine the accuracy of those predictions.
The hypothesis was supported, NOAA made the most accurate predictions compared to the other weather applications that were accounted for. This project applies to society because people want to use the most accurate weather application in the Cape Cod area. These people may recognize that NOAA (Weather.gov) has the most accurate weather predictions according to this experiment.

P23 Catching Stellar Dust

Earth & Space Science
Alexia Bartolomeo, Grace Mullaly
Everett High School

My project is based on catching stellar dust using homemade satellites and dropping something into a flour substance, creating an impact. I create mini satellites and tie them to a coat hanger using a string and hang it over the flour as I drop a rock onto the flour, causing the flour to fly up and land on the satellites.

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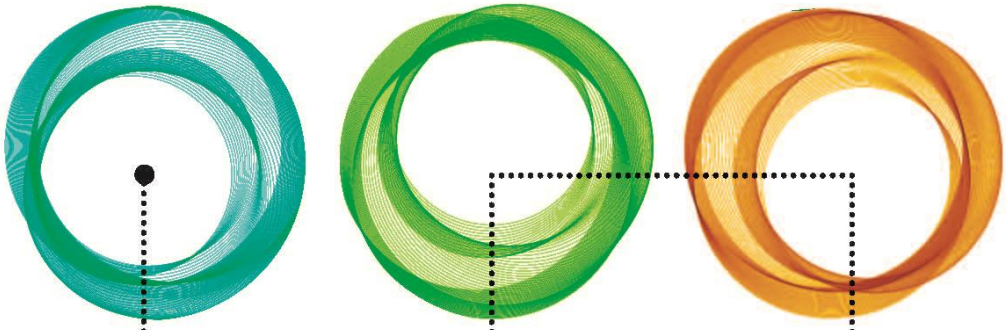

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