2018

69TH ANNUAL **MASSACHUSETTS STATE**

Science & Engineering Fair

OFFICIAL PROGRAM AND ABSTRACT BOOK

HIGH SCHOOL DIVISION

May 4-5, 2018

Building for
the future

MSSEF and cmi

Mark, Atopic Dermatitis, Denmark

FOCUSED ON DEVELOPING SPECIALTY TREATMENTS

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

Conratulations to all of this year's MSSEF participants!

www.sanofigenzyme.com

SAUS.GZ.18.03.1374 03/2018

SANOFI GENZYME

2018
MASSACHUSETTS STATE SCIENCE & ENGINEERING FAIR

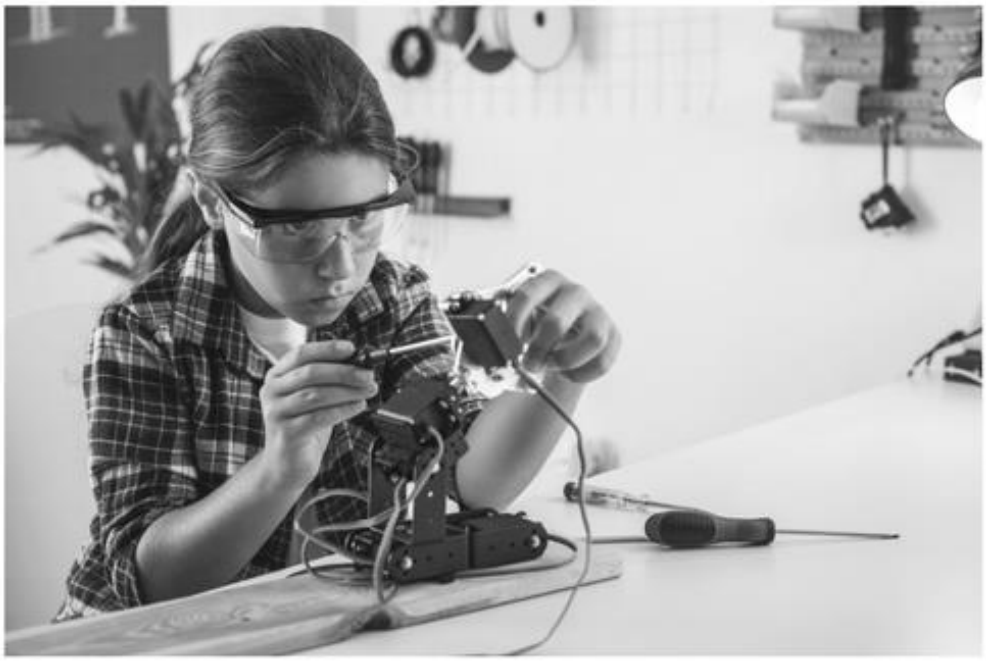
Official Program & Abstract Book

May 3-5, 2018

CELEBRATING MSSEF'S 69TH ANNIVERSARY!

YOU INSPIRE US!

Fish & Richardson is proud to support STEM learning and the **Massachusetts State Science & Engineering Fair**.



FISH.

FISH & RICHARDSON

info@fr.com :: @FishRichardson

fr.com

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

TABLE OF CONTENTS

A proud sponsor of the 2018 Massachusetts State Science and Engineering Fair

WPI

IMAGINE ANYTHING
INNOVATE EVERYTHING

Explore top science, engineering, and technology programs at Worcester Polytechnic Institute—a nationally renowned research university distinguished by our innovative project-based education, transformative real-world learning experiences, and a collaborative problem-solving environment. Here you can imagine across boundaries and in all directions.

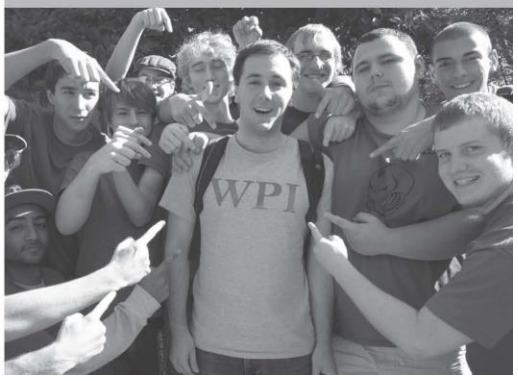
admissions.wpi.edu

95-acre
hilltop campus in Worcester, Massachusetts, the second largest city in New England

14:1
student-to-faculty ratio

50+
degree programs

4,275
students from 48 states and 70 countries



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

SCHEDULE OF EVENTS

May 3 – 5, 2018

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 3, 2018

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

Friday, May 4, 2018

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 – 11:15am
Lunch provided for students

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

Judging of Exhibits — 11:30 – 6:00pm
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 & MSSEF Volunteers!
Student Challenge, fascinating activities/displays, food and social
Stratton Student Center/Lobdell Dining Area

Saturday, May 5, 2018

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

2018 SCIENCE FAIR STEM EXPO

Featuring Major MSSEF Sponsors & Partners
Sat, May 5 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 2018 Massachusetts State Science & Engineering Fair!

Celebrating 69 Years of Inspiring Student Research & Innovation

Envision a future where every student is empowered through learning in science & 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, locally and globally. Each year, when we walk through the showcase of projects created by the 400 most outstanding MA high school student researchers and innovators, we are awed and grateful. The future looks bright in the hands of these talented young scientists and engineers.

A recent MSSEF alumnus said of his science fair experience: "the MSSEF journey certainly lead me to my career in STEM today."

"I first began participating in Massachusetts Science Fairs in the 6th grade. What was initially an attempt to extort a soldering iron and a microcontroller under the guise of "education" turned into exactly that -- a profoundly educational experience. MSSEF provided me with the opportunity to explore a passion and share that passion with industry professionals and academics. It encouraged me, a once shy and academically un-inclined student, to explore complex and exciting ideas; to build, to test, and to design with purpose. The MSSEF journey certainly lead me to my career in STEM today - where I continue to build, test, and design with the enthusiasm it once conceived."

Why MSSEF programs matter so much to all of our futures!
Through MSSEF, students actually get to "do" science and engineering -- the way it is done professionally. Motivated by the potential of discovery and learning something new, 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, guided by a mentor or teacher, 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 69 years, and it is now an essential part of the Massachusetts revised science, technology & engineering standards.

MSSEF programs reach over 70,000 students each year, and the majority attend schools in high-needs districts. MSSEF's Curious Minds Initiative supports independent research investigations by thousands of students statewide (57% of "CMI Schools" are in high-needs districts, 93% 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 Committee, we gratefully thank MIT for hosting the statewide MSSEF High School Fair through every one of our 69 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 2018 Massachusetts State Science & Engineering Fair – an experience that lasts a lifetime!

Sincerely,

Barnas G. Monteith
Chairman of the Board

Cora Beth Abel
President & CEO

William F. Rigney
Chair, High School Committee

OFFICE OF THE GOVERNOR
COMMONWEALTH OF MASSACHUSETTS
STATE HOUSE • BOSTON, MA 02133
(617) 725-4000

CHARLES D. BAKER
GOVERNOR

KARYN E. POLITO
LIEUTENANT GOVERNOR

May 2018

Dear 2018 Science Fair Students,

On behalf of the Commonwealth of Massachusetts, Lieutenant Governor Karyn Polito and I would like to congratulate each and every high school student who has earned a place in the 2018 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 69th year as a national academic 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 the sponsors and partners who support it, including the many Massachusetts companies that are leaders in the science and technology sectors and our institutions of higher education, including the University of Massachusetts network.

Thank you for all that you do and best of luck to all of the 2018 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

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

The Patent Award Winners – 2002-2017

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.
2017 Indumathi Prakash
Sharon High School
John Ta
Mass. Academy of Math & Science

2018

69TH ANNUAL **MASSACHUSETTS STATE**

Science & Engineering Fair

Saluting Our 2018

Sponsors, Donors & Contributors

Building for *the future*

MSSEF and cmi

April 15, 2018

• 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.

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.

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.

STEM SYNERGY

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

LINDE FAMILY FOUNDATION

UMASS BOSTON

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

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.

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.

• SUSTAINING •

HOLOGIC® The Science of Sure

MathWorks® Accelerating the pace of engineering and science

UMASS LOWELL

VERTEX

• CONTRIBUTING •

Analog Devices • DCU for Kids • INTEL Corp.
Pfizer Inc. | Worldwide Research & Development • Regis College • Shire Human Genetic Therapies
UMASS Amherst • Waters Corp. • Wentworth Institute of Technology

• GOLD •

BAE Systems
Framingham State University
Harvard Summer Secondary School Program
Massachusetts College of Liberal Arts
Moderna Therapeutics
National Youth Science Foundation
Novartis
Pearson North America

• SILVER •

Applied BioMath, LLC
Broadcom Foundation
Stephen Marcus
Massachusetts Chemistry & Technology Alliance, Inc.
Omnova Solutions, Inc.
Ricoh Americas Corporation
Teradyne, Inc.

• BRONZE •

AbbVie, Inc.
American Society of Safety Engineers
Mr. and Mrs. Samuel Batchelder
ImmunoGen, Inc.
Kronos Inc.
Massachusetts Educational Finance Authority
Massachusetts School Administrators' Association (MSAA)
MIT Educational Studies Program
MIT Lincoln Laboratory
Move the World Foundation
Northrop Grumman Corporation
Optical Society of America/ New England Section
Mr. Rishi Shukla
The Harvard University Press
US China Scitech Education Promotion Association

• PEWTER •

John Buster & Cora Abel
Eaton Vance Matching Gift Fund
Ned Forrester
Independent Testing Laboratory Association
Judi Cranna & Harry Leichtman
Massachusetts Medical Society
The Ben Eisenstadt Memorial Award
The Pauline J. LaMarche Memorial Award
The MITRE Corp.
UMASS Medical School

• FRIENDS •

Dr. and Mrs. David Brooks
Kennett Burnes
Mr. and Mrs Charles R. Carey
Louise & Jeffrey Clarke
Lauren R. Doty
Susan Farnsworth
James Fitzgibbons
Paul R. Gallagher
Dr. and Mrs. Marvin C. Grossman
Sally Hampton
Neil Hodes
Shaikh Hoque
Mr. and Mrs. Chris Housley
Humble Bumble
Kraft Tire & Auto
Caroline Lamb
John Martin
Richard Moyse
Northeast Br./American Society for Microbiology
Judith and Thoru Pederson
Stephen Pitcher
Paulette Rand
William F. Rigney
Brenda Roder
AnJeannine Romero
James Shanahan
Michael Silveira
Roger Sullivan
Jack & Ellie Tishler
U.S. Air Force
US Navy – Office of Naval Research

• LEVELS OF SUPPORT •

SPONSORS

Lead $200,000 • Supporting $50,000 • Sustaining $25,000 • Contributing $10,000

DONORS

Gold $5,000 • Silver $2,500 • Bronze $1,000 • Pewter $500 • Friends

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

MANAGER OF MAJOR GIFTS & GRANTS

Lauren R. Doty
Tel: 617-892-5224
ldoty@scifair.com

• IN APPRECIATION •

We are grateful to our supporters – companies, universities, foundations, individuals and professional organizations, for their help over the past 69 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

MSSEF
Massachusetts State Science & Engineering Fair

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

INTERNATIONAL SCIENCE & ENGINEERING FAIR

Hats off to the 2018 Massachusetts Delegates!

The 2018 Massachusetts delegates to the Intel International Science and Engineering Fair (ISEF) will be introduced at the Award Recognition Ceremony on May 5. The International Fair will be held in Pittsburgh from May 13-19.

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 24 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 1,800 high school students from over 75 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 $4 million in prizes and scholarships.

We wish to thank the INTEL Foundation and our other generous sponsors for their support of our Massachusetts/ISEF delegates. We salute our full delegation, including the chaperones, and extend our best wishes to all for much success and pleasure at the 2018 "International".

CONGRATULATIONS
& Best Wishes
To the 2018 Massachusetts Delegates to the Intel International Science & Engineering Fair

GOOD LUCK in Pittsburgh

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

MSSEF Massachusetts State **Science & Engineering** Fair

MSSEF Mini-Grants – Up to $2,500

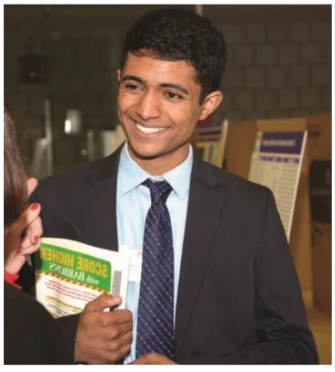
This Could Be **YOUR** School!

MSSEF and Curious Minds!

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

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

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



APPLY NOW! *Rolling Applications — No Deadline*

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

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 $2,500 for a multi-year program.
- Tuition Scholarships of $3,500 for up to 6 STEM teachers to enroll in CMI Courses **scifair.com/curious-minds/**
- Science Fair consultant to visit your school upon request
- Invitations for Teachers & School Leaders to:

— Join meetings of 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.

For more information: scifair.com | cmi@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 4, 2018
11:30 am – 1:30 pm
Stratton Student Center – Mezzanine Lounge

Panel Members

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

Oliver Souyavong
Assistant 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 ·

UMASS BOSTON

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

The "Curious Minds" Initiative (CMI)

Students Learn through Science/Engineering Practices & Guided Independent Research
A scalable MSSEF Program with special funding for students in high-needs schools

Three CMI programs work together to support schools, empower teachers and provide opportunities for students to experience the "real world" practices of professional scientists and engineers. Grants to schools and CMI professional development enable STEM teachers to integrate the revised MA standards into their *existing* curricula, and to run exciting competitions (science fair events) that showcase student research and innovation projects.

1. **CMI Courses & the STEM Certificate in Science & Engineering Practices**
   Teachers learn to create exciting project-based units and to guide student independent research. CMI's three graduate-credit courses plus educator workshops have helped 400+ STEM educators to dramatically increase their teaching effectiveness—and they are impacting 19,000+ students each year.
2. **STEM Mentoring for Students:** As part of an MSSEF-School District partnership, CMI pairs young students (grades 6-12) with STE M 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, and a STEM teacher from each school are awarded stipends to help lead this afterschool program.
3. **Mini-Grants for Schools: IMAGINE** a school in 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" of up to $2,500 enable schools and teachers to do just that: to inspire students to pursue STEM learning through direct engagement in research & innovation, and through excitement of science fair competition.

Learn more at: http://scifair.com/curious-minds/
Interested in CMI at your School? Contact us today! cmi@scifair.com

cmi Curious Minds Initiative

Give Your Students the Independent Research Experience

Take CMI Courses in 2018!

1

TSIP: "Teaching Science through the Inquiry Process"

6 days • 3 credits

Practical strategies to infuse more science practices into your teaching

July 30-August 3 & November 3
Framingham State University

2

PCS: "Project-based Classroom Science"

5 days • 2 credits

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

August 6-9 & November 3
Framingham State University

3

GRIPS: "Guiding Research & Innovation Projects by Students"

2 days • 1 credit

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

August 9-10
Framingham State University

- Complete all three CMI Courses for graduate credit and earn the

STEM Certificate in Science & Engineering Practices

from Framingham State University!

Be Our Guest!

2018 MSSEF Educator Day
May 4th @ MIT...

"Behind the Scenes" at the high school State Science Fair

MSSEF Massachusetts State Science & Engineering Fair

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

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)

MSSEF, Inc. | 955 Massachusetts Avenue #350 • Cambridge, MA 02139 • (617) 491-1500 • **www.scifair.com**

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

MSSEF EDUCATOR DAY @ MIT

Friday May 4, 2018 □ 8:30am – 1:30pm

Held during the 2018 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.jotform.com/80966345883168

1:30 **Adjourn**

2018 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 and DCU for Kids

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

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.

2018 COP Panel

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

Ricky Housley
Research Scientist
Red Balloon Security, Inc.

Maggie Lazeros
Corporate Lead Executive &
Dr. David M. DeNofrio
Northrup Grumman

Jon Siddall
Research Fellow
Cabot Corporation

Held on Saturday morning, May 5 @ 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.

MIT is proud to host the Massachusetts State Science & Engineering Fair for the 69th consecutive year…

and to help further the pursuit of scientific excellence and inquiry-based learning. MIT gratefully acknowledges MSSEF's sincere appreciation to the leadership and administration of the university for providing the venue, encouragement and support to students throughout the Commonwealth who present their work.

Congratulations to MSSEF's sponsors, donors and its administrative staff on another fine year. Much success to all participating students.

Massachusetts Institute of Technology

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

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/Co-Chairs: Monica Joslin; Shannon Zayac & Jennifer LaForest

Region II: Central Massachusetts
Worcester Regional Science & Engineering Fair
Worcester Polytechnic Institute, Worcester
Chair: Nicholas Guerin

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

Region IV: Northeastern Massachusetts
Massachusetts Region IV Science Fair
Somerville High School, Somerville
Chair: Mr. Chris Angelli

Region V: Southeastern Massachusetts
South Shore Regional Science Fair
Bridgewater State College, Bridgewater
Chair: Daniel T. Adams

Region VI: City of Boston
Boston Public Schools Regional Science Fair
Northeastern University, Boston
Chairs: Pamela Pelletier

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

Visit the 2018 Science Fair Expo

An eye-catching showcase of exhibits to engage the mind and spark the scientific spirit. Come and meet the exhibitors. Find out more about how science, technology, engineering and math play key roles in today's business and industry, on college campuses and in professional sectors — including law, medicine, invention, the media, and non-profits.

Saturday, May 5 12:30 to 3 pm

MIT Johnson Athletics Center

EXPO EXHIBITORS

April 20, 2018

MathWorks, Inc.

Optical Society of New England

Tumblehome Learning

YOUR FUTURE AWAITS YOU AT UMASS BOSTON

Enjoy our:

- Campus – minutes from downtown Boston
- Generous financial aid
- Engaging Honors College curriculum
- Range of science and engineering majors in the
  - College of Science and Mathematics
  - College of Nursing and Health Sciences
  - School for the Environment

www.umb.edu

UMASS BOSTON

18.XXXCF

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

In Appreciation of Our 2018 Judges

To the Companies, Educational Institutions, Professional Organizations and Individuals represented in out prestigious 2018 MSSEF Judging Corps

MSSEF highly values your volunteer service to our student science fair programs. Over 325 Judges from more than 100 companies, educational institutions and professional organizations in Massachusetts will participate in the 69th year of MSSEF's statewide high school Science & Engineering Fair at MIT.

Your volunteer work is helping to inspire the next generation of scientists and engineers. On behalf of the entire MSSEF community — the board of directors, the officers, staff and hundreds of science teachers who guide student projects year round, we offer our special thanks and appreciation. (Effective : Apr 14 2018)

A G Reinhold
Mr. Arnold Reinhold

Abbott Bioresearch Center
Dr. Sami Osman

Acacia Communications
Mr. Glen Miller

AccuBoost
Mr. Raymond Bricault

Aeroplas Corp. Intl.
Mr. Thomas Walton

American Tower Corporation
Ms. Jenna Metznik

Amgen, Inc.
Dr. Oleg Epstein

Analog Devices, Inc.
Mr. Badhri Uppiliappan
Daniel Leibholz
Mr. Jeremy Holland
William Crocker

Aramco - Research Lab
Mr. Trey Lawrence
Dr. Shitong Sherry Zhu
Ms. Rachael Grudt
Dr. Hooisweng Ow

Archetype Technologies, Inc.
Dr. Bryan Bergeron

Baker Hughes, a GE Company
Mr. Gary Kozinski

BayCoast Bank
Paul Jankowski

Beth Israel Deaconess Medical Center
Dr. Emily Cohen
Dr. Lawrence Tartaglia
Dr. Cordelia Manickam

Boston University
Mr. Peng Lin
Mr. William Mau
Ms. Elizabeth Becker

Boston University School of Medicine
Ms. Chelsey LeBlang
Mr. Nicholas Nicoletti
Brandy Dupee
Katharine Babcock
Chris Brooks

Brigham & Women's Hospital
Dr. Mario Manresa
Dr. Melissa St. Hilaire

Broadcom Corp.
Mr. Bhaskara Sherigar

Cabot Corporation
Dr. Ishrat Chaudhuri
Ms. Lauren Bradford
Mr. Gerry Caron
Roarke Burnett

Cell Press/Elsevier
Dr. Lara Szewczak

Draper Laboratory, Inc.
Dr. Richard Dargusch

Children's Hospital Boston
Dr. Julie Liao
Giovanna Ramirez

Clark & Elbing LLP
Dr. Maria DeCicco RePass

Commonwealth of Massachusetts
Leslie Collyer
Ms. Sylvia Hobbs
Dr. Hotze Wijnja
Dr. Rueyjing Tang

Commonwealth of Massachusetts, Executive Office of Labor and Workforce Development
Dr. Susan Shepherd

Computer Sports Systems, Inc.
Mr. Charles Housman

Conservacion Panama Inc.
Mr. Ezekiel Jakub

Consultant
Dr. Byron Delabarre
Neil Hodes
Ms. Nan Doyle
Mr. Norman Gallant
Mr. Paul Lubin
Dr. Keith Kawate
Christina Bramante
Mrs. Kristin Dorfman

Corporate Environmental Advisors
Mr. Adam Last

CR Media Technologies
Mr. Rick Posch

Curis, Inc.
Mr. Paul Marinelli

Cypress Semiconductor Corp.
Ali Atti

Dana Farber Cancer Institute
Dennis Bonal
Dr. Bhavik Nathwani

Decision Resources Group LLC
Dr. Michael Breen

Dell EMC
Mr. Mark Stephan
Mr. Rajasekaran Rajagopal
Mrs. Aparna Ramasundar
Mr. Mahesh Babani

Destination Imagination
Mrs. Amber Khan

Dexter Southfield School
Dr. Norman Wittels

Draper Laboratory, Inc.
Mr. Bernard Antkowiak

Eastern Nazarene College
Dr. Matthew Waterman

EMD Millipore
Michael Whalen
Mr. Tom Maloney

EMD Serono
Dr. Andrew Bender

Engineering Lens
William Wolfson

ESM Health Care Consultants
Elizabeth Minassian, RN

Firespeak
Barbara Bazemore Kiszka

GE Healthcare
Gordon Mills

General Dynamics C4 Systems
Mr. Jacob Mullen

Gillette P&G
Mr. John Cahill

HAML Clinical Associates
Harry Leichtman

Harvard Medical School
Dr. Theodore Feldman
Dr. Emily Mevers
Sonia N. Kim
Hoang Le
Dr. Hartmut Wohlrab

Harvard School of Public Health
Mr. Chris Itoh
Dr. Jeff Wagner

Harvard University
Joseph Peidle
Denise Yoon
Dr. Navish Wadhwa
Mr. James Valcourt
Justin Teesdale
Ms. Emily Erickson
Lisa Heppler
Renee Geck
Mrs. Janice Nieves-Bonilla

Harvard-Smithsonian Center for Astrophysics
Ms. Ashley Villar
Mr. Tanveer Karim

High Performance Systems Software
Mr. John R Sopka

Hologic, Inc.
Dr. Estefi Alvarez

HPrentice Consulting, LLC
Dr. Holly Prentice

Hyper Sonic Sensors
Rick Peralta

IBM
Ms. Lori Davidson
Mr. Kenney Ng

Imaginic, Inc.
Dr. Elizabeth Rudnick

ImmunoGen, Inc.
Erin Maloney
Ms. Lauren Harvey
Xinrong Liu

InfoScope Research
Dr. Yagiz Sutcu

INTEL Massachusetts
Michael Adler

Invaluable.com
Ms. Relly Banker

inviCRO
Ms. Fiona Wood

Jacobs Engineering
Mr. John Hitsos, PE, CxA

Keurig Green Mountain, Inc.
Mr. Ajith Chandrasekharan
Mr. Muthukumar Vanniaperumal

Kronos, Inc.
Maureen Chmielecki

LEDVANCE
Dr. Arunava Dutta

MA Dept. of Energy & Environmental Affairs
Hem Pokharel
Todd Callaghan
Ms. Hong-Hanh Chu
Nora Hanley

MA Dept. of Environmental Protection
Tim Dame
Mr. Michael Stroman
MaryAnn DiPinto
Judith Schmitz
Ms. Albelee Haque
Juliet Swigor
Ms. hui liang

MA Dept. of Public Health
Mr. Anthony Osinski
Mr. Logan Bailey
Ms. Lindsay Bouton
Mr. Michael Farris
Ms. Kerri Barton

MA Dept. of Transportation DOT
Mr. Lokman Arran
Ms. Adetoyin Olaoye

MA Div. of Fisheries & Wildlife
Dr. Rebecca Quiñones

MA Div. of Marine Fisheries
Dr. Greg DeCelles
Vincent Malkoski
Ms. Devon Winkler
Neil Churchill

MA Div. of Occupational Safety
Maria Colon-Galarza

MA State Police Forensic & Technology Center
Christine Lemire

MACOM
Mr. Francesco Caggioni

Marine Biological Laboratory
Marshall Otter
Ms. Suzanne Thomas

Martin Klein Consultants
Mr. Martin Klein

Massachusetts General Hospital
Ms. Hoai Ton
Dr. Khanh Ha
Dr. Lynn Buttolph

Massachusetts Institute of Technology
Mr. Steven Bernstein
Dr. Sukrit Ranjan
Mr. Andrew Fishberg
Dr. Rodrigo Garcia MIT
Mr. George Sun
Mr. Jeffrey Psencik
Marvin Nayan
Dr. Adam Santone
Josh Moss
Michelle Oraa Ali
Edward Pang
Dr. Paul Woskov
Glenn Allen
Dr. Jefferson Roy
Mr. Hao Shen
Dr. Emily Stephen
Ally Huang
Ms. Shannon Johnson
Dr. Austin Jones

Massachusetts Water Resources Authority
Mr. Thomas Renaud
Denise Ellis-Hibbett
Mr. Marcelo Machado
Ms. Sarah Shong

MathWorks, Inc.
Dr. Fu Zhang
Dr. Paul Kassebaum
Saurabh Gujaradhi
Dr. Zhuohua Shen

MCPHS University
Lindsay Tallon

Merck Research Laboratories
Tom Wyche
Dr. Pulkit Gupta
Bimjhana Bishwokarma

Merrimack College
Ms. Maureen Sakakeeny

Millennium Pharmaceuticals, Inc.
Magdalena Prentice

MIT Lincoln Laboratory
Dr. Jean Eugene Piou
David Brown
Mr. Sean O'Melia
Ken Kolodziej
Dr. Phillip Bailey
Dr. Siva Yegnanarayanan
Dr. Joshua Dettman
Mr. Robert Moss
Dr. Christopher Lloyd

MIT Museum
Dr. Brindha Muniappan

MKS Instruments
Mark S. Hoffman

Moderna Therapeutics
Ms. Rosalie Philpot
Ms. Cassandra Borenstein

MOSES
Joe Dorant

Museum of Science, Boston
Dr. Elizabeth Kong

National Center for Science Education
Stephanie Keep

National Oceanic and Atmospheric Administration
Peter Kelliher

New England Cord Blood Bank
Mr. Matthew Wilgo

Nimbus Therapeutics
Ms. Sarah Knutson
Dr. Lewis Whitehead

Novartis
Dr. Joe Loureiro
Dr. Jovita Marcinkeviciene
Dr. Mike Tarselli
Dr. Alan Xiao
Zinger Yang
Dr. Yohann Potier
Philip Lam
Sarah Salas
Dr. Jennifer Allport
Dr. Jennifer Cotton
Dr. Michelle Sidor
Ms. Lauren Goldfinger

Oasis Systems LLC
Jeff Broitman

Office of Naval Research
Richard Rigazio
Benjamin Poole

Oracle
Mr. Marc Howes

OSRAM Sylvania
Mr. David Gross
Dr. Richard Garner

OTHER
Ms. Rebecca Friedline
Mrs. Jacqueline Barnhart
Dr. Ryan Harrison
Mrs. Revathi Pillai

Overnia, LLC
Dr. John Prohaska

Pall Corporation
Dr. Eilidh Bedford

Panasonic Boston Library
Dr. Nanu Brates

Partners Healthcare
Ms. Sarah Dougherty
Diane Seger

PerkinElmer Life Sciences
Ms. April Blodgett

Pfizer Global Research & Development
Dr. Julia Brosnan
Dr. Uthpala Seneviratne

Pfizer Research Technology Center
Dr. Sudhir Sivakumaran

Post Optical LLC
Mr. Ben Wells

Primary Care Innovation Consulting
Dr. Eugene Buff

Rapid Micro Biosystems
Ms. Meredith Rioux

Red Balloon Security, Inc.
Rick Housley

Retired
Dr. Richard Rubinstein
Dr. Bruce Earnley
Carol Hausner
Mr. Douglas Gibson
Dr. John Song
Mr. Peter Anderson
Mr. Frank Marino
Mr. Peter Kingsley
Lyndon Braun
Rich Olsen
Dr. Kenneth Jacobs
Mr. Ernest Wolshin
Dr. Jack Martin
Dr. Patrick Dunne
Dr. Christopher Webster
Mr. James Livingston
Richard Feren

Ribon Therapeutics
Mrs. Demet Guntas
Christina Majer

Riparian Pharmaceuticals
Will Adams

Robert E. Ricles, Esq.
Robert E Ricles

Roche Diagnostics
Jessica Young

Rogers Corporation
Dr. Murali Sethumadhavan

Rubius Therapeutics, Inc.
Kristian Teichert

SanDisk Corporation
Mr. Sameed Shafi

Sanofi
Mrs. Norline Crossdale-Walker
Sanket Patke

Sanofi Genzyme
Ms. Katherine Aldrich
Mr. Christopher Paige
Dr. Gene Malin
Ryan Pepi
Joe Thompson

Schneider Electric
Mr. Paul Blecharczyk
Mr. Patrick Pizzimenti

Sciomix
Dr. Can Bruce

SeaFire Micros, Inc.
James Awrach

Seagate Technology
Ray Pavlak

Sensata Technologies, Inc.
Mr. Douglas Strott
Mr. Aditya Balasubramanian

Seres Therapeutics, Inc.
Mr. David Lichter

Sonos, Inc.
Mr. Scott Weinstein
Mr. Wesley Cox

Southie Autonomy Works
Mr. Jay M. Wong

StemCell Technologies Inc.
Mr. Armel Nibasumba
Dr. Joseph Yawe
Dr. Julie Martell
Ms. Tingting Zhang
Garima Bhardwaj
Dr. Ami Ashar
Christian Skorik
Amanda Flies

SynDevRx, Inc.
Mr. James Shanahan

Systems & Technology Research
Scott Philips
Gokul Subramanian

Takeda Pharmaceuticals
Ms. Beth Piro
Laura Burke

The Broad Institute
Tina Naik

The Data Detektiv
Dr. Anne Thessen

The MITRE Corporation
Mrs. Kristin Fitzgerald
Les Servi
Kristina Groenwoldt

The Singing Torah
Mike Speciner

Thermo Fisher Scientific
Ms. Janet Merrill
Joe Hewitt
Dr. Eric Martin

Toxikon Corporation
Mr. Nathan Blazon-Brown

Tufts University
Kaitlin Chambers
Mrs. Joslyn Mills
Christopher Luby

UMASS Amherst
Ms. Grace Pold
Marie Kroeger
Ms. Gina Chaput

UMASS Boston
William Hagar

UMASS Dartmouth
Mr. Donald Foster
Dr. Barry Haimson

UMASS Lowell
Dr. Elliot Entin

UMASS Medical School
Allison Blodgett
Judy Savageau

University of New Hampshire
Joshua Smith

US Air Force - Hanscom AFB
Mr. Richard Moore

US Army Corps of Engineers, New England District
Dr. Charles Farris

US Army Natick RD&E Center
Dr. Matthew Cain
Dr. Michael Wiederoder

UTC Aerospace Systems
Dr. James Johnson
Mrs. Caren Friedman
Dr. Haftay Hailu
Elliott Strizhak

Verik Bio
Dr. Susan Sullivan

Vertex Pharmaceuticals, Inc.
Dr. Jeansun Lee

VHB
Ms. Tess Paganelli

Visterra, Inc
Ken Johnson

Waters Corp.
Dr. Patrick Brophy
Mrs. Maureen DeLoffi
Jennifer Nguyen
Mr. Corey Reed

Wentworth Institute of Technology
Dr. Mekhala Pati
Dr. Dipti Sharma

WGBH
Ranida McKneally

Wheaton College
Dr. Maria Thandi Buthelezi

WHOI
Ned Forrester
Dr. Ralph Stephen

Worcester Fluids Technology,LLC
Mr. Rafael Lazo

Section

Worcester Polytechnic Institute
Mr. Bryan Choate
Ross Lagoy

X-Chem Parmaceuticals
Ms. Sarah Talcott

Judges Listing by Last Name

Judge	Affiliation
Adams, Will	Riparian Pharmaceuticals
Adler, Michael	INTEL Massachusetts
Aldrich, Katherine	Sanofi Genzyme
Allen, Glenn	Massachusetts Institute of Technology
Allport, Jennifer	Novartis
Alvarez, Estefi	Hologic, Inc.
Anderson, Peter	Retired
Antkowiak, Bernard	Draper Laboratory, Inc.
Arran, Lokman	MA Dept. of Transportation DOT
Ashar, Ami	StemCell Technologies Inc.
Atti, Ali	Cypress Semiconductor Corp.
Awrach, James	SeaFire Micros, Inc.
Babani, Mahesh	Dell EMC
Babcock, Katharine	Boston University School of Medicine
Bailey, Logan	MA Dept. of Public Health
Bailey, Phillip	MIT Lincoln Laboratory
Balasubramanian, Aditya	Sensata Technologies, Inc.
Banker, Relly	Invaluable.com
Barnhart, Jacqueline	OTHER
Barton, Kerri	MA Dept. of Public Health
Bazemore Kiszka, Barbara	Firespeak
Becker, Elizabeth	Boston University
Bedford, Eilidh	Pall Corporation
Bender, Andrew	EMD Serono
Bergeron, Bryan	Archetype Technologies, Inc.
Bernstein, Steven	Massachusetts Institute of Technology
Bhardwaj, Garima	StemCell Technologies Inc.
Bishwokarma, Bimjhana	Merck Research Laboratories
Blazon-Brown, Nathan	Toxikon Corporation
Blecharczyk, Paul	Schneider Electric
Blodgett, Allison	UMASS Medical School
Blodgett, April	PerkinElmer Life Sciences
Bonal, Dennis	Dana Farber Cancer Institute
Borenstein, Cassandra	Moderna Therapeutics
Bouton, Lindsay	MA Dept. of Public Health
Bradford, Lauren	Cabot Corporation
Bramante, Christina	Consultant
Brates, Nanu	Panasonic Boston Library
Braun, Lyndon	Retired
Breen, Michael	Decision Resources Group LLC
Bricault, Raymond	AccuBoost

Broitman, Jeff	Oasis Systems LLC
Brooks, Chris	Boston University School of Medicine
Brophy, Patrick	Waters Corp.
Brosnan, Julia	Pfizer Global Research & Development
Brown, David	MIT Lincoln Laboratory
Bruce, Can	Sciomix
Buff, Eugene	Primary Care Innovation Consulting
Burke, Laura	Takeda Pharmaceuticals
Burnett, Roarke	Cabot Corporation
Buthelezi, Maria Thandi	Wheaton College
Buttolph, Lynn	Massachusetts General Hospital
Caggioni, Francesco	MACOM
Cahill, John	Gillette P&G
Cain, Matthew	US Army Natick RD&E Center
Callaghan, Todd	MA Dept. of Energy & Environmental Affairs
Caron, Gerry	Cabot Corporation
Chambers, Kaitlin	Tufts University
Chandrasekharan, Ajith	Keurig Green Mountain, Inc.
Chaput, Gina	UMASS Amherst
Chaudhuri, Ishrat	Cabot Corporation
Chmielecki, Maureen	Kronos, Inc.
Choate, Bryan	Worcester Polytechnic Institute
Chu, Hong-Hanh	MA Dept. of Energy & Environmental Affairs
Churchill, Neil	MA Div. of Marine Fisheries
Cohen, Emily	Beth Israel Deaconess Medical Center
Collyer, Leslie	Commonwealth of Massachusetts
Colon-Galarza, Maria	MA Div. of Occupational Safety
Cotton, Jennifer	Novartis
Cox, Wesley	Sonos, Inc.
Crocker, William	Analog Devices, Inc.
Crossdale-Walker, Norline	Sanofi
Dame, Tim	MA Dept. of Environmental Protection
Dargusch, Richard	Draper Laboratory, Inc.
Davidson, Lori	IBM
DeCelles, Greg	MA Div. of Marine Fisheries
DeCicco RePass, Maria	Clark & Elbing LLP
Delabarre, Byron	Consultant
DeLoffi, Maureen	Waters Corp.
Dettman, Joshua	MIT Lincoln Laboratory
DiPinto, MaryAnn	MA Dept. of Environmental Protection
Dorant, Joe	MOSES
Dorfman, Kristin	Consultant
Dougherty, Sarah	Partners Healthcare
Doyle, Nan	Consultant

Dunne, Patrick	Retired
Dupee, Brandy	Boston University School of Medicine
Dutta, Arunava	LEDVANCE
Earnley, Bruce	Retired
Ellis-Hibbett, Denise	Massachusetts Water Resources Authority
Entin, Elliot	UMASS Lowell
Epstein, Oleg	Amgen, Inc.
Erickson, Emily	Harvard University
Farris, Michael	MA Dept. of Public Health
Farris, Charles	US Army Corps of Engineers, New England District
Feldman, Theodore	Harvard Medical School
Feren, Richard	Retired
Fishberg, Andrew	Massachusetts Institute of Technology
Fitzgerald, Kristin	The MITRE Corporation
Flies, Amanda	StemCell Technologies Inc.
Forrester, Ned	WHOI
Foster, Donald	UMASS Dartmouth
Friedline, Rebecca	OTHER
Friedman, Caren	UTC Aerospace Systems
Gujaradhi, Saurabh	MathWorks, Inc.
Gallant, Norman	Consultant
MIT, Rodrigo Garcia	Massachusetts Institute of Technology
Garner, Richard	OSRAM Sylvania
Geck, Renee	Harvard University
Gibson, Douglas	Retired
Goldfinger, Lauren	Novartis
Groenwoldt, Kristina	The MITRE Corporation
Gross, David	OSRAM Sylvania
Grudt, Rachael	Aramco - Research Lab
Guntas, Demet	Ribon Therapeutics
Gupta, Pulkit	Merck Research Laboratories
Ha, Khanh	Massachusetts General Hospital
Hagar, William	UMASS Boston
Hailu, Haftay	UTC Aerospace Systems
Haimson, Barry	UMASS Dartmouth
Hanley, Nora	MA Dept. of Energy & Environmental Affairs
Haque, Albelee	MA Dept. of Environmental Protection
Harrison, Ryan	OTHER
Harvey, Lauren	ImmunoGen, Inc.
Hausner, Carol	Retired
Heppler, Lisa	Harvard University
Hewitt, Joe	Thermo Fisher Scientific
Hitsos, PE, CxA, John	Jacobs Engineering
Hobbs, Sylvia	Commonwealth of Massachusetts

Hodes, Neil	Consultant
Hoffman, Mark S.	MKS Instruments
Holland, Jeremy	Analog Devices, Inc.
Housley, Rick	Red Balloon Security, Inc.
Housman, Charles	Computer Sports Systems, Inc.
Howes, Marc	Oracle
Huang, Ally	Massachusetts Institute of Technology
Itoh, Chris	Harvard School of Public Health
Jacobs, Kenneth	Retired
Jakub, Ezekiel	Conservacion Panama Inc.
Jankowski, Paul	BayCoast Bank
Johnson, Ken	Visterra, Inc
Johnson, Shannon	Massachusetts Institute of Technology
Johnson, James	UTC Aerospace Systems
Jones, Austin	Massachusetts Institute of Technology
Karim, Tanveer	Harvard-Smithsonian Center for Astrophysics
Kassebaum, Paul	MathWorks, Inc.
Kawate, Keith	Consultant
Keep, Stephanie	National Center for Science Education
Kelliher, Peter	National Oceanic and Atmospheric Administration
Khan, Amber	Destination Imagination
Kim, Sonia N.	Harvard Medical School
Kingsley, Peter	Retired
Klein, Martin	Martin Klein Consultants
Knutson, Sarah	Nimbus Therapeutics
Kolodziej, Ken	MIT Lincoln Laboratory
Kong, Elizabeth	Museum of Science, Boston
Kozinski, Gary	Baker Hughes, a GE Company
Kroeger, Marie	UMASS Amherst
Lagoy, Ross	Worcester Polytechnic Institute
Lam, Philip	Novartis
Last, Adam	Corporate Environmental Advisors
Lawrence, Trey	Aramco - Research Lab
Lazo, Rafael	Worcester Fluids Technology,LLC
Le, Hoang	Harvard Medical School
LeBlang, Chelsey	Boston University School of Medicine
Lee, Jeansun	Vertex Pharmaceuticals, Inc.
Leibholz, Daniel	Analog Devices, Inc.
Leichtman, Harry	HAML Clinical Associates
Lemire, Christine	MA State Police Forensic & Technology Center
liang, hui	MA Dept. of Environmental Protection
Liao, Julie	Children's Hospital Boston
Lichter, David	Seres Therapeutics, Inc.
Lin, Peng	Boston University

Liu, Xinrong	ImmunoGen, Inc.
Livingston, James	Retired
Lloyd, Christopher	MIT Lincoln Laboratory
Loureiro, Joe	Novartis
Lubin, Paul	Consultant
Luby, Christopher	Tufts University
Machado, Marcelo	Massachusetts Water Resources Authority
Majer, Christina	Ribon Therapeutics
Malin, Gene	Sanofi Genzyme
Malkoski, Vincent	MA Div. of Marine Fisheries
Maloney, Erin	ImmunoGen, Inc.
Maloney, Tom	EMD Millipore
Manickam, Cordelia	Beth Israel Deaconess Medical Center
Manresa, Mario	Brigham & Women's Hospital
Marcinkeviciene, Jovita	Novartis
Marinelli, Paul	Curis, Inc.
Marino, Frank	Retired
Martell, Julie	StemCell Technologies Inc.
Martin, Eric	Thermo Fisher Scientific
Martin, Jack	Retired
Mau, William	Boston University
McKneally, Ranida	WGBH
Merrill, Janet	Thermo Fisher Scientific
Metznik, Jenna	American Tower Corporation
Mevers, Emily	Harvard Medical School
Miller, Glen	Acacia Communications
Mills, Joslyn	Tufts University
Mills, Gordon	GE Healthcare
Minassian, RN, Elizabeth	ESM Health Care Consultants
Moore, Richard	US Air Force - Hanscom AFB
Moss, Josh	Massachusetts Institute of Technology
Moss, Robert	MIT Lincoln Laboratory
Mullen, Jacob	General Dynamics C4 Systems
Muniappan, Brindha	MIT Museum
Naik, Tina	The Broad Institute
Nathwani, Bhavik	Dana Farber Cancer Institute
Nayan, Marvin	Massachusetts Institute of Technology
Ng, Kenney	IBM
Nguyen, Jennifer	Waters Corp.
Nibasumba, Armel	StemCell Technologies Inc.
Nicoletti, Nicholas	Boston University School of Medicine
Nieves-Bonilla, Janice	Harvard University
O'Melia, Sean	MIT Lincoln Laboratory
Olaoye, Adetoyin	MA Dept. of Transportation DOT

Olsen, Rich	Retired
Oraa Ali, Michelle	Massachusetts Institute of Technology
Osinski, Anthony	MA Dept. of Public Health
Osman, Sami	Abbott Bioresearch Center
Otter, Marshall	Marine Biological Laboratory
Ow, Hooisweng	Aramco - Research Lab
Paganelli, Tess	VHB
Paige, Christopher	Sanofi Genzyme
Pang, Edward	Massachusetts Institute of Technology
Pati, Mekhala	Wentworth Institute of Technology
Patke, Sanket	Sanofi
Pavlak, Ray	Seagate Technology
Peidle, Joseph	Harvard University
Pepi, Ryan	Sanofi Genzyme
Peralta, Rick	Hyper Sonic Sensors
Philips, Scott	Systems & Technology Research
Philpot, Rosalie	Moderna Therapeutics
Pillai, Revathi	OTHER
Piou, Jean Eugene	MIT Lincoln Laboratory
Piro, Beth	Takeda Pharmaceuticals
Pizzimenti, Patrick	Schneider Electric
Pokharel, Hem	MA Dept. of Energy & Environmental Affairs
Pold, Grace	UMASS Amherst
Poole, Benjamin	Office of Naval Research
Posch, Rick	CR Media Technologies
Potier, Yohann	Novartis
Prentice, Holly	HPrentice Consulting, LLC
Prentice, Magdalena	Millennium Pharmaceuticals, Inc.
Prohaska, John	Overnia, LLC
Psencik, Jeffrey	Massachusetts Institute of Technology
Quiñones, Rebecca	MA Div. of Fisheries & Wildlife
Rajagopal, Rajasekaran	Dell EMC
Ramasundar, Aparna	Dell EMC
Ramirez, Giovanna	Children's Hospital Boston
Ranjan, Sukrit	Massachusetts Institute of Technology
Reed, Corey	Waters Corp.
Reinhold, Arnold	A G Reinhold
Renaud, Thomas	Massachusetts Water Resources Authority
Ricles, Robert E	Robert E. Ricles, Esq.
Rigazio, Richard	Office of Naval Research
Rioux, Meredith	Rapid Micro Biosystems
Roy, Jefferson	Massachusetts Institute of Technology
Rubinstein, Richard	Retired
Rudnick, Elizabeth	Imaginic, Inc.

Sakakeeny, Maureen	Merrimack College
Salas, Sarah	Novartis
Santone, Adam	Massachusetts Institute of Technology
Savageau, Judy	UMASS Medical School
Schmitz, Judith	MA Dept. of Environmental Protection
Seger, Diane	Partners Healthcare
Seneviratne, Uthpala	Pfizer Global Research & Development
Servi, Les	The MITRE Corporation
Sethumadhavan, Murali	Rogers Corporation
Shafi, Sameed	SanDisk Corporation
Shanahan, James	SynDevRx, Inc.
Sharma, Dipti	Wentworth Institute of Technology
Shen, Hao	Massachusetts Institute of Technology
Shen, Zhuohua	MathWorks, Inc.
Shepherd, Susan	Commonwealth of Massachusetts, Executive Office of Labor and Workforce Development
Sherigar, Bhaskara	Broadcom Corp.
Shong, Sarah	Massachusetts Water Resources Authority
Sidor, Michelle	Novartis
Sivakumaran, Sudhir	Pfizer Research Technology Center
Skorik, Christian	StemCell Technologies Inc.
Smith, Joshua	University of New Hampshire
Song, John	Retired
Sopka, John R	High Performance Systems Software
Speciner, Mike	The Singing Torah
St. Hilaire, Melissa	Brigham & Women's Hospital
Stephan, Mark	Dell EMC
Stephen, Emily	Massachusetts Institute of Technology
Stephen, Ralph	WHOI
Strizhak, Elliott	UTC Aerospace Systems
Stroman, Michael	MA Dept. of Environmental Protection
Strott, Douglas	Sensata Technologies, Inc.
Subramanian, Gokul	Systems & Technology Research
Sullivan, Susan	Verik Bio
Sun, George	Massachusetts Institute of Technology
Sutcu, Yagiz	InfoScope Research
Swigor, Juliet	MA Dept. of Environmental Protection
Szewczak, Lara	Cell Press/Elsevier
Talcott, Sarah	X-Chem Parmaceuticals
Tallon, Lindsay	MCPHS University
Tang, Rueyjing	Commonwealth of Massachusetts
Tarselli, Mike	Novartis
Tartaglia, Lawrence	Beth Israel Deaconess Medical Center
Teesdale, Justin	Harvard University

Teichert, Kristian	Rubius Therapeutics, Inc.
Thessen, Anne	The Data Detektiv
Thomas, Suzanne	Marine Biological Laboratory
Thompson, Joe	Sanofi Genzyme
Ton, Hoai	Massachusetts General Hospital
Uppiliappan, Badhri	Analog Devices, Inc.
Valcourt, James	Harvard University
Vanniaperumal, Muthukumar	Keurig Green Mountain, Inc.
Villar, Ashley	Harvard-Smithsonian Center for Astrophysics
Wadhwa, Navish	Harvard University
Wagner, Jeff	Harvard School of Public Health
Walton, Thomas	Aeroplas Corp. Intl.
Waterman, Matthew	Eastern Nazarene College
Webster, Christopher	Retired
Weinstein, Scott	Sonos, Inc.
Wells, Ben	Post Optical LLC
Whalen, Michael	EMD Millipore
Whitehead, Lewis	Nimbus Therapeutics
Wiederoder, Michael	US Army Natick RD&E Center
Wijnja, Hotze	Commonwealth of Massachusetts
Wilgo, Matthew	New England Cord Blood Bank
Winkler, Devon	MA Div. of Marine Fisheries
Wittels, Norman	Dexter Southfield School
Wohlrab, Hartmut	Harvard Medical School
Wolfson, William	Engineering Lens
Wolshin, Ernest	Retired
Wong, Jay M.	Southie Autonomy Works
Wood, Fiona	inviCRO
Woskov, Paul	Massachusetts Institute of Technology
Wyche, Tom	Merck Research Laboratories
Xiao, Alan	Novartis
Yang, Zinger	Novartis
Yawe, Joseph	StemCell Technologies Inc.
Yegnanarayanan, Siva	MIT Lincoln Laboratory
Yoon, Denise	Harvard University
Young, Jessica	Roche Diagnostics
Zhang, Tingting	StemCell Technologies Inc.
Zhang, Fu	MathWorks, Inc.
Zhu, Shitong Sherry	Aramco - Research Lab

2018 Exhibitors

Apr 13, 2018

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
Abdulkerim, Sarah	N18	Medford High School
Addanki, Anvitha	H19	Canton High School
Adiletta, Jack	B21	Worcester Academy
Adiletta, Andrew	B14	Worcester Academy
Agosto, Adamaris	N25	Edward M. Kennedy Academy for Health Careers
Agyei, Amma	A1	Assabet Valley Voc. H. S.
Aiello, Vito	C11	Martha's Vineyard Regional H. S.
Alayon, Zedah	H25	Brockton High School
Allen, William	K12	St. Mark's School
Alvarez, Rudy	G10	Edward M. Kennedy Academy for Health Careers
Amiji, Salima	G11	Bishop Feehan High School
Anantha, Sidharth	B8	Lexington High School
Anyosa-Galvez, Gonzalo	K17	Cambridge Rindge & Latin High School
Arroyave, Jacqueline	K14	Edward M. Kennedy Academy for Health Careers
Asumadu, Augustine	G28	Taconic High School
Athipathy, Nikhita	G27	Advanced Math and Science Academy
August, Colby	C27	St. John Paul II High School
Baker, Mairead	F6	Boston Latin Academy
Balaji, Shreya	N2	Grafton Memorial Senior H. S.
Ballentos, Rechelle	J27	Pioneer Charter School of Science II

Barberis, Hugo	D20	Wachusett Regional High School
Bautista, Ysatti	K14	Edward M. Kennedy Academy for Health Careers
Beach, Carlisle	F24	Wareham High School
Beaudoin, Bridget	N3	Falmouth High School
Beausoleil, Chase	D21	Bishop Feehan High School
Benack, Alexa	J6	Hopkinton High School
Bereus, Sophia	N24	Jeremiah E. Burke H.S. - Dorchester
Bhalla, Neel	F13	Lexington High School
Bharadwaj, Pratik	A28	Acton-Boxboro Reg. H.S.
Bhupatiraju, Vivek	C21	Lexington High School
Billo, Tess	H26	Stoughton High School
Blaise, Meredith	H13	Bishop Feehan High School
Bloch-Jones, Owen	F23	Boston Latin Academy
Bogle, Conner	K23	Marlborough High School
Bone, Eric	B18	Westfield High School
Bonilla, Daniela	G4	Pioneer Charter School of Science
Boonpongmanee, Inthat	F19	Deerfield Academy
Bourzgui, Driss	H9	Berkshire Arts & Technology Charter Public School
Bowyer, Bridgette	B27	Southeastern Reg. Voc-Tech. H S
Brassard, Hunter	D27	Hudson High School
Brodie, Evan	C25	Falmouth High School
Brooks, Kyle	K4	Berkshire Arts & Technology Charter Public School
Brown, Zachary	G8	Joseph Case High School
Bui, Kenny	N20	East Boston High School
Bulovic, Ian	D9	Lexington High School
Cahill, Sara	J6	Hopkinton High School
Carney, Marie	K20	St. John Paul ll High School
Cartagena, Jennifer	K26	Edward M. Kennedy Academy for Health Careers
Caufield, Hayley	K3	Berkshire Arts & Technology Charter Public School
Chalvire, Gamael	P3	Excel High
Chan, Alvin	J11	Community Charter School of Cambridge
Chang, Donald	D16	Westfield High School
Chase, Milo	B1	Bancroft School
Chavez, Heily	K13	East Boston High School
Chen, Benjamin	F21	Weston High School
Chen, Kimberly	C20	Boston Latin Academy
Chen, Robert	P15	Lexington High School
Childs, Emily	P14	Somerville High School
Chisholm, Aiden	B20	Westfield High School
Chittibabu, Shriyaa	A18	Shrewsbury High School
Choi, Jiwon	A5	St. Mark's School
Chopra, Rohit	K27	Community Charter School of Cambridge
Chunyu, Zhaohua	N14	Falmouth Academy
Clardy, Lily	K21	Hudson High School

Coelho, Emily	G4	Pioneer Charter School of Science
Coffey, Liam	B19	Westfield High School
Cohen, Mya	N17	Bourne High School
Colleoni-Pimenta, Alex	D27	Hudson High School
Colon, Emily	K11	Taunton High School
Contrera, Daniela	C23	East Boston High School
Cox, Rebecca	H2	Falmouth Academy
Cullen, Aedan	D10	Hopkins Academy
Currie, Alexander	P19	Taconic High School
Dabel, Carlia	G3	Edward M. Kennedy Academy for Health Careers
Daignault, MaiLee	K10	Berkshire Arts & Technology Charter Public School
Dalal, Aneeha	J3	Grafton Memorial Senior H. S.
Daly, John	N26	Hanover High School
Danga, Lazi	C18	Bancroft School
Danko, Julia	D19	Wachusett Regional High School
Dartois, Gislaine	P25	Urban Science Academy
Davis, Teyah	N24	Jeremiah E. Burke H.S. - Dorchester
De Luis, Maya	B25	Newton Country Day Sch/Sacred Heart
Defay, Benjamin	A21	Lexington High School
Defay, John	A21	Lexington High School
Delcompare, Janaisha	H22	Edward M. Kennedy Academy for Health Careers
Deveney, Chloe	J3	Grafton Memorial Senior H. S.
Dhaurali, Shubhecchha	B3	Medford High School
Diaz, Iseliz	H7	Edward M. Kennedy Academy for Health Careers
Dillon, Steve	N24	Jeremiah E. Burke H.S. - Dorchester
Diltz, Jackson	B18	Westfield High School
DiMare, Francesca	N6	Brockton High School
Ding, Elizabeth	J10	Lexington High School
Dorazio, Madison	N2	Grafton Memorial Senior H. S.
Douyon, Wiener	K25	Prospect Hill Academy Charter School
Dsouza, Rohit	F8	Concord-Carlisle Regional H. S.
Dsouza, Kiran	F8	Concord-Carlisle Regional H. S.
Duclos-Orsello, Luca	P4	Somerville High School
Dunn, Fiona	G26	The Winsor School
Dwyer, Christopher	F15	Wachusett Regional High School
El Atifi, Soukaina	D15	Excel High
Elfman, Andrew	C13	Southeastern Reg. Voc-Tech. H S
Esteves-Ruiz, Julya	F17	Assabet Valley Voc. H. S.
Etienne, Jared	N11	Foxborough Regional Charter School
Fang, Joyce	B22	Mass. Academy of Math & Science
Farah, Albert	A12	Medford High School
Favreau, Owen	C14	Martha's Vineyard Regional H. S.
Feng, Chuxian	H27	Revere High School
Fenske, Charlie	C8	Falmouth Academy

Ferrin, Rachel	K24	Taconic High School
Figueroa, Ashley	N20	East Boston High School
Fisher, Curtis	B28	Martha's Vineyard Regional H. S.
Fossile, Brandon	F17	Assabet Valley Voc. H. S.
Gallagher, Timmarie	D18	Wachusett Regional High School
Gallagher, Kelly	P13	Bishop Feehan High School
Gallison, Kieran	J12	Bishop Stang High School
Gebru, Lydia	D15	Excel High
Genova, Abby	K21	Hudson High School
Germain, Marsha	N15	Quincy High School
Glasgow, Noah	H3	Falmouth Academy
Gliklich, Jennifer	P16	Gann Academy
Goldbach, James	K7	Falmouth Academy
Gonzalez, Nayely	J14	Boston Latin Academy
Gonzalez, Melissa	G4	Pioneer Charter School of Science
Goodnow-Russell, Luke	P14	Somerville High School
Green, Mitchell	H8	Foxborough Regional Charter School
Guerard, Paul	N21	Boston Latin Academy
Gupta, Mahika	F4	North Attleboro High School
Gustafson, Jason	C1	Westfield High School
Halak, Dania	H12	Revere High School
Han, Taehoon	B23	Northfield-Mt.Hermon School
Hargraves-Johnson, Kiiyah	C19	Taconic High School
Harrington, Crystal	K10	Berkshire Arts & Technology Charter Public School
Haugen, Sophie	A15	St. Mark's School
Hayes, Mary	N10	Taconic High School
He, James	A25	Shrewsbury High School
Helfrich, Bennett	C25	Falmouth High School
Heo, Hyun Jun	J28	Lexington High School
Hobson, Sydney	A17	Mass. Academy of Math & Science
Hoffmeister, Ashlinn	C12	St. John Paul ll High School
Hoose, Leeyia	K2	Taconic High School
Hossaini, Chaimaa	G12	Pioneer Charter School of Science
Hou, Kaiying	G17	Phillips Academy
Hoxha, Sokol	H10	Doherty Memorial H. S.
Huang, RuiPei	A26	Bancroft School
Huang, Aaron	G2	North Quincy High School
Igoe, Jillian	P9	Falmouth Academy
Iqbal, Marzuq	A23	Advanced Math and Science Academy
Ireland, Alexander	P5	Quincy High School
Johansen, Lida	K9	Assabet Valley Voc. H. S.
Jude, Sadie	J5	Burncoat Senior H.S.
Kalinowsky, Joy	P12	Berkshire Arts & Technology Charter Public School
Kantrowitz, Hava	A20	Mass. Academy of Math & Science

Karim, Asiya	F9	Lexington High School
Kebichi, Nabil	D11	Lexington High School
Keeler, Emma	C7	Falmouth Academy
Kelliher, Grace	K15	North Quincy High School
Kelly, Emma	N27	Newton Country Day Sch/Sacred Heart
Kennedy, Brenna	J4	Bishop Feehan High School
Khandekar, Nikhil	P24	Acton-Boxboro Reg. H.S.
Khandelwal, Shiv	F14	Lexington High School
Kim, Jennifer	B5	Mass. Academy of Math & Science
Kini, Anjalie	G23	Phillips Academy
Kleindinst, Charlie	F28	Upper Cape Cod Voc-Tec. H. S.
Klessel, Sophia	B25	Newton Country Day Sch/Sacred Heart
Koran, Isabel	N9	Foxborough Regional Charter School
Krishnan, Nikhil	A25	Shrewsbury High School
Krishnan, Rohan	F27	Worcester Academy
Krstanovic, Katerina	J13	Matignon High School
Kullas, Dylan	K1	Taunton High School
Kumar, Deep	D12	Upper Cape Cod Voc-Tec. H. S.
Kundu, Piyusha	A16	Mass. Academy of Math & Science
Kuruvilla, Eva	J6	Hopkinton High School
Kuszmaul, John	P15	Lexington High School
Kwon, Grace	B24	Falmouth High School
LaBelle, Emily	B11	Wachusett Regional High School
Lam, Emily	C20	Boston Latin Academy
Langille, Marissa	A14	Mass. Academy of Math & Science
Laufer, Alexandra	H1	Weston High School
Le, Christina	P6	Burncoat Senior H.S.
Le, Mya	K18	North Quincy High School
Leopold, Grace	J18	Calvary Chapel Academy
Lerkvikarn, Shane	G19	North Quincy High School
Li, Clara	C16	Phillips Academy
Liang, Zifeng	G25	Miss Hall's School
Liazos, Chris	J2	Marian High School
Lim, Cheaheon	C17	Northfield-Mt.Hermon School
Lin, Nuo	K16	North Quincy High School
Lin, Zekai	J24	St. John's Prep. School
Lin, John	G22	Boston Latin School
Lin, Xiandong	A13	Stoneleigh-Burnham School
Lin, Yi	G20	North Quincy High School
Lineaweaver, Abraham	H28	Falmouth High School
Link, Ansel	K28	Lexington High School
Littlefield, Leah	H5	Falmouth Academy
Liu, Zhengde	C22	St. John Paul ll High School
Liu, Mo	B4	St. Mark's School

Lo, Wesley	F25	Concord Academy
Loffredo, Alessandra	P18	Stoughton High School
Lomino, Vincent	B9	Wachusett Regional High School
Lott, Sarah	H2	Falmouth Academy
Louw, Roman	P26	Berkshire Waldorf High School
Lu, Hung-Wei	J7	Northfield-Mt.Hermon School
Lyle, William	N12	Foxborough Regional Charter School
Lysonski-Phillips, Ariana	K2	Taconic High School
Mallory, India	H22	Edward M. Kennedy Academy for Health Careers
Manic, Mila	F11	Plymouth South High School
Mansoor, Mariah	F26	Boston Latin School
Marroquin, Dixon	N28	Urban Science Academy
Martelly, Logan	G8	Joseph Case High School
Massoni-Nesman, Rianna	B10	Wachusett Regional High School
Matis, Natalie	F16	Wachusett Regional High School
McCaffery, Kyle	D4	Westfield High School
Medeiros, Zachary	B19	Westfield High School
Mehta, Karan	B2	Bancroft School
Mehta, Rishab	A6	Mass. Academy of Math & Science
Mendez, Alexa	J17	Calvary Chapel Academy
Minier, Ian	G14	Marlborough High School
Minocha, Himanshu	D24	Hopkinton High School
Minocha, Rohan	D24	Hopkinton High School
Mitte, Isaiah	K26	Edward M. Kennedy Academy for Health Careers
Mizerak, Elise	F1	Wachusett Regional High School
Mizerak, Evan	A8	Wachusett Regional High School
Mohammad, Faateh	D22	Hopkinton High School
Mohamud, Maryan	N23	Jeremiah E. Burke H.S. - Dorchester
Mondol, Zeus	N13	Cambridge Rindge & Latin High School
Montilla, Ianna	N23	Jeremiah E. Burke H.S. - Dorchester
Moore-Ellis, NaShanti	D25	Cardinal Spellman High
Moriarty, Brigid	D2	Westfield High School
Morrissey, Catherine	A22	Westfield High School
Morrissey, Brendan	B20	Westfield High School
Mufti, Saad	B12	St. John's High School
Muñeton, Camila	D1	Boston Latin Academy
Murphy, Hannah	G13	Quincy High School
Najah, Aiman	A11	Pioneer Charter School of Science II
Nance, Bailey	H4	Upper Cape Cod Voc-Tec. H. S.
Nandyalam, Gayathri	B7	Mass. Academy of Math & Science
Nathan, Krish	A19	Mass. Academy of Math & Science
Neguse, Mary	N18	Medford High School
Nene, Advait	G16	Hopkinton High School
Newman, Celeste	H28	Falmouth High School

Ng, Esther	N2	Grafton Memorial Senior H. S.
Nguyen, Ngoc Tram	H23	Miss Hall's School
Nichols-Worley, Sada	A15	St. Mark's School
Noorwez, Sufana	C4	Shrewsbury High School
Novick, Peter	J22	Somerville High School
Nur, Rukia	D17	Excel High
O'Gara, Emily	P10	Taunton High School
OBryant, John Richard	G10	Edward M. Kennedy Academy for Health Careers
Ocegueda, Evelyn	F5	East Boston High School
Okar, Zeina	N22	Mary Lyon Pilot High School
Olson, Emma	H14	Bishop Feehan High School
Orszulak, Adrian	C2	Westfield High School
Osorio, Daiana	P23	Madison Park Tech Voc HS
Otter, Troy	C9	Falmouth High School
Padaki, Ashwin	F14	Lexington High School
Pannirselvam, Aadharsh	F12	Lexington High School
Patel, Hirni	H16	North Attleboro High School
Patta, Anoop	B15	Westborough High School
Paul, Harrison	G14	Marlborough High School
Paul, Carter	G14	Marlborough High School
Pecci, Rose	F22	Tantasqua Reg. H. S.
Peloquin, John	C6	Westfield High School
Pena, Citlali	N28	Urban Science Academy
Penubarthi, Vishnu	A7	Mass. Academy of Math & Science
Perez, Taylor	G21	Oliver Ames High School
Perumal, Neha	D3	Westborough High School
Pil, Gedeon	G6	Falmouth Academy
Pinto, Cianna	N25	Edward M. Kennedy Academy for Health Careers
Pinto, Katia	N23	Jeremiah E. Burke H.S. - Dorchester
Pires, Luis	A27	Excel High
Podesta, Jessica	P18	Stoughton High School
Portelli, Julian	J22	Somerville High School
Prabhakar, Garima	D5	Shrewsbury High School
Prakash, Indumathi	G5	Sharon High School
Preble, Brandon	P7	Winthrop Sr. High School
Proudman, Freya	K19	Hopkinton High School
Proudman, Daniel	K19	Hopkinton High School
Pyrdol, Mary	P21	Brockton High School
Qi, Kevin	J26	Boston Latin School
Quinn, Patrick	N19	Boston Latin Academy
Quinn, Catherine	G21	Oliver Ames High School
Raghunathan, Divya	N5	Shrewsbury High School
Raj, Yashasvi	B6	Lexington High School
Raja, Menaja	F7	Tahanto Regional High School

Rajagopal, Saniya	J15	Falmouth Academy
Rajesh, Sreshtaa	A9	Mass. Academy of Math & Science
Ravikumar, Akshaya	N4	Sharon High School
Regnier, Elizabeth	A22	Westfield High School
Rhee, Brian	G17	Phillips Academy
Rhodes, Tyler	G16	Hopkinton High School
Riley, Parker	F22	Tantasqua Reg. H. S.
Rivera, Yomari	G15	Worcester Technical High School
Rivera, Britney	K13	East Boston High School
Rivera, Joshua	P23	Madison Park Tech Voc HS
Rosario, Joselyn	P23	Madison Park Tech Voc HS
Rosen, Elan	C5	Hopkinton High School
Rosenzweig, Noah	K23	Marlborough High School
Rotondo, Elias	D7	Upper Cape Cod Voc-Tec. H. S.
Rotondo, Joseph	H15	Upper Cape Cod Voc-Tec. H. S.
Rudnick, Zoe	A24	Shrewsbury High School
Ruiz, Sabrina	K13	East Boston High School
Russell, Grace	H11	Falmouth Academy
Sadagopan, Ananthan	B16	Westborough High School
Sadhuka, Shuvom	G9	Cambridge Rindge & Latin High School
Salah, Habso	P8	Edward M. Kennedy Academy for Health Careers
Sanborn, Kaylen	J20	Taunton High School
Sane, Eshan	B15	Westborough High School
Sathiyamoorthy, Ooviya	C23	East Boston High School
Schifman, Arianna	K6	Bishop Feehan High School
Schmitt, Mary	N17	Bourne High School
Schneider, Jeremy	F3	Marian High School
Schremp, Michele	J19	Bishop Feehan High School
Schwenk, Ben	K8	Falmouth Academy
Sheputa, Joshua	D23	Calvary Chapel Academy
Silva, Erick	J22	Somerville High School
Simaku, Patricia	G18	North Quincy High School
Simmons, Ben	K23	Marlborough High School
Simon, Andreas	P7	Winthrop Sr. High School
Smith, Thomas	J25	Stoughton High School
Sobers, Jamir	G3	Edward M. Kennedy Academy for Health Careers
Sonti, Advika	G24	Tahanto Regional High School
Soto, Shandira	D1	Boston Latin Academy
Soto, Onasis	G3	Edward M. Kennedy Academy for Health Careers
Srinivasan, Shruti	H21	North Attleboro High School
Stanton, Ricky	G1	Bishop Feehan High School
Stawasz, Kristen	C2	Westfield High School
Stillman, Hannah	J9	Falmouth Academy
Suhocki, Renee	C15	Westfield High School

Sukthankar, Ashwin	B13	St. John's High School
Sullivan, Patrick	P7	Winthrop Sr. High School
Sundararajan, Suvin	B17	Westfield High School
Sunkari, Aakash	D13	North Attleboro High School
Syed, Muneeb	B12	St. John's High School
Taub, Ezra	F23	Boston Latin Academy
Tavares, Nolan	P11	Taunton High School
Taylor, Emily	H17	Berkshire Arts & Technology Charter Public School
Taylor, Jillian	C24	Upper Cape Cod Voc-Tec. H. S.
Taylor, Kylie	H9	Berkshire Arts & Technology Charter Public School
Terpstra, Irene	D28	Lincoln-Sudbury Reg. H. S.
Thalmann, Jack	J23	St. Mark's School
Theodoridou, Maria	H7	Edward M. Kennedy Academy for Health Careers
Thirumalai, Amrita	N7	Worcester Academy
Thompson, Brian	G7	Mary Lyon Pilot High School
Tian, Daniel	D14	Berkshire School
Toncelli, Silvia	N16	Bishop Feehan High School
Torkornoo, Justice	D26	Worcester Technical High School
Torres, Gabriel	P4	Somerville High School
Tran, Christopher	P21	Brockton High School
Tran, Twuyen	N1	North Quincy High School
Traver, Lily	N8	Bourne High School
Ural, Barut	C26	Southeastern Reg. Voc-Tech. H S
Vallejo, Sofia	P6	Burncoat Senior H.S.
Vazquez, Juliana	F18	East Boston High School
Veilleux, Serena	P2	Shepherd Hill Reg. H. S.
Vinals, Maite	P8	Edward M. Kennedy Academy for Health Careers
Wadekar, Adway	A2	Westborough High School
Wang, Daisy	J21	Boston Latin School
Wang, Christopher	H24	Algonquin Regional H.S.
Watson, Amber	D8	Southeastern Reg. Voc-Tech. H S
Weber, Olivia	F20	Taunton High School
Weissburg, Evan	D9	Lexington High School
Wen, Kevin	P1	Somerville High School
Whitehead, Emma	H6	Shepherd Hill Reg. H. S.
Wold-Grover, Ariana	D8	Southeastern Reg. Voc-Tech. H S
Wong, Lance	D6	Shrewsbury High School
Wong, Alice	C28	Taunton High School
Woods, Mary	F2	Bishop Feehan High School
Woolbert, Avery	B26	Newton Country Day Sch/Sacred Heart
Wren, Abigail	A4	Mass. Academy of Math & Science
Wu, Kayli	H18	North Quincy High School
Xu, Frank	P20	Brookline High School
Xu, Charles	J16	Falmouth High School

Xu, Eileen	P22	Wachusett Regional High School
Xu, Shidong	J1	Boston University Academy
Yee, Stefania	K22	Urban Science Academy
Yoo, Seo-Hyun	H20	Lexington High School
Zeng, Jenny	K5	North Quincy High School
Zheng, Yiming	P15	Lexington High School
Zhou, Kevin	J8	Lexington High School
Zimu, Meng	C22	St. John Paul ll High School
Zizi, Berlinda	N28	Urban Science Academy
Zou, Alicia	P17	Boston Latin School

Exhibitors by School City/Town, School, Student

Acton	Acton-Boxboro Reg. H.S.	Region: 4
Khandekar, Nikhil	Discipline : Biology	Exhibit: P24
	An Inquiry on the Evolution of Candidate Genes in the Origins of Span	
Acton	Acton-Boxboro Reg. H.S.	Region: 4
Bharadwaj, Pratik	Discipline : Computers	Exhibit: A28
	Deep Learning Analysis of Mammograms	
Adams	Berkshire Arts & Technology Charter Public School	Region: 1
Taylor, Emily	Discipline : Engineering	Exhibit: H17
	A Noninvasive Hand Tremors Reduction Device	
Adams	Berkshire Arts & Technology Charter Public School	Region: 1
Bourzgui , Driss	Discipline : Biology	TEAM Exhibit: H9
	Comparing Effectiveness of Bacteria and E. hortensis to Degrade PCBs	
Adams	Berkshire Arts & Technology Charter Public School	Region: 1
Daignault , MaiLee	Discipline : Biology	TEAM Exhibit: K10
	Transgenesis in Drosophila Using Caffeine	
Adams	Taconic High School	Region: 1
Ferrin, Rachel	Discipline : Biology	Exhibit: K24
	What's in the Balance?	
Adams	Berkshire Arts & Technology Charter Public School	Region: 1
Taylor, Kylie	Discipline : Biology	TEAM Exhibit: H9
	Comparing Effectiveness of Bacteria and E. hortensis to Degrade PCBs	
Adams	Berkshire Arts & Technology Charter Public School	Region: 1
Caufield, Hayley	Discipline : Physics & Electronics	Exhibit: K3
	Cleaning Up The Trash	
Adams	Berkshire Arts & Technology Charter Public School	Region: 1
Brooks, Kyle	Discipline : Physics & Electronics	Exhibit: K4
	Are We Becoming More Alone in Space?	
Adams	Berkshire Arts & Technology Charter Public School	Region: 1
Kalinowsky, Joy	Discipline : Computers	Exhibit: P12
	Cracking Ciphers	
Adams	Berkshire Arts & Technology Charter Public School	Region: 1
Harrington , Crystal	Discipline : Biology	TEAM Exhibit: K10
	Transgenesis in Drosophila Using Caffeine	
Andover	Phillips Academy	Region: 4
Kini, Anjalie	Discipline : Computers	Exhibit: G23
	Visualizing Ground-Based VLF Transmissions Using RPI Data	

Andover	Phillips Academy	Region: 4
Hou, Kaiying	Discipline : Mathematics	TEAM Exhibit: G17
	Continuum Modelling of Traffic Systems with Autonomous Vehicles	
Andover	Phillips Academy	Region: 4
Li, Clara	Discipline : Behavioral Science	Exhibit: C16
	Racial Differences in Brain Response to Errors	
Attleboro	Bishop Feehan High School	Region: 3
Gallagher, Kelly	Discipline : Environmental Science	Exhibit: P13
	Living Light	
Attleboro	Bishop Feehan High School	Region: 3
Schifman, Arianna	Discipline : Biology	Exhibit: K6
	Effects of Agricultural Antibiotics on Bacterial Antibiotic Resistance	
Attleboro	Bishop Feehan High School	Region: 3
Olson, Emma	Discipline : Physics & Electronics	Exhibit: H14
	Wave Hello to Renewable Energy	
Attleboro	Bishop Feehan High School	Region: 3
Kennedy , Brenna	Discipline : Biology	Exhibit: J4
	How Acne Medications Affect Bacterial Growth	
Attleboro	Bishop Feehan High School	Region: 3
Beausoleil, Chase	Discipline : Environmental Science	Exhibit: D21
	Illuminating the Problem: Bioluminescence	
Attleboro	Bishop Feehan High School	Region: 3
Toncelli, Silvia	Discipline : Biochemistry	Exhibit: N16
	What Type of Algae Produces the Most Biofuel?	
Attleboro	Bishop Feehan High School	Region: 3
Stanton, Ricky	Discipline : Behavioral Science	Exhibit: G1
	Pen and Paper vs. iPad and Stylus	
Attleboro	Bishop Feehan High School	Region: 3
Amiji, Salima	Discipline : Chemistry	Exhibit: G11
	Near IR Absorbing Gold Nanorods for Cancer Imaging and Therapy	
Attleboro	Bishop Feehan High School	Region: 3
Woods, Mary	Discipline : Behavioral Science	Exhibit: F2
	Do People of Different Ages Have Different Fears?	
Attleboro	Bishop Feehan High School	Region: 3
Schremp, Michele	Discipline : Environmental Science	Exhibit: J19
	Improving the Energy Produced by a Flexible Solar Cell	

Attleboro	Bishop Feehan High School	Region: 3
Blaise, Meredith	Discipline : Behavioral Science	Exhibit: H13
	Effects of Stress on Neuroanatomical Functionality	
Boston	Excel High	Region: 6
Gebru, Lydia	Discipline : Biochemistry	TEAM Exhibit: D15
	Organic Arch Support	
Boston	Excel High	Region: 6
Nur, Rukia	Discipline : Biology	Exhibit: D17
	Effect of Curcumin Based Biosynthetic System on Growth Rate of P acnes	
Boston	East Boston High School	Region: 6
Ocegueda, Evelyn	Discipline : Chemistry	Exhibit: F5
	Measuring Calories	
Boston	Boston Latin Academy	Region: 6
Soto, Shandira	Discipline : Chemistry	TEAM Exhibit: D1
	Experiments to Identify a Mystery Metal	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 4
Vinals, Maite	Discipline : Biology	TEAM Exhibit: P8
	Does Feeding Animals GMO Foods Affect Their DNA?	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Sobers , Jamir	Discipline : Engineering	TEAM Exhibit: G3
	Face Fits	
Boston	Boston Latin Academy	Region: 6
Baker, Mairead	Discipline : Biochemistry	Exhibit: F6
	Difference in Energy Release of Lipids vs. Carbohydrates	
Boston	Urban Science Academy	Region: 6
Dartois, Gislaine	Discipline : Biology	Exhibit: P25
	Bubble-ology	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Pinto, Cianna	Discipline : Environmental Science	TEAM Exhibit: N25
	Freshwater Organism: The Effect of Water Pollutants	
Boston	The Winsor School	Region: 5
Dunn, Fiona	Discipline : Environmental Science	Exhibit: G26
	PH Effects on Freshwater Snails	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
OBryant, John Richard	Discipline : Engineering	TEAM Exhibit: G10
	Universal Earbud Case	

Boston	East Boston High School	Region: 6
Sathiyamoorthy, Ooviya	Discipline : Behavioral Science	TEAM Exhibit: C23
	How Effective is Your Brain Mapping Experience?	
Boston	Boston Latin Academy	Region: 6
Bloch-Jones, Owen	Discipline : Physics & Electronics	TEAM Exhibit: F23
	The Effect of Different Liquids on the Faraday Effect	
Boston	Boston Latin School	Region: 6
Lin, John	Discipline : Biology	Exhibit: G22
	Effect of Glucose on the Sex Ratio of Drosophila Melanogaster	
Boston	East Boston High School	Region: 6
Chavez, Heily	Discipline : Environmental Science	TEAM Exhibit: K13
	Examining the Effects of Land Use on Water Quality	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Agosto, Adamaris	Discipline : Environmental Science	TEAM Exhibit: N25
	Freshwater Organism: The Effect of Water Pollutants	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Delcompare, Janaisha	Discipline : Chemistry	TEAM Exhibit: H22
	Turning Milk into Plastic	
Boston	East Boston High School	Region: 6
Ruiz, Sabrina	Discipline : Environmental Science	TEAM Exhibit: K13
	Examining the Effects of Land Use on Water Quality	
Boston	Boston Latin Academy	Region: 6
Guerard, Paul	Discipline : Chemistry	Exhibit: N21
	Hot Pucks	
Boston	Excel High	Region: 6
Pires, Luis	Discipline : Environmental Science	Exhibit: A27
	Vitamin C	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Soto, Onasis	Discipline : Engineering	TEAM Exhibit: G3
	Face Fits	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Cartagena, Jennifer	Discipline : Biochemistry	TEAM Exhibit: K26
	Effects of Organic Solvents on Tetrahymena Phaygocytosis	
Boston	Boston Latin School	Region: 6
Qi, Kevin	Discipline : Computers	Exhibit: J26
	Plant Disease Identification Using Deep Learning	

Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Bautista, Ysatti	Discipline : Biology	TEAM Exhibit: K14
	Drugs & Genetics	
Boston	Boston University Academy	Region: 5
Xu, Shidong	Discipline : Chemistry	Exhibit: J1
	Generation of Cost-Effective Nanoparticles for Fuel Cell Efficiency	
Boston	East Boston High School	Region: 6
Contrera, Daniela	Discipline : Behavioral Science	TEAM Exhibit: C23
	How Effective is Your Brain Mapping Experience?	
Boston	Boston Latin School	Region: 6
Zou, Alicia	Discipline : Biology	Exhibit: P17
	Effect of Cytokines on the Function of the Salivary Glands	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Diaz , Iseliz	Discipline : Biology	TEAM Exhibit: H7
	Effect of Baking Soda on a Pancake	
Boston	Boston Latin Academy	Region: 6
Lam, Emily	Discipline : Biology	TEAM Exhibit: C20
	The Effect of pH on Plant Growth	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Arroyave, Jacqueline	Discipline : Biology	TEAM Exhibit: K14
	Drugs & Genetics	
Boston	Boston Latin Academy	Region: 6
Gonzalez, Nayely	Discipline : Chemistry	Exhibit: J14
	Effects of Milk Fat on Cheese Curd Yield	
Boston	Madison Park Tech Voc HS	Region: 6
Rosario, Joselyn	Discipline : Behavioral Science	TEAM Exhibit: P23
	Monochromatic Colors	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Theodoridou, Maria	Discipline : Biology	TEAM Exhibit: H7
	Effect of Baking Soda on a Pancake	
Boston	Boston Latin Academy	Region: 6
Chen , Kimberly	Discipline : Biology	TEAM Exhibit: C20
	The Effect of pH on Plant Growth	
Boston	Boston Latin Academy	Region: 6
Quinn, Patrick	Discipline : Physics & Electronics	Exhibit: N19
	The Durability of Pens	

Boston	Boston Latin School	Region: 6
Mansoor, Mariah	Discipline : Engineering	Exhibit: F26
	An Effective Solution to the Clean Water Crisis in Developing Nations	
Boston	Boston Latin Academy	Region: 6
Taub, Ezra	Discipline : Physics & Electronics	TEAM Exhibit: F23
	The Effect of Different Liquids on the Faraday Effect	
Boston	Excel High	Region: 6
El Atifi, Soukaina	Discipline : Biochemistry	TEAM Exhibit: D15
	Organic Arch Support	
Boston	Madison Park Tech Voc HS	Region: 6
Rivera, Joshua	Discipline : Behavioral Science	TEAM Exhibit: P23
	Monochromatic Colors	
Boston	Jeremiah E. Burke H.S. - Dorchester	Region: 6
Dillon, Steve	Discipline : Behavioral Science	TEAM Exhibit: N24
	Physiological Analysis of Stress Response on Indiviuals	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Salah, Habso	Discipline : Biology	TEAM Exhibit: P8
	Does Feeding Animals GMO Foods Affect Their DNA?	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Mallory, India	Discipline : Chemistry	TEAM Exhibit: H22
	Turning Milk into Plastic	
Boston	Boston Latin School	Region: 6
Wang, Daisy	Discipline : Biology	Exhibit: J21
	A Comparison of Meat Freshness upon Different Thawing Methods	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Mitte, Isaiah	Discipline : Biochemistry	TEAM Exhibit: K26
	Effects of Organic Solvents on Tetrahymena Phaygocytosis	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Dabel, Carlia	Discipline : Engineering	TEAM Exhibit: G3
	Face Fits	
Boston	Madison Park Tech Voc HS	Region: 6
Osorio, Daiana	Discipline : Behavioral Science	TEAM Exhibit: P23
	Monochromatic Colors	
Boston	Edward M. Kennedy Academy for Health Careers	Region: 6
Alvarez, Rudy	Discipline : Engineering	TEAM Exhibit: G10
	Universal Earbud Case	

Boston	Urban Science Academy	Region: 6
Yee, Stefania	Discipline : Chemistry	Exhibit: K22
	Can Temperature Affect How Long a Glow Stick Stays Lit	
Bourne	Bourne High School	Region: 5
Traver , Lily	Discipline : Biology	Exhibit: N8
	How Do Changes in pH Affect Plants in an Aquatic Environment	
Bourne	Upper Cape Cod Voc-Tec. H. S.	Region: 5
Kleindinst, Charlie	Discipline : Engineering	Exhibit: F28
	TEA Laser	
Bourne	Bourne High School	Region: 5
Schmitt, Mary	Discipline : Engineering	TEAM Exhibit: N17
	Developing an Automatic Watering System Using Microprocessing	
Bourne	Upper Cape Cod Voc-Tec. H. S.	Region: 5
Taylor, Jillian	Discipline : Environmental Science	Exhibit: C24
	The Decomposition of Plant Matter in Salt Marshes	
Bourne	Upper Cape Cod Voc-Tec. H. S.	Region: 5
Nance, Bailey	Discipline : Environmental Science	Exhibit: H4
	Food For Thought	
Bourne	Upper Cape Cod Voc-Tec. H. S.	Region: 5
Kumar, Deep	Discipline : Engineering	Exhibit: D12
	Robotic Hand	
Bourne	Bourne High School	Region: 5
Cohen, Mya	Discipline : Engineering	TEAM Exhibit: N17
	Developing an Automatic Watering System Using Microprocessing	
Bourne	Upper Cape Cod Voc-Tec. H. S.	Region: 5
Rotondo, Elias	Discipline : Behavioral Science	Exhibit: D7
	Ready. Set. GO!	
Boylston	Tahanto Regional High School	Region: 2
Raja, Menaja	Discipline : Computers	Exhibit: F7
	Cybersecurity: How Quickly Can Your Password be Cracked?	
Boylston	Tahanto Regional High School	Region: 2
Sonti, Advika	Discipline : Biology	Exhibit: G24
	Fibonacci in Nature: Investigation on Mathematical Patterns in Plants	
Brighton	Mary Lyon Pilot High School	Region: 6
Thompson, Brian	Discipline : Engineering	Exhibit: G7
	Integrating a Hamilton Water Jet Engine with a Tesla Turbine	

Brighton	Mary Lyon Pilot High School	Region: 6
Okar, Zeina	Discipline : Physics & Electronics	Exhibit: N22
	3-2-1 Blood	
Brockton	Brockton High School	Region: 5
Pyrdol, Mary	Discipline : Physics & Electronics	TEAM Exhibit: P21
	Piezoelectric Shoes	
Brockton	Brockton High School	Region: 5
Alayon, Zedah	Discipline : Chemistry	Exhibit: H25
	A Rainbow of Colors to Aid a Chemical Reaction	
Brockton	Brockton High School	Region: 5
Tran, Christopher	Discipline : Physics & Electronics	TEAM Exhibit: P21
	Piezoelectric Shoes	
Brockton	Cardinal Spellman High	Region: 5
Moore-Ellis, NaShanti	Discipline : Environmental Science	Exhibit: D25
	Saving the Environment with Wave Energy	
Brockton	Brockton High School	Region: 5
DiMare, Francesca	Discipline : Physics & Electronics	Exhibit: N6
	Using Light to Measure Water Quality in Streams and Rivers	
Brookline	Brookline High School	Region: 5
Xu, Frank	Discipline : Biochemistry	Exhibit: P20
	Functional Interactions of Metalloproteinases in Kidney Cystogenesis	
Cambridge	Community Charter School of Cambridge	Region: 4
Chan, Alvin	Discipline : Biology	Exhibit: J11
	Charles River - Dangerous or Not: Identify and Characterize Bacteria	
Cambridge	Cambridge Rindge & Latin High School	Region: 4
Mondol, Zeus	Discipline : Biology	Exhibit: N13
	Inflammation and TWEAK	
Cambridge	Prospect Hill Academy Charter School	Region: 4
Douyon, Wiener	Discipline : Environmental Science	Exhibit: K25
	One Pebble, One Life: Reducing Water Pollution by Natural Filtration	
Cambridge	Cambridge Rindge & Latin High School	Region: 4
Anyosa-Galvez, Gonzalo	Discipline : Biology	Exhibit: K17
	The Use of Essential Oils to Fight Fire Blight in Fruit Trees	
Cambridge	Cambridge Rindge & Latin High School	Region: 4
Sadhuka, Shuvom	Discipline : Physics & Electronics	Exhibit: G9
	Acoustic Topological Waveguide in a Hexagonal Pillar Array	

Cambridge	Matignon High School	Region: 4
Krstanovic, Katerina	Discipline : Biology	Exhibit: J13
	The Effects of PH Level within a Designated Range on Hydra Populations	
Cambridge	Community Charter School of Cambridge	Region: 4
Chopra, Rohit	Discipline : Biochemistry	Exhibit: K27
	Isolation of High-Molecular-Weight Tau from Alzheimer’s Disease Brain	
Canton	Canton High School	Region: 5
Addanki, Anvitha	Discipline : Biology	Exhibit: H19
	Effects of Alcohol and Nicotine on Fecundity in D. melanogaster	
Concord	Concord-Carlisle Regional H. S.	Region: 4
Dsouza, Kiran	Discipline : Earth & Space Science	TEAM Exhibit: F8
	Algorithmic New England Leaves	
Concord	Concord-Carlisle Regional H. S.	Region: 4
Dsouza, Rohit	Discipline : Earth & Space Science	TEAM Exhibit: F8
	Algorithmic New England Leaves	
Concord	Concord Academy	Region: 4
Lo, Wesley	Discipline : Biology	Exhibit: F25
	Applying Machine Learning to Predictive Gene Data Analysis Tools	
Danvers	St. John's Prep. School	Region: 4
Lin, Zekai	Discipline : Biology	Exhibit: J24
	Deep Learning Approach for Classifying Motor Imagery EEG	
Deerfield	Deerfield Academy	Region: 1
Boonpongmanee, Inthat	Discipline : Biology	Exhibit: F19
	Neural Networks and Colon Polyp Detection	
Dorchester	Jeremiah E. Burke H.S. - Dorchester	Region: 6
Davis, Teyah	Discipline : Behavioral Science	TEAM Exhibit: N24
	Physiological Analysis of Stress Response on Indiviuals	
Dorchester	Jeremiah E. Burke H.S. - Dorchester	Region: 6
Mohamud, Maryan	Discipline : Biology	TEAM Exhibit: N23
	Microbial Sensitivity and Resistance to Antibiotics between Subjects	
Dorchester	Jeremiah E. Burke H.S. - Dorchester	Region: 6
Pinto, Katia	Discipline : Biology	TEAM Exhibit: N23
	Microbial Sensitivity and Resistance to Antibiotics between Subjects	
Dorchester	Jeremiah E. Burke H.S. - Dorchester	Region: 6
Montilla, Ianna	Discipline : Biology	TEAM Exhibit: N23
	Microbial Sensitivity and Resistance to Antibiotics between Subjects	

Dorchester	Jeremiah E. Burke H.S. - Dorchester	Region: 6
Bereus, Sophia	Discipline : Behavioral Science	TEAM Exhibit: N24
	Physiological Analysis of Stress Response on Indiviuals	
Dorchester	Boston Latin Academy	Region: 6
Muñeton, Camila	Discipline : Chemistry	TEAM Exhibit: D1
	Experiments to Identify a Mystery Metal	
Dudley	Shepherd Hill Reg. H. S.	Region: 2
Veilleux, Serena	Discipline : Behavioral Science	Exhibit: P2
	The Problem With Google	
Dudley	Shepherd Hill Reg. H. S.	Region: 2
Whitehead, Emma	Discipline : Engineering	Exhibit: H6
	Forget Me Knot: The Effect of Thermal Bonding on Suture Strength	
East Boston	East Boston High School	Region: 6
Figueroa, Ashley	Discipline : Biology	TEAM Exhibit: N20
	Enzymatic Browning	
East Boston	East Boston High School	Region: 6
Rivera, Britney	Discipline : Environmental Science	TEAM Exhibit: K13
	Examining the Effects of Land Use on Water Quality	
East Boston	East Boston High School	Region: 6
Vazquez, Juliana	Discipline : Biology	Exhibit: F18
	Bacterial Transformation	
East Boston	East Boston High School	Region: 6
Bui, Kenny	Discipline : Biology	TEAM Exhibit: N20
	Enzymatic Browning	
Easton	Southeastern Reg. Voc-Tech. H S	Region: 5
Bowyer, Bridgette	Discipline : Environmental Science	Exhibit: B27
	Benthic Macroinvertebrates as Bioindicators	
Easton	Southeastern Reg. Voc-Tech. H S	Region: 5
Watson, Amber	Discipline : Biology	TEAM Exhibit: D8
	What Are You Eating?	
Easton	Southeastern Reg. Voc-Tech. H S	Region: 5
Elfman, Andrew	Discipline : Engineering	Exhibit: C13
	Vex Robotics: In the Zone	
Everett	Pioneer Charter School of Science	Region: 4
Coelho, Emily	Discipline : Environmental Science	TEAM Exhibit: G4
	Mosquito Madness Massacre	

Everett	Pioneer Charter School of Science	Region: 4
Bonilla, Daniela	Discipline : Environmental Science	TEAM Exhibit: G4
	Mosquito Madness Massacre	
Everett	Pioneer Charter School of Science	Region: 4
Hossaini, Chaimaa	Discipline : Biology	Exhibit: G12
	The Effect of Ginger and Zingiberene on the Lysozyme Activity of the Bombyx mori	
Everett	Pioneer Charter School of Science	Region: 4
Gonzalez, Melissa	Discipline : Environmental Science	TEAM Exhibit: G4
	Mosquito Madness Massacre	
Exeter	Phillips Academy	Region: 4
Rhee, Brian	Discipline : Mathematics	TEAM Exhibit: G17
	Continuum Modelling of Traffic Systems with Autonomous Vehicles	
Falmouth	Falmouth Academy	Region: 5
Schwenk, Ben	Discipline : Environmental Science	Exhibit: K8
	Habitat Modeling of Northern Sand Lance in the Stellwagen Bank Region	
Falmouth	Falmouth High School	Region: 5
Otter, Troy	Discipline : Engineering	Exhibit: C9
	Hyperloop Vehicle Levitation Using Circular Halbach Arrays	
Falmouth	Falmouth High School	Region: 5
Lineaweaver, Abraham	Discipline : Biology	TEAM Exhibit: H28
	Bacterial Communities Kitchen Sponges	
Falmouth	Falmouth Academy	Region: 5
Keeler, Emma	Discipline : Biology	Exhibit: C7
	Bioprospecting for Benthic Fungi and Their Bactericidal Antibiotics	
Falmouth	Falmouth Academy	Region: 5
Igoe, Jillian	Discipline : Biology	Exhibit: P9
	Impact of Temperature on Coral Symbioses	
Falmouth	Falmouth Academy	Region: 5
Pil, Gedeon	Discipline : Physics & Electronics	Exhibit: G6
	The Effect of Different Alcohols on Cloud Chamber Reactivity	
Falmouth	Falmouth Academy	Region: 5
Lott, Sarah	Discipline : Biochemistry	TEAM Exhibit: H2
	Exploring the Lower Oceanic Crust, One of the Last Frontiers on Earth	
Falmouth	Falmouth Academy	Region: 5
Chunyu, Zhaohua	Discipline : Biology	Exhibit: N14
	Nrf2b’s Regulation of Oxidative Stress Response Genes in Zebrafish	

Falmouth	Falmouth Academy	Region: 5
Glasgow, Noah	Discipline : Biology	Exhibit: H3
	Creamery Sanitation Method Efficacies Relative to Creamery Surfaces	
Falmouth	Falmouth Academy	Region: 5
Russell, Grace	Discipline : Environmental Science	Exhibit: H11
	The Effect of Lowered Oxygen Levels on Hermit Crab Behavior	
Falmouth	Falmouth Academy	Region: 5
Cox, Rebecca	Discipline : Biochemistry	TEAM Exhibit: H2
	Exploring the Lower Oceanic Crust, One of the Last Frontiers on Earth	
Falmouth	Falmouth Academy	Region: 5
Rajagopal, Saniya	Discipline : Environmental Science	Exhibit: J15
	The Effect of Noise Pollution on Grass Shrimp	
Falmouth	Falmouth High School	Region: 5
Helfrich, Bennett	Discipline : Engineering	TEAM Exhibit: C25
	Creating a Rocket Platform to Improve Data Acquisition & Reusability	
Falmouth	Falmouth Academy	Region: 5
Stillman, Hannah	Discipline : Biochemistry	Exhibit: J9
	Correction of Mutations Underlying Tay Sachs Disease by RNA Editing	
Falmouth	Falmouth High School	Region: 5
Beaudoin, Bridget	Discipline : Biology	Exhibit: N3
	Occurence of Symbiosis in the Deep-Sea	
Falmouth	Falmouth High School	Region: 5
Xu, Charles	Discipline : Environmental Science	Exhibit: J16
	Nutrient Leaching From Arctic Permafrost Thaw	
Falmouth	Falmouth Academy	Region: 5
Fenske, Charlie	Discipline : Engineering	Exhibit: C8
	Analysis of Morphing Wings to Enhance Aircraft Efficiency	
Falmouth	Falmouth High School	Region: 5
Kwon, Grace	Discipline : Engineering	Exhibit: B24
	Prototypical Real-Time Simultaneous Air/Sea Acoustic Monitoring System	
Falmouth	Falmouth High School	Region: 5
Brodie, Evan	Discipline : Engineering	TEAM Exhibit: C25
	Creating a Rocket Platform to Improve Data Acquisition & Reusability	
Falmouth	Falmouth Academy	Region: 5
Littlefield, Leah	Discipline : Physics & Electronics	Exhibit: H5
	Passive Blood Spatter Pattern Analysis on Different Substrates	

Falmouth	Falmouth High School	Region: 5
Newman, Celeste	Discipline : Biology	TEAM Exhibit: H28
	Bacterial Communities Kitchen Sponges	
Falmouth	Falmouth Academy	Region: 5
Goldbach, James	Discipline : Biology	Exhibit: K7
	The Effects of Arbuscular Mycorrhizal Fungi and Rhizobacteria on Peas	
Fiskdale	Tantasqua Reg. H. S.	Region: 2
Riley, Parker	Discipline : Engineering	TEAM Exhibit: F22
	Keys to Dyslexia	
Fiskdale	Tantasqua Reg. H. S.	Region: 2
Pecci, Rose	Discipline : Engineering	TEAM Exhibit: F22
	Keys to Dyslexia	
Foxboro	Foxborough Regional Charter School	Region: 3
Green, Mitchell	Discipline : Environmental Science	Exhibit: H8
	Circumvention of Barriers by Lower Troposphere Aerosolized Pollutants	
Foxboro	Foxborough Regional Charter School	Region: 3
Koran, Isabel	Discipline : Engineering	Exhibit: N9
	Resistive Heating of Commuter Bicycle Mitts	
Foxborough	Foxborough Regional Charter School	Region: 3
Etienne, Jared	Discipline : Biology	Exhibit: N11
	A Novel Approach to Transplantation without Immunosuppression	
Foxborough	Foxborough Regional Charter School	Region: 3
Lyle, William	Discipline : Chemistry	Exhibit: N12
	Yeast: Brick to Bread	
Framingham	Marian High School	Region: 2
Liazos, Chris	Discipline : Biology	Exhibit: J2
	Survey of Critical and Lethal Temperature Range of Achetus domesticus	
Framingham	Marian High School	Region: 2
Schneider, Jeremy	Discipline : Computers	Exhibit: F3
	Using Twitter to Predict Influenza Outbreaks	
Gill	Northfield-Mt.Hermon School	Region: 1
Lu, Hung-Wei	Discipline : Physics & Electronics	Exhibit: J7
	The Investigation of Pepper’s Ghost	
Grafton	Grafton Memorial Senior H. S.	Region: 2
Ng, Esther	Discipline : Engineering	TEAM Exhibit: N2
	Increasing the Accesibility of Hydroelectric Energy	

Grafton	Grafton Memorial Senior H. S.	Region: 2
Balaji, Shreya	Discipline : Engineering	TEAM Exhibit: N2
	Increasing the Accesibility of Hydroelectric Energy	
Grafton	Grafton Memorial Senior H. S.	Region: 2
Dalal, Aneeha	Discipline : Biology	TEAM Exhibit: J3
	The Use of Enhanced Image Processing to Detect Bovine Rumen Acidosis	
Grafton	Grafton Memorial Senior H. S.	Region: 2
Dorazio , Madison	Discipline : Engineering	TEAM Exhibit: N2
	Increasing the Accesibility of Hydroelectric Energy	
Grafton	Grafton Memorial Senior H. S.	Region: 2
Deveney, Chloe	Discipline : Biology	TEAM Exhibit: J3
	The Use of Enhanced Image Processing to Detect Bovine Rumen Acidosis	
Greenfield	Stoneleigh-Burnham School	Region: 1
Lin, Xiandong	Discipline : Engineering	Exhibit: A13
	Hexapod Robot	
Hadley	Hopkins Academy	Region: 1
Cullen, Aedan	Discipline : Computers	Exhibit: D10
	A Recurrent Approach to Artificial General Intelligence Algorithms	
Hanover	Hanover High School	Region: 5
Daly, John	Discipline : Physics & Electronics	Exhibit: N26
	How Golf Ball Core Affects Distance	
Holden	Wachusett Regional High School	Region: 2
Gallagher, Timmarie	Discipline : Biology	Exhibit: D18
	Effect of Melatonin on Tachycardia in Daphnia Magna	
Holden	Wachusett Regional High School	Region: 2
Danko, Julia	Discipline : Environmental Science	Exhibit: D19
	Ceasing Coral Bleaching	
Holden	Wachusett Regional High School	Region: 2
Dwyer, Christopher	Discipline : Biology	Exhibit: F15
	Analyzing Effect of Nitrogen Starvation vs Carbon on Microalgal Lipids	
Holden	Wachusett Regional High School	Region: 2
Lomino, Vincent	Discipline : Computers	Exhibit: B9
	Networking of a Cellular Communications Mesh-Net	
Holden	Wachusett Regional High School	Region: 2
Matis, Natalie	Discipline : Biology	Exhibit: F16
	The Effect of Growth Hormone on Daphnia magna Reproduction	

Holden	Wachusett Regional High School	Region: 2
Massoni-Nesman, Rianna	Discipline : Biology	Exhibit: B10
The Effect of Tangerine Citric Acid on Pogonomyrmex Barbatus		
Holden	Wachusett Regional High School	Region: 2
Barberis, Hugo	Discipline : Biology	Exhibit: D20
Al, NaF, and C4H6O2 Impacts on Learning and Memory in D. melanogaster		
Holden	Wachusett Regional High School	Region: 2
Mizerak, Elise	Discipline : Environmental Science	Exhibit: F1
What's In Your Water?		
Holden	Wachusett Regional High School	Region: 2
LaBelle, Emily	Discipline : Engineering	Exhibit: B11
Gray Water Recycler		
Holden	Wachusett Regional High School	Region: 2
Xu, Eileen	Discipline : Physics & Electronics	Exhibit: P22
Photovoltaichroma		
Holden	Wachusett Regional High School	Region: 2
Mizerak, Evan	Discipline : Biology	Exhibit: A8
Implications of Epigenetic Mechanisms in Heritable Fertility Trends		
Hopkinton	Hopkinton High School	Region: 2
Kuruvilla, Eva	Discipline : Environmental Science	TEAM Exhibit: J6
Finding Biodegradable Alternatives to Synthetic Plastics		
Hopkinton	Hopkinton High School	Region: 2
Minocha, Himanshu	Discipline : Computers	TEAM Exhibit: D24
Intelligent Cloud-Based Medication Dispensing and Scheduling System		
Hopkinton	Hopkinton High School	Region: 2
Cahill, Sara	Discipline : Environmental Science	TEAM Exhibit: J6
Finding Biodegradable Alternatives to Synthetic Plastics		
Hopkinton	Hopkinton High School	Region: 2
Rosen, Elan	Discipline : Computers	Exhibit: C5
Reinforcement Learning Used For Aggressive Maneuvers On Quadcopters		
Hopkinton	Hopkinton High School	Region: 2
Minocha, Rohan	Discipline : Computers	TEAM Exhibit: D24
Intelligent Cloud-Based Medication Dispensing and Scheduling System		
Hopkinton	Hopkinton High School	Region: 2
Rhodes, Tyler	Discipline : Computers	TEAM Exhibit: G16
Machine Learning to Find Correlations Between Diseases and Habits		

Hopkinton	Hopkinton High School	Region: 2
Proudman, Freya	Discipline : Behavioral Science	TEAM Exhibit: K19
	An Analysis of Social Media and Subjective Well Being in Adolescents	
Hopkinton	Hopkinton High School	Region: 2
Proudman, Daniel	Discipline : Behavioral Science	TEAM Exhibit: K19
	An Analysis of Social Media and Subjective Well Being in Adolescents	
Hopkinton	Hopkinton High School	Region: 2
Mohammad, Faateh	Discipline : Computers	Exhibit: D22
	System for Consumer Controlled Credit History on Blockchain	
Hopkinton	Hopkinton High School	Region: 2
Nene, Advait	Discipline : Computers	TEAM Exhibit: G16
	Machine Learning to Find Correlations Between Diseases and Habits	
Hopkinton	Hopkinton High School	Region: 2
Benack, Alexa	Discipline : Environmental Science	TEAM Exhibit: J6
	Finding Biodegradable Alternatives to Synthetic Plastics	
Hudson	Hudson High School	Region: 2
Clardy , Lily	Discipline : Biology	TEAM Exhibit: K21
	GenEon Spray Solution Kill Bacteria?	
Hudson	Hudson High School	Region: 2
Brassard, Hunter	Discipline : Physics & Electronics	TEAM Exhibit: D27
	The Magnus Effect	
Hudson	Hudson High School	Region: 2
Colleoni-Pimenta, Alex	Discipline : Physics & Electronics	TEAM Exhibit: D27
	The Magnus Effect	
Hudson	Hudson High School	Region: 2
Genova, Abby	Discipline : Biology	TEAM Exhibit: K21
	GenEon Spray Solution Kill Bacteria?	
Hyannis	St. John Paul ll High School	Region: 5
August, Colby	Discipline : Engineering	Exhibit: C27
	Bringing the Heat	
Hyannis	St. John Paul ll High School	Region: 5
Liu, Zhengde	Discipline : Biology	TEAM Exhibit: C22
	Memory Retention and Structure Changes in Planarian After Regeneration	
Hyannis	St. John Paul ll High School	Region: 5
Zimu, Meng	Discipline : Biology	TEAM Exhibit: C22
	Memory Retention and Structure Changes in Planarian After Regeneration	

Hyannis	St. John Paul ll High School	Region: 5
Carney, Marie	Discipline : Chemistry	Exhibit: K20
	Saponification Sensation	
Hyannis	St. John Paul ll High School	Region: 5
Hoffmeister, Ashlinn	Discipline : Biology	Exhibit: C12
	The Effect of Barometric Pressure on Joints	
Lexington	Lexington High School	Region: 4
Bulovic, Ian	Discipline : Biology	TEAM Exhibit: D9
	Protein Structure Prediction with Recurrent Neural Networks	
Lexington	Lexington High School	Region: 4
Ding, Elizabeth	Discipline : Computers	Exhibit: J10
	Building a Novel Autism Classifier with Machine Learning Approaches	
Lexington	Lexington High School	Region: 4
Kebichi, Nabil	Discipline : Computers	Exhibit: D11
	Predicting Long Term Stock Price Movement Through Machine Learning	
Lexington	Lexington High School	Region: 4
Bhupatiraju, Vivek	Discipline : Computers	Exhibit: C21
	On the Development of Efficient Append-Only Authenticated Dictionaries	
Lexington	Lexington High School	Region: 4
Karim, Asiya	Discipline : Physics & Electronics	Exhibit: F9
	Optimization of AC Heating in Ferrofluid and Diamagnetic Bismuth	
Lexington	Lexington High School	Region: 4
Kuszmaul, John	Discipline : Computers	TEAM Exhibit: P15
	KeyChat: Secure Messaging via Bitcoin	
Lexington	Lexington High School	Region: 4
Zhou, Kevin	Discipline : Environmental Science	Exhibit: J8
	Deicing Alternatives - Better for Surfaces and the Environment	
Lexington	Lexington High School	Region: 4
Weissburg, Evan	Discipline : Biology	TEAM Exhibit: D9
	Protein Structure Prediction with Recurrent Neural Networks	
Lexington	Lexington High School	Region: 4
Bhalla, Neel	Discipline : Computers	Exhibit: F13
	Remote Sensing Using Drone and Machine Learning Algorithms	
Lexington	Lexington High School	Region: 4
Zheng, Yiming	Discipline : Computers	TEAM Exhibit: P15
	KeyChat: Secure Messaging via Bitcoin	

Lexington	Lexington High School	Region: 4
Raj, Yashasvi	Discipline : Engineering	Exhibit: B6
	TheraLux: Engineering Light-Based Approaches to Treat Acne	
Lexington	Lexington High School	Region: 4
Yoo, Seo-Hyun	Discipline : Biology	Exhibit: H20
	Blocking Multidrug Resistance in Cancer Cells with MicroRNA Mimics	
Lexington	Lexington High School	Region: 4
Khandelwal, Shiv	Discipline : Computers	TEAM Exhibit: F14
	Detection of Malignant Melanoma Using Machine Learning Algorithms	
Lexington	Lexington High School	Region: 4
Pannirselvam, Aadharsh	Discipline : Biology	Exhibit: F12
	RepeatFinder: A Trinucleotide Repeat Search Tool	
Lexington	Lexington High School	Region: 4
Padaki, Ashwin	Discipline : Computers	TEAM Exhibit: F14
	Detection of Malignant Melanoma Using Machine Learning Algorithms	
Lexington	Lexington High School	Region: 4
Defay, Benjamin	Discipline : Engineering	TEAM Exhibit: A21
	Untethered Firefly Synchronization	
Lexington	Lexington High School	Region: 4
Anantha, Sidharth	Discipline : Engineering	Exhibit: B8
	Seeing for the Blind	
Lexington	Lexington High School	Region: 4
Heo, Hyun Jun	Discipline : Biology	Exhibit: J28
	Effect of Pesticides on Lotus Rhizome's Antibacterial Ability	
Lexington	Lexington High School	Region: 4
Defay, John	Discipline : Engineering	TEAM Exhibit: A21
	Untethered Firefly Synchronization	
Lexington	Lexington High School	Region: 4
Chen, Robert	Discipline : Computers	TEAM Exhibit: P15
	KeyChat: Secure Messaging via Bitcoin	
Lexington	Lexington High School	Region: 4
Link, Ansel	Discipline : Biology	Exhibit: K28
	NGS Analysis of Multiplex Programmable DNA Assemblies	
Marlboro	Assabet Valley Voc. H. S.	Region: 2
Agyei, Amma	Discipline : Behavioral Science	Exhibit: A1
	Neuroprotective Effect of Caffeine on a TBI-induced Drosophila model	

Marlborough	Marlborough High School	Region: 2
Paul, Harrison	Discipline : Environmental Science	TEAM Exhibit: G14
	Affordable Desalination Of Ocean Water	
Marlborough	Marlborough High School	Region: 2
Rosenzweig, Noah	Discipline : Engineering	TEAM Exhibit: K23
	Space Expedition - Beyond The System	
Marlborough	Assabet Valley Voc. H. S.	Region: 2
Johansen, Lida	Discipline : Engineering	Exhibit: K9
	Modifying Respiratory Medical Tubes to Reduce Microbial Adhesion	
Marlborough	Marlborough High School	Region: 2
Bogle, Conner	Discipline : Engineering	TEAM Exhibit: K23
	Space Expedition - Beyond The System	
Marlborough	Marlborough High School	Region: 2
Simmons, Ben	Discipline : Engineering	TEAM Exhibit: K23
	Space Expedition - Beyond The System	
Marlborough	Advanced Math and Science Academy	Region: 2
Athipathy, Nikhita	Discipline : Biology	Exhibit: G27
	Using SNP Correlation to Find the Risk of Developing a Genetic Disease	
Marlborough	Advanced Math and Science Academy	Region: 2
Iqbal, Marzuq	Discipline : Biochemistry	Exhibit: A23
	How Bacteria Can Help Us Treat Diabetes	
Marlborough	Assabet Valley Voc. H. S.	Region: 2
Esteves-Ruiz, Julya	Discipline : Environmental Science	TEAM Exhibit: F17
	Bioluminescence with Fireflies	
Marlborough	Assabet Valley Voc. H. S.	Region: 2
Fossile, Brandon	Discipline : Environmental Science	TEAM Exhibit: F17
	Bioluminescence with Fireflies	
Marlborough	Marlborough High School	Region: 2
Minier, Ian	Discipline : Environmental Science	TEAM Exhibit: G14
	Affordable Desalination Of Ocean Water	
Marlborough	Marlborough High School	Region: 2
Paul, Carter	Discipline : Environmental Science	TEAM Exhibit: G14
	Affordable Desalination Of Ocean Water	
Medford	Medford High School	Region: 4
Dhaurali, Shubhecchha	Discipline : Physics & Electronics	Exhibit: B3
	Optical Monitoring of Muscle Hemodynamics in Humans after Exercise	

Medford	Medford High School	Region: 4
Farah, Albert	Discipline : Engineering	Exhibit: A12
	Advancements in the Staging of Rockets to Better Utilize Thrust	
Medford	Medford High School	Region: 4
Neguse , Mary	Discipline : Biology	TEAM Exhibit: N18
	Improving Efficacy of Ultrasonic Nutraceutical Liposomal Delivery	
Medford	Medford High School	Region: 4
Abdulkerim, Sarah	Discipline : Biology	TEAM Exhibit: N18
	Improving Efficacy of Ultrasonic Nutraceutical Liposomal Delivery	
Mount Hermon	Northfield-Mt.Hermon School	Region: 1
Lim, Cheaheon	Discipline : Environmental Science	Exhibit: C17
	Light Sensitive Turntable: Effects on Brassica rapa	
Mount Hermon	Northfield-Mt.Hermon School	Region: 1
Han, Taehoon	Discipline : Computers	Exhibit: B23
	Predicting Response of Visual Neurons with Machine Learning Techniques	
Newton	Newton Country Day Sch/Sacred Heart	Region: 5
Klessel, Sophia	Discipline : Engineering	TEAM Exhibit: B25
	Apotheca 2.0	
Newton	Newton Country Day Sch/Sacred Heart	Region: 5
Woolbert, Avery	Discipline : Computers	Exhibit: B26
	Impact of Smartphone Use on Traffic Flow	
Newton	Newton Country Day Sch/Sacred Heart	Region: 5
Kelly, Emma	Discipline : Biochemistry	Exhibit: N27
	Modification of Tumor Environment by Secreted miRNA	
Newton	Newton Country Day Sch/Sacred Heart	Region: 5
De Luis, Maya	Discipline : Engineering	TEAM Exhibit: B25
	Apotheca 2.0	
North Attleboro	North Attleboro High School	Region: 3
Sunkari, Aakash	Discipline : Physics & Electronics	Exhibit: D13
	High Energy Quantum Nanosuperconducting Portable Nuclear “ARC” Reactor	
North Attleboro	North Attleboro High School	Region: 3
Gupta, Mahika	Discipline : Environmental Science	Exhibit: F4
	Decomposition of Plastic	
North Attleborough	North Attleboro High School	Region: 3
Srinivasan, Shruti	Discipline : Biochemistry	Exhibit: H21
	How to Break Down Superbug Bacteria	

North Attleborough	North Attleboro High School	Region: 3
Patel, Hirni	Discipline : Behavioral Science	Exhibit: H16
	Memory: Encoding to Retrieval	
North Dartmouth	Bishop Stang High School	Region: 3
Gallison, Kieran	Discipline : Biochemistry	Exhibit: J12
	The Effects of CO2 on the Growth of Crops in an Underwater Biosphere.	
North Easton	Oliver Ames High School	Region: 5
Perez, Taylor	Discipline : Environmental Science	TEAM Exhibit: G21
	D.O. Disaster	
North Easton	Oliver Ames High School	Region: 5
Quinn, Catherine	Discipline : Environmental Science	TEAM Exhibit: G21
	D.O. Disaster	
North Quincy	North Quincy High School	Region: 5
Lin, Yi	Discipline : Environmental Science	Exhibit: G20
	The Quality of Drinking Water	
Northborough	Algonquin Regional H.S.	Region: 2
Wang, Christopher	Discipline : Biochemistry	Exhibit: H24
	Biomimetic Method Mediated by LRAP to Regenerate Enamel in 3D Spaces	
Oak Bluffs	Martha's Vineyard Regional H. S.	Region: 5
Favreau, Owen	Discipline : Environmental Science	Exhibit: C14
	Urban Turbines	
Oak Bluffs	Martha's Vineyard Regional H. S.	Region: 5
Aiello, Vito	Discipline : Engineering	Exhibit: C11
	Designing a Combined Solar-Hydroelectric Power System	
Oak Bluffs	Martha's Vineyard Regional H. S.	Region: 5
Fisher, Curtis	Discipline : Environmental Science	Exhibit: B28
	A Modular Platform for Node-Based Environmental Sensor Networks	
Pittsfield	Miss Hall's School	Region: 1
Liang, Zifeng	Discipline : Biology	Exhibit: G25
	Expression of Carbonic Anhydrase Ion Channels in Ameloblasts	
Pittsfield	Taconic High School	Region: 1
Lysonski-Phillips, Ariana	Discipline : Environmental Science	TEAM Exhibit: K2
	Curing Ailments but Poisoning the Environment?	
Pittsfield	Taconic High School	Region: 1
Hoose, Leeyia	Discipline : Environmental Science	TEAM Exhibit: K2
	Curing Ailments but Poisoning the Environment?	

Pittsfield	Taconic High School	Region: 1
Hayes, Mary	Discipline : Behavioral Science	Exhibit: N10
	Effects of Static and Dynamic Stretching in Athletes	
Pittsfield	Taconic High School	Region: 1
Asumadu, Augustine	Discipline : Engineering	Exhibit: G28
	Hand Charger	
Pittsfield	Taconic High School	Region: 1
Hargraves-Johnson, Kiiyah	Discipline : Engineering	Exhibit: C19
	A Pop of Life	
Pittsfield	Miss Hall's School	Region: 1
Nguyen, Ngoc Tram	Discipline : Engineering	Exhibit: H23
	Pain, Pain Go Away	
Pittsfield	Taconic High School	Region: 1
Currie, Alexander	Discipline : Engineering	Exhibit: P19
	Sound the Alarm!	
Plymouth	Plymouth South High School	Region: 5
Manic, Mila	Discipline : Behavioral Science	Exhibit: F11
	The Solar Powered Sea Slug	
Quincy	Quincy High School	Region: 5
Ireland, Alexander	Discipline : Engineering	Exhibit: P5
	Stackable Shelters for Natural Disaster Victims and Refugees	
Quincy	Quincy High School	Region: 5
Germain, Marsha	Discipline : Biology	Exhibit: N15
	Phytohormone Manipulation	
Quincy	North Quincy High School	Region: 5
Kelliher, Grace	Discipline : Biology	Exhibit: K15
	The Effect of pH on Fluorescence	
Quincy	North Quincy High School	Region: 5
Lin, Nuo	Discipline : Physics & Electronics	Exhibit: K16
	Magnetized Water	
Quincy	North Quincy High School	Region: 5
Wu, Kayli	Discipline : Physics & Electronics	Exhibit: H18
	Water Drying	
Quincy	North Quincy High School	Region: 5
Le, Mya	Discipline : Chemistry	Exhibit: K18
	Temperature on the Intensity and Length of Glow Stick Luminescence	

Quincy	North Quincy High School	Region: 5
Huang, Aaron	Discipline : Chemistry	Exhibit: G2
	Strength of Magnetic Field in Acids and Bases	
Quincy	North Quincy High School	Region: 5
Simaku, Patricia	Discipline : Biology	Exhibit: G18
	The Effect of Guarana, Ginseng, and Vitamin C on Daphnia Magna Heart	
Quincy	Quincy High School	Region: 5
Murphy, Hannah	Discipline : Biology	Exhibit: G13
	The Effect of Carbon Dioxide on Plant Growth and Nutritional Value	
Quincy	North Quincy High School	Region: 5
Zeng, Jenny	Discipline : Chemistry	Exhibit: K5
	The Absorbency Power of Fruit Peels	
Quincy	North Quincy High School	Region: 5
Tran, Twuyen	Discipline : Chemistry	Exhibit: N1
	Can Coffee Filters Be Used To Clean Oil Spills?	
Quincy	North Quincy High School	Region: 5
Lerkvikarn, Shane	Discipline : Chemistry	Exhibit: G19
	The Ascorbic Acid Concentration in Orange Juices	
Revere	Revere High School	Region: 4
Halak, Dania	Discipline : Behavioral Science	Exhibit: H12
	What Is To Blame For Depression?	
Revere	Revere High School	Region: 4
Feng, Chuxian	Discipline : Biology	Exhibit: H27
	The Effect of Different Anti-Fungal Agents Have On Yeast Infection	
Rockland	Calvary Chapel Academy	Region: 5
Mendez, Alexa	Discipline : Physics & Electronics	Exhibit: J17
	How To Build an X-ray Machine	
Rockland	Calvary Chapel Academy	Region: 5
Leopold, Grace	Discipline : Engineering	Exhibit: J18
	Dealing with Diabetes: The Road to Developing an Artificial Pancreas	
Rockland	Calvary Chapel Academy	Region: 5
Sheputa, Joshua	Discipline : Engineering	Exhibit: D23
	Wireless Outlet Control	
Sandwich	Upper Cape Cod Voc-Tec. H. S.	Region: 5
Rotondo, Joseph	Discipline : Environmental Science	Exhibit: H15
	Designing a P-Band Radar System to Measure Soil Moisture Content	

Saugus	Pioneer Charter School of Science II	Region: 4
Najah, Aiman	Discipline : Chemistry	Exhibit: A11
	Effect of Mg(OH)2 and Al(OH)3 on Reducing the Flammability of Paint	
Saugus	Pioneer Charter School of Science II	Region: 4
Ballentos, Rechelle	Discipline : Biology	Exhibit: J27
	The Effect of Household Products on Staphylococcus epidermidis	
Sharon	Sharon High School	Region: 5
Prakash, Indumathi	Discipline : Biology	Exhibit: G5
	Innovative & Affordable Smart Syringe to Contain Epidemic for Billions	
Sharon	Sharon High School	Region: 5
Ravikumar, Akshaya	Discipline : Biology	Exhibit: N4
	Accelerating Zika Virus Drug Discovery Using Chemogenomic Approaches	
Sheffield	Berkshire School	Region: 1
Tian, Daniel	Discipline : Computers	Exhibit: D14
	Accurate and Affordable Device for Skin Condition Diagnosis	
Shrewsbury	Shrewsbury High School	Region: 2
He, James	Discipline : Engineering	TEAM Exhibit: A25
	Fighting Fire with... Sound?	
Shrewsbury	Shrewsbury High School	Region: 2
Noorwez, Sufana	Discipline : Biology	Exhibit: C4
	The Effects of Temperature on Mealworm Metabolism of Plastic	
Shrewsbury	Shrewsbury High School	Region: 2
Prabhakar, Garima	Discipline : Earth & Space Science	Exhibit: D5
	A Novel Algorithm to Increase Exoplanetary Detection Accuracy	
Shrewsbury	Shrewsbury High School	Region: 2
Chittibabu , Shriyaa	Discipline : Chemistry	Exhibit: A18
	Addressing Global Water Scarcity Using Light Absorbing Nanomaterials	
Shrewsbury	Shrewsbury High School	Region: 2
Wong, Lance	Discipline : Biochemistry	Exhibit: D6
	Effects of Inter-alpha-Trypsin Inhibitors on Erythrocyte Aggregation	
Shrewsbury	St. John's High School	Region: 2
Syed, Muneeb	Discipline : Engineering	TEAM Exhibit: B12
	Harnessing IoT to Autonomously Alert Emergency Services	
Shrewsbury	Shrewsbury High School	Region: 2
Rudnick, Zoe	Discipline : Engineering	Exhibit: A24
	Robot Navigation for the Exploration of Lunar and Planetary Surfaces	

Shrewsbury	St. John's High School	Region: 2
Mufti, Saad	Discipline : Engineering	TEAM Exhibit: B12
	Harnessing IoT to Autonomously Alert Emergency Services	
Shrewsbury	Shrewsbury High School	Region: 2
Raghunathan, Divya	Discipline : Environmental Science	Exhibit: N5
	De-Icers: Are We A-Salting Our Environment? The Effects of Road Salt.	
Shrewsbury	St. John's High School	Region: 2
Sukthankar, Ashwin	Discipline : Behavioral Science	Exhibit: B13
	Staring Contest: An App For Teaching Eye Contact	
Shrewsbury	Shrewsbury High School	Region: 2
Krishnan, Nikhil	Discipline : Engineering	TEAM Exhibit: A25
	Fighting Fire with... Sound?	
Somerville	Somerville High School	Region: 4
Novick, Peter	Discipline : Biology	TEAM Exhibit: J22
	The Tell-Tale Hearts	
Somerville	Somerville High School	Region: 4
Wen, Kevin	Discipline : Chemistry	Exhibit: P1
	Solid Acid Catalysts: A Greener Alternative for Pharmaceutical Field	
Somerville	Somerville High School	Region: 4
Childs, Emily	Discipline : Environmental Science	TEAM Exhibit: P14
	The Effect of Heat and Light on Water Bottles' Fluid Purity	
Somerville	Somerville High School	Region: 4
Duclos-Orsello, Luca	Discipline : Environmental Science	TEAM Exhibit: P4
	Effect of Ammonium Sulfate on the Thoracic Movement of Daphnia Magna	
Somerville	Somerville High School	Region: 4
Goodnow-Russell, Luke	Discipline : Environmental Science	TEAM Exhibit: P14
	The Effect of Heat and Light on Water Bottles' Fluid Purity	
Somerville	Somerville High School	Region: 4
Silva, Erick	Discipline : Biology	TEAM Exhibit: J22
	The Tell-Tale Hearts	
Somerville	Somerville High School	Region: 4
Portelli, Julian	Discipline : Biology	TEAM Exhibit: J22
	The Tell-Tale Hearts	
Somerville	Somerville High School	Region: 4
Torres, Gabriel	Discipline : Environmental Science	TEAM Exhibit: P4
	Effect of Ammonium Sulfate on the Thoracic Movement of Daphnia Magna	

South Boston	Excel High	Region: 6
Chalvire , Gamael	Discipline : Environmental Science	Exhibit: P3
	Eggshells vs. Coffee Ground	
South Easton	Southeastern Reg. Voc-Tech. H S	Region: 5
Ural, Barut	Discipline : Physics & Electronics	Exhibit: C26
	Effects of Aerodynamics and Buoyancy on Pendulum Motion	
South Easton	Southeastern Reg. Voc-Tech. H S	Region: 5
Wold-Grover, Ariana	Discipline : Biology	TEAM Exhibit: D8
	What Are You Eating?	
Southboro	St. Mark's School	Region: 2
Allen, William	Discipline : Biology	Exhibit: K12
	Dietary Effects on Immunosuppressant Cytokines in Drosophila	
Southborough	St. Mark's School	Region: 2
Haugen, Sophie	Discipline : Biology	TEAM Exhibit: A15
	Oxidative Stress and Neurodegeneration in Alzheimer's Disease	
Southborough	St. Mark's School	Region: 2
Thalmann, Jack	Discipline : Biology	Exhibit: J23
	Nutrition of Drosophila on Sex-Linked Inheritance of l(2)gl Mutation.	
Southborough	St. Mark's School	Region: 2
Nichols-Worley, Sada	Discipline : Biology	TEAM Exhibit: A15
	Oxidative Stress and Neurodegeneration in Alzheimer's Disease	
Southborough	St. Mark's School	Region: 2
Liu, Mo	Discipline : Biology	Exhibit: B4
	Germination of Mung Bean and Maize at Low Pressure	
Southborough	St. Mark's School	Region: 2
Choi, Jiwon	Discipline : Engineering	Exhibit: A5
	Pressure-Assisted Bioprinting	
Stockbridge	Berkshire Waldorf High School	Region: 1
Louw, Roman	Discipline : Environmental Science	Exhibit: P26
	Microplastics in Shrimp: Farmed vs. Wild	
Stoughton	Stoughton High School	Region: 5
Billo, Tess	Discipline : Biology	Exhibit: H26
	Can You Go "All Natural" With Antibiotics?	
Stoughton	Stoughton High School	Region: 5
Smith, Thomas	Discipline : Computers	Exhibit: J25
	Using Machine Learning to Predict the Stock Market	

Stoughton	Stoughton High School	Region: 5
Loffredo, Alessandra	Discipline : Chemistry	TEAM Exhibit: P18
	How the pH of a Consumed Beverage Affects Drug Solubility	
Stoughton	Stoughton High School	Region: 5
Podesta, Jessica	Discipline : Chemistry	TEAM Exhibit: P18
	How the pH of a Consumed Beverage Affects Drug Solubility	
Sudbury	Lincoln-Sudbury Reg. H. S.	Region: 2
Terpstra, Irene	Discipline : Engineering	Exhibit: D28
	Handriod	
Swansea	Joseph Case High School	Region: 3
Brown, Zachary	Discipline : Physics & Electronics	TEAM Exhibit: G8
	How Far Away from a Tesla Coil Can a Light Bulb Be Illuminated?	
Swansea	Joseph Case High School	Region: 3
Martelly, Logan	Discipline : Physics & Electronics	TEAM Exhibit: G8
	How Far Away from a Tesla Coil Can a Light Bulb Be Illuminated?	
Taunton	Taunton High School	Region: 3
Colon, Emily	Discipline : Behavioral Science	Exhibit: K11
	Accuracy of Eyewitness Testimony	
Taunton	Taunton High School	Region: 3
Kullas, Dylan	Discipline : Engineering	TEAM Exhibit: K1
	Can Robot Technology Help the Visually Impaired Navigate Independently	
Taunton	Taunton High School	Region: 3
Weber, Olivia	Discipline : Chemistry	Exhibit: F20
	Minimizing Bacteria in Thawing of Meat	
Taunton	Taunton High School	Region: 3
O'Gara, Emily	Discipline : Biology	Exhibit: P10
	The Effect of Spices to Inhibit Bacterial Growth	
Taunton	Taunton High School	Region: 3
Tavares, Nolan	Discipline : Biology	Exhibit: P11
	Do Different Dilutions of Disinfectants Affect Bacterial Resistance?	
Taunton	Taunton High School	Region: 3
Wong, Alice	Discipline : Biology	Exhibit: C28
	Environmental Factors on Cellular Respiration Rates	
Taunton	Taunton High School	Region: 3
Sanborn, Kaylen	Discipline : Biology	Exhibit: J20
	The Effects of CO2 on Plant Growth	

Waltham	Gann Academy	Region: 4
Gliklich, Jennifer	Discipline : Behavioral Science	Exhibit: P16
	Do Parents Text and Drive with Children in Their Cars?	
Wareham	Wareham High School	Region: 5
Beach, Carlisle	Discipline : Computers	Exhibit: F24
	Assistance for the Ethical Hacker	
West Roxbury	Urban Science Academy	Region: 6
Pena, Citlali	Discipline : Chemistry	TEAM Exhibit: N28
	Plant Based Dye vs. Chemical Based Dye	
West Roxbury	Urban Science Academy	Region: 6
Zizi, Berlinda	Discipline : Chemistry	TEAM Exhibit: N28
	Plant Based Dye vs. Chemical Based Dye	
West Roxbury	Urban Science Academy	Region: 6
Marroquin, Dixon	Discipline : Chemistry	TEAM Exhibit: N28
	Plant Based Dye vs. Chemical Based Dye	
Westborough	Westborough High School	Region: 2
Perumal, Neha	Discipline : Biology	Exhibit: D3
	The Effects of Ibuprofen on Motor Function in Drosophila Melanogaster	
Westborough	Westborough High School	Region: 2
Sane, Eshan	Discipline : Biochemistry	TEAM Exhibit: B15
	Designing A Thyroid Hormone Detection System	
Westborough	Westborough High School	Region: 2
Wadekar, Adway	Discipline : Behavioral Science	Exhibit: A2
	The Demographic Divide in Advanced Placement Subjects	
Westborough	Westborough High School	Region: 2
Patta, Anoop	Discipline : Biochemistry	TEAM Exhibit: B15
	Designing A Thyroid Hormone Detection System	
Westborough	Westborough High School	Region: 2
Sadagopan, Ananthan	Discipline : Chemistry	Exhibit: B16
	Constrained Chemical Descriptor Based QSAR	
Westfield	Westfield High School	Region: 1
Regnier, Elizabeth	Discipline : Biology	TEAM Exhibit: A22
	The Effect of Temperature Stimulus on Drosophila Melanogaster Activity Level and Reproduction Rate	
Westfield	Westfield High School	Region: 1
Diltz, Jackson	Discipline : Engineering	TEAM Exhibit: B18
	Magnetic vs. Electromagnetic Helmets	

Westfield	Westfield High School	Region: 1
Morrissey, Catherine	Discipline : Biology	TEAM Exhibit: A22
The Effect of Temperature Stimulus on Drosophila Melanogaster Activity Level and Reproduction Rate		
Westfield	Westfield High School	Region: 1
Moriarty, Brigid	Discipline : Biochemistry	Exhibit: D2
Effects of Phone Screens on the Eyes		
Westfield	Westfield High School	Region: 1
Coffey, Liam	Discipline : Engineering	TEAM Exhibit: B19
Maximizing Wind Power Efficiency Using Nosecones		
Westfield	Westfield High School	Region: 1
Chisholm, Aiden	Discipline : Biology	TEAM Exhibit: B20
Analysis of Microbes Cultured From Keys of a Computer		
Westfield	Westfield High School	Region: 1
Orszulak, Adrian	Discipline : Engineering	TEAM Exhibit: C2
Designing a Lead Test Kit: A Solution to the Shortcomings of Others		
Westfield	Westfield High School	Region: 1
McCaffery, Kyle	Discipline : Physics & Electronics	Exhibit: D4
Conductivity and Weight, Copper, Aluminum, Maybe Both.		
Westfield	Westfield High School	Region: 1
Morrissey, Brendan	Discipline : Biology	TEAM Exhibit: B20
Analysis of Microbes Cultured From Keys of a Computer		
Westfield	Westfield High School	Region: 1
Medeiros, Zachary	Discipline : Engineering	TEAM Exhibit: B19
Maximizing Wind Power Efficiency Using Nosecones		
Westfield	Westfield High School	Region: 1
Gustafson, Jason	Discipline : Engineering	Exhibit: C1
Helio Tracker		
Westfield	Westfield High School	Region: 1
Peloquin, John	Discipline : Biology	Exhibit: C6
How Much Bacteria is Growing in Your Pouf?		
Westfield	Westfield High School	Region: 1
Stawasz, Kristen	Discipline : Engineering	TEAM Exhibit: C2
Designing a Lead Test Kit: A Solution to the Shortcomings of Others		
Westfield	Westfield High School	Region: 1
Suhocki, Renee	Discipline : Physics & Electronics	Exhibit: C15
Comparing the Cost, Longevity and Voltage of 3 Different Battery Types		

Westfield	Westfield High School	Region: 1
Bone, Eric	Discipline : Engineering	TEAM Exhibit: B18
	Magnetic vs. Electromagnetic Helmets	
Westfield	Westfield High School	Region: 1
Chang, Donald	Discipline : Engineering	Exhibit: D16
	The Purifying Effect of Graphene Coated Sand on Water Samples	
Westfield	Westfield High School	Region: 1
Sundararajan, Suvin	Discipline : Chemistry	Exhibit: B17
	The Effect of Household Substances on Biodegradable Plastic	
Weston	Weston High School	Region: 5
Laufer, Alexandra	Discipline : Biology	Exhibit: H1
	Where Did All The Males Go?	
Weston	Weston High School	Region: 5
Chen, Benjamin	Discipline : Computers	Exhibit: F21
	Using Machine Learning to Predict Where a Reddit User Posts Most	
Winthrop	Winthrop Sr. High School	Region: 4
Preble, Brandon	Discipline : Engineering	TEAM Exhibit: P7
	Hinged Counterweight Trebuchet	
Winthrop	Winthrop Sr. High School	Region: 4
Sullivan, Patrick	Discipline : Engineering	TEAM Exhibit: P7
	Hinged Counterweight Trebuchet	
Winthrop	Winthrop Sr. High School	Region: 4
Simon, Andreas	Discipline : Engineering	TEAM Exhibit: P7
	Hinged Counterweight Trebuchet	
Worcester	Worcester Academy	Region: 2
Krishnan, Rohan	Discipline : Behavioral Science	Exhibit: F27
	Effect of Gun Control on Mass Shootings	
Worcester	Mass. Academy of Math & Science	Region: 2
Mehta, Rishab	Discipline : Engineering	Exhibit: A6
	Air Warming Device for Asthmatics	
Worcester	Worcester Academy	Region: 2
Adiletta, Jack	Discipline : Engineering	Exhibit: B21
	Building a Robotic Hand That Can Do Sign Language	
Worcester	Burncoat Senior H.S.	Region: 2
Le, Christina	Discipline : Engineering	TEAM Exhibit: P6
	Biodegradable Water Bottles	

Worcester	Bancroft School	Region: 2
Danga, Lazi	Discipline : Environmental Science	Exhibit: C18
	Reaction of SO2 with Cement and Impact on Chloride Induced Degradation	
Worcester	Mass. Academy of Math & Science	Region: 2
Fang, Joyce	Discipline : Computers	Exhibit: B22
	MelaNOma: Application-Based Melanoma Detection Using Machine Learning	
Worcester	Mass. Academy of Math & Science	Region: 2
Kundu, Piyusha	Discipline : Biology	Exhibit: A16
	Identifying Proteins Associated with Mitotic Defects in pRB Pathway	
Worcester	Burncoat Senior H.S.	Region: 2
Jude, Sadie	Discipline : Engineering	Exhibit: J5
	Making Battery Life Efficient	
Worcester	Doherty Memorial H. S.	Region: 2
Hoxha, Sokol	Discipline : Biochemistry	Exhibit: H10
	Is Organic Really Organic?	
Worcester	Bancroft School	Region: 2
Huang, RuiPei	Discipline : Physics & Electronics	Exhibit: A26
	Laternfish: A Low-Cost Industrial Gripper to Optimize Gripping Force	
Worcester	Mass. Academy of Math & Science	Region: 2
Hobson, Sydney	Discipline : Biology	Exhibit: A17
	Alternate Allergy Testing for Eosinophilic Esophagitis	
Worcester	Worcester Technical High School	Region: 2
Rivera, Yomari	Discipline : Biology	Exhibit: G15
	Does Dehydration Affect Your Innate Imune System?	
Worcester	Mass. Academy of Math & Science	Region: 2
Kim, Jennifer	Discipline : Behavioral Science	Exhibit: B5
	The Behavioral Effect of Light Stimulation on apl-1 Mutant C. elegans	
Worcester	Mass. Academy of Math & Science	Region: 2
Langille, Marissa	Discipline : Engineering	Exhibit: A14
	Aim Flex Run: Engineering a New Pepper Spray Device	
Worcester	Mass. Academy of Math & Science	Region: 2
Penubarthi, Vishnu	Discipline : Computers	Exhibit: A7
	EmerSave: A Novel Crowdsourcing Emergency Response Application	
Worcester	Burncoat Senior H.S.	Region: 2
Vallejo, Sofia	Discipline : Engineering	TEAM Exhibit: P6
	Biodegradable Water Bottles	

Worcester	Mass. Academy of Math & Science	Region: 2
Nandyalam, Gayathri	Discipline : Biology	Exhibit: B7
	Activity of the Basal Ganglia in Schizophrenia and Bipolar Disorder	
Worcester	Mass. Academy of Math & Science	Region: 2
Nathan, Krish	Discipline : Computers	Exhibit: A19
	Developing An Algorithm for Feature Detection in Noisy Medical Images	
Worcester	Mass. Academy of Math & Science	Region: 2
Rajesh, Sreshtaa	Discipline : Engineering	Exhibit: A9
	Brace for Impact! A Joint-Bleed Detection Device for Hemophiliacs	
Worcester	Worcester Technical High School	Region: 2
Torkornoo, Justice	Discipline : Computers	Exhibit: D26
	JARVIS, My Homemade Digital Assistant	
Worcester	Mass. Academy of Math & Science	Region: 2
Wren, Abigail	Discipline : Behavioral Science	Exhibit: A4
	Psychotropic Medications and Suicidal Ideation During Pregnancy	
Worcester	Mass. Academy of Math & Science	Region: 2
Kantrowitz, Hava	Discipline : Computers	Exhibit: A20
	Dewey Wins: Predicting United States Presidential Elections	
Worcester	Bancroft School	Region: 2
Chase, Milo	Discipline : Chemistry	Exhibit: B1
	Improving Water Desalination: Enhancing Shock Electrodialysis	
Worcester	Worcester Academy	Region: 2
Thirumalai, Amrita	Discipline : Physics & Electronics	Exhibit: N7
	Geomagnetic Field Strength Measurement	
Worcester	Bancroft School	Region: 2
Mehta, Karan	Discipline : Biochemistry	Exhibit: B2
	Using siRNAs to Promote Homology-Directed DNA Repair	
Worcester	Worcester Academy	Region: 2
Adiletta, Andrew	Discipline : Engineering	Exhibit: B14
	A Study in Mechanics and Processing for Chess	

Section 4 - Page 32 of 32

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

EXTENDING A GRACIOUS WELCOME TO OUR INTERNATIONAL EXHIBITORS

As part of a global collaboration between science and engineering fairs, MSSEF extends a warm welcome to three high school students from Beijing, China. This collaboration is the first of its kind in science fair history to have future world talents from two countries work together for a common goal. In today's world, there are so many diseases, energy needs, climate changes, hunger/nutrition and other major issues that will require cooperative work between nations, and we hope that students can begin to work this way at an early age. We thank the US China Scitech Education Promotion Association for arranging for the Beijing students to attend the 2018 Massachusetts State Science & Engineering Fair, and we encourage our Massachusetts students to extend a warm welcome to the delegates.

Introducing the Beijing Student Delegation

A10 **XiaoQiu An**
Engineering
Beijing Number 166 High School
Artificially Intelligent Video Processing System To Assist The Blind With Obstacle Avoidance

According to the Chinese National Bureau of statistics, in 2014 China had a population of approximately 600-700 million legally blind persons, and as the general population grows, this number is sure to grow over time as well. Currently, more than half of this group does not have personal care service, and they often need to go outside alone on a daily basis. However, blind people face serious inconveniences as well as potentially dangerous threats, due to obstacles when they move about public areas. For instance, when they need to rest, they may wish to sit on a public bench, however some public benches are not properly maintained, and there may be items or people already seated on the bench. Tools to aid the blind, such as walking sticks and guide dogs are unable to help with this, so quite often, blind people have to give up the right to sit on the public bench. This makes it more difficult for them to go out, and serves as a psychological barrier to their desire to participate in society, which is a detriment to their well being and overall quality of life. In addition, lack of fully handicapped-accessible public facilities creates societal inequity and is a violation of laws both in China and the U.S. which promote equal access to publicly owned assets for all members of the community. However, without considerable investment into equipment and infrastructure at parks, and/or without support staff, or improved personal individual care, solving such problems proves to be difficult without a portable device that can assist the blind in avoiding such common obstacles in their everyday lives.

As such, for a small scale demonstration of a system which can assist the blind in identifying and/or avoiding obstacles in their everyday life, I propose designing a smart, artificially intelligent device which uses visual cues to assist blind people judge in determining whether or not someone is sitting on a bench, in addition to other potential obstacles. The prototype I have designed uses high resolution, fast-speed image recognition technology combined with machine learning algorithms to be able to identify benches within a public park environment, and to classify

(Continued on next page)

whether or not the bench is completely empty, partly empty or if there are any other obstacles which may prevent a person from sitting comfortably. I have used pre-collected visual and video samples to train the system (including various kinds of seated and non-seated benches under different visual circumstances, such various weather conditions and times of day). A Raspberry Pi was used as the platform for my preliminary algorithm, along with relevant training data, and a high resolution camera in order to achieve high precision recognition of potential bench obstacles, and it also contains a modular extension to notify the user via auditory and/or other signals. The system was tested in a real world environment, using real benches in various public parks, in order to demonstrate the overall effectiveness of the system. This system may have the potential to expand, to assist the blind with other more crucial daily matters, such as navigating sidewalks through high traffic areas, banking, visiting the hospital, obtaining food at the supermarket, and/or emergency situations. Preliminary data shows that the system indeed shows real promise as a potential low cost and scalable solution to enhance everyday safety for blind people in public environments, within the near future.

C10 Chenyue Guo
Biology
Beijing Number 4 High School
Improving MOOC Learning via Implicit Physiological Signal Sensing

Massive Open Online Courses (MOOCs) have attracted over 700 universities and 58 million registered learners worldwide according to 2017 data. They are changing the landscape of how people learn by providing high-quality educational content in a large scale at low cost. More importantly, MOOC learners have control over what, when and how they learn. A major portion of learners has reported both career benefits and educational benefits after finishing MOOCs. Despite the great potential, today's MOOCs still suffer from low completion rates, low engagement, little personalization, and lack of instructor-student interaction. Such "one-size-fits-all" dilemma was caused, at least in part, by three reasons. First, comparing with traditional classroom education, MOOC learning usually happens in highly diversified environments and highly interruptive contexts. Second, instructors in MOOCs no longer have access to important cues such as raised hands or facial expressions at the time of teaching. As a result, he/she cannot fully understand students' learning progress. Third, it is challenging to design fine-grained assessment mechanisms in MOOC learning.

In this project, I propose novel methods to improve MOOC Learning via implicit physiological signal sensing. Specifically, I use functional near-infrared spectroscopy (fNIRS) to detect learners' attention, cognitive workloads, as well as perceived difficulty levels during lecture watching sessions. fNIRS is a noninvasive and lightweight device that detects changes in oxygenated and deoxygenated blood in a region of the brain by using optical fiber to emit near-infrared light, which can reflect a variety of cognitive states of humans. Moreover, I propose an intervention technology—an adaptive review interface to recommend lecture topics that learners might benefit most based on the inference of their dynamic cognitive states. I also propose an instructor-side dashboard, which presents the aggregated view of students' learning states (e.g., attention levels) synchronized with the learning material to help them improve their syllabus and teaching style. The preliminary results show that such an approach can benefit both instructors and students in MOOC environments.

F10 Yunting Yan
Engineering
Beijing Number 35 High School
Structural Design and Analysis of Morphing Aerodynamic Surface

According to recent estimates, there are over 100,000 commercial airline flights every single day, in addition to military, recreational and other types of flights. Airplanes are a major source of atmospheric pollution throughout the world, and this problem continues to grow as globalization expands and travel increases. With the development of novel carbon, polymer and composite materials and new mechanical and structural engineering advances in aerospace, there has been considerable interest in applying these new technologies to the improvement of aircraft efficiency. Improvements in wing design, in particular flexible wings, have the potential not only to improve aircraft performance and safety, but also to reduce the costs of air travel while at the same time reducing pollution.

(Continued on next page)

Yunting Yan ***(continued)***

Traditional aircraft wings are comprised of spoilers, flaps and ailerons which are mechanically complex, and create a high level of drag, thus making flights slower and increasing fuel consumption. Whereas morphing wings contain no major joints or other obstructions to wind flow, and thus are more aerodynamic, and can more evenly bear physical forces from wind and weather. This field of research is currently being actively studied by NASA and the defense industry as well as the commercial airline industry.

As such, this project focuses on the application of FEA (Finite Element Analysis) to a number of novel morphing wing designs, in order to determine an approach that will yield the highest efficiencies, with the best potential for scalability. In addition, physical aircraft models incorporating these designs were created to study the effects of the overall structure of morphing aerodynamic surfaces, employed to optimize the aircraft's aerodynamic efficiency, within a simulated real-world environment. Based on both theoretical computer models as well as collected wind tunnel data and prototype flight tests, my newly created wing designs have demonstrated that morphing aerodynamic surfaces not only reduce drag, but also appear to increase the handling of the aircraft by a significant margin, as compared to equivalent conventional wing designs. This creates lower stress on aircraft parts, and thus has the potential to provide a longer service life with lower overall maintenance, in addition to numerous other global-scale environmental and economic benefits.

// END //

2018 Project Abstracts

This Section contains abstracts for the exhibited projects and are presented by the Discipline.

April 13, 2018

Disciplines

Behavioral Science

Behavioral Science

A1 Neuroprotective Effect of Caffeine on a TBI-induced Drosophila model
A2 The Demographic Divide in Advanced Placement Subjects
A4 Psychotropic Medications and Suicidal Ideation During Pregnancy
B5 The Behavioral Effect of Light Stimulation on apl-1 Mutant C. elegans
B13 Staring Contest: An App For Teaching Eye Contact
C16 Racial Differences in Brain Response to Errors
C23 How Effective is Your Brain Mapping Experience?
D7 Ready. Set. GO!
F2 Do People of Different Ages Have Different Fears?
F11 The Solar Powered Sea Slug
F27 Effect of Gun Control on Mass Shootings
G1 Pen and Paper vs. iPad and Stylus
H12 What Is To Blame For Depression?
H13 Effects of Stress on Neuroanatomical Functionality
H16 Memory: Encoding to Retrieval
K11 Accuracy of Eyewitness Testimony
K19 An Analysis of Social Media and Subjective Well Being in Adolescents
N10 Effects of Static and Dynamic Stretching in Athletes
N24 Physiological Analysis of Stress Response on Individuals
P2 The Problem With Google
P16 Do Parents Text and Drive with Children in Their Cars?
P23 Monochromatic Colors

A1 Neuroprotective Effect of Caffeine on a TBI-induced Drosophila model

Behavioral Science
Amma Agyei
Assabet Valley Voc. H. S.

Caffeine is hypothesized to protect against neurodegenerative diseases such as Alzheimer's Disease and Parkinson's disease. There is insufficient data to support this hypothesis and no research has been conducted to determine if caffeine protects against traumatic brain injury. Given the recent scare and increasing cases of chronic traumatic encephalopathy in deceased NFL footballers, there is a need to find a solution to this problem. Female D. melanogaster were divided into three groups (Group A-control, Group B- no caffeine but trauma, Group C- chronic caffeine treatment) and trained in a t-maze using an aversive phototaxis suppression assay. A learning score of the various groups was obtained and a brain injury was inflicted on the fruit flies using a HIT device. A learning score was recorded again after the injury and the groups were compared. A negative geotaxis assay was used to assess the locomotor capabilities of the various groups. It was determined that caffeine significantly increased the learning score, memory, and survival rate of the fruit flies after the brain injury, and improved their locomotor abilities. In the future, male fruit flies and different strains of fruit flies will be tested. Also, an imaging assay will be performed using autofluorescence confocal microscopy to view specific proteins in the dissected brains of the flies.

A2 The Demographic Divide in Advanced Placement Subjects

Behavioral Science
Adway Wadekar
Westborough High School

This project investigates whether various demographic groups show a significant difference in performance in AP subjects, using data from the May 2016 AP examination. Initially, three demographic variables and their underlying sub-groups were considered: gender (male, female), grade (juniors, seniors), and ethnicity (white, Asian, African-American, Hispanic). A visual comparison of subject-wise mean AP scores eliminated African-Americans and Hispanic students from further analysis, because these two sub-groups score much lower compared to white and Asian students. Next, the z-test, at a significance level of 0.05, was used to test the hypotheses that the difference in the average scores of juniors vs. seniors, males vs. females, and white vs. Asian students is statistically significant. Although the z-test identified subjects where the average scores differ significantly, it was not adequate to quantify the size of this difference. Therefore, Cohen's d effect size was used to identify subjects where the difference in the average scores is significant but trivial, or significant and non-trivial. The results indicate that a demographic divide exists in the AP curriculum. Juniors outperform seniors; may be because junior year scores are crucial to college admissions. Males perform significantly better in theoretical, math, and science subjects while females perform only slightly better in art and languages; possibly because society inadvertently encourages these gender stereotypes. Finally, Asian students outperform white students in every subject with a statistically significant difference, debunking the myth that Asian students only excel at math and science. Some policy suggestions, based on these findings taken together with existing research are offered.

A4 Psychotropic Medications and Suicidal Ideation During Pregnancy

Behavioral Science
Abigail Wren
Mass. Academy of Math & Science

During pregnancy, women with mental illnesses may stop taking their psychotropic medications. The purpose of this study was to investigate the association between continued prescribed psychotropic medication use and suicidal ideation during pregnancy. Data from the National Survey of Drug Use and Health, years 2010 through 2014, were analyzed. SAS 9.4 was used to clean and analyze the data. A chi-square test for independence was used to analyze the population of survey respondents who had been diagnosed with an anxiety or depressive disorder in the past and had taken prescribed psychotropic medication before becoming pregnant. No evidence of an association between psychotropic medication use and suicidal ideation during the gestational period was found ($p = 0.9808$). Results were adjusted for the confounding variables annual income, maternal age, trimester of pregnancy, and psychotherapy treatment. The findings of this investigation suggested that continued use of prescribed psychotropic medications during pregnancy does not decrease the probability of suicidal ideation.

B5 The Behavioral Effect of Light Stimulation on apl-1 Mutant C. elegans

Behavioral Science
Jennifer Kim
Mass. Academy of Math & Science

Alzheimer's disease, the 6th leading cause of death among Americans, is a neurodegenerative disorder that causes learning and memory deficits. Recent research has revealed that exposure to specific light frequencies reduces amyloid precursor protein (APP) plaque accumulation, one of the main indicators of the disease. However, information on behavioral effects is still needed. Mutations in the amyloid precursor-like (apl-1) gene, a worm homolog of APP, causes abnormalities in locomotion. This study investigated whether improvements in locomotion and longevity would occur in the apl-1 mutant C. elegans treated with light stimulation, as compared to those in the non-treated control groups. Wild type and apl-1 mutants were exposed to LED lights programmed at 30, 40, and 50 Hz. The worms' speeds were subsequently recorded using video tracking technology. An analysis of variance yielded an overall p-value of 1.1102x10¬-16 for speed, indicating that the treatment significantly affected worm behavior. The longevity of the worms was not affected by the light stimulation. The results suggest that this new innovative light treatment may be effective in treating Alzheimer's disease.

B13 Staring Contest: An App For Teaching Eye Contact

Behavioral Science
Ashwin Sukthankar
St. John's High School

Eye contact is an essential aspect of communication and social interaction. Children with autism have trouble with maintaining or making eye contact. Eye tracking technology is available but can be very expensive and not easily accessible. This project is about creating software using commercially available eye trackers to help enhance eye contact for kids with autism. Two prototypes were created. Both prototypes used a Tobii EyeX (eye tracker), a laptop, Unity, and Visual C#, and their feasibility was tested with seven people. Feedback was positive and several improvements were requested and will be incorporated into the second phase of this project.

C16 Racial Differences in Brain Response to Errors

Behavioral Science
Clara Li
Phillips Academy

Although cultural differences have been well documented on a behavioral level, how these differences manifest on a neural level is less known. Previous studies have demonstrated cultural differences between cohorts of Americans and East Asians in delay discounting, intergroup empathy, and general/contextual self-judgments, among other exercises. These processes were found to correlate with specific areas of the brain in both Asians and Americans, with heightened neural responses varying from group to group within each task. To further address this neural manifestation of culture, I investigated the cultural and racial differences in brain response to error commissions. 168 Caucasians and 28 Asians were recruited in completing a stop signal task, during a functional magnetic resonance imaging or fMRI scan. Asians and Caucasians were found to perform similarly in the stop signal task; they were equally fast in responding to the go signal and similarly accurate in stopping the response in stop trials. However, Asians showed higher activity compared to Caucasians in the anterior cingulate cortex (ACC) during errors. The ACC is part of the so-called "saliency" circuit of the brain. The disparity suggests that errors are more salient and physiologically arousing in Asians than in Caucasians. The finding indicates racial differences in basic cognitive and emotional response, and can perhaps also explain why Asians prefer "calm" and "comfort" whereas Caucasians prefer "exhilaration" and "excitement". This difference suggests that distinctions in the values cultivated by Western and Eastern cultures have translated directly onto a neuronal scale for the participants of either culture. With this study,I hope to add to the growing literature surrounding cultural neuroscience.

C23 How Effective is Your Brain Mapping Experience?

Behavioral Science
Ooviya Sathiyamoorthy, Daniela Contrera
East Boston High School

The goal of this study is to investigate changes in brain waves and their influence on different lobes of brain, by measuring any change in positive and negative valence and high and low arousal, and to quantify these measurements on individual brain maps. Thirty test subjects, of various ages and genders, are tested over a ten-day time frame. Each subject is prepared for testing and data collection using the GTEC® EEG platform and Gamma Box amplifier. The electrodes are connected with wires to the amplifier and the various brain waves are recorded on the GUI program (or Graphical User Interface program) on a laptop computer. Each test subject observes a series of eighty separate images for fifteen minutes. These images originate from the International Affective Picture System (IAPS). IAPS is a database that provides a set of normative emotional images for experimental investigations on valence and arousal. The images displayed represent three different types of scales: positive, neutral and negative. Using the GUI, subjects are given three seconds to observe an image and prompted to rate the picture as (1) unpleasant, (4) neutral or (7) pleasant by pressing on the corresponding numerical key. A one second delay is then provided, and afterward, the subject is prepared for the next image by observing a large red cross. Each test subject is monitored throughout the experiment for electrophysiological measurements including positive and negative valence and arousal. After data collection, statistical analysis are completed including the p-value for each subject and a t-test is calculated as part of the comparison between the classes. It was determined that the classes were significant with regards to their brain effect as the p-values for the classes were near zero.

D7 Ready. Set. GO!

Behavioral Science
Elias Rotondo
Upper Cape Cod Voc-Tec. H. S.

The purpose of this experiment is to determine what driving condition results in the fastest reaction time. This experiment will determine which audio condition results in the fastest reaction time. The tested conditions are no outside influence, music with lyrics, music without lyrics, radio talk show, and conversation. The hypothesis is that the effect of outside influences on the speed of reaction time will support that music without lyrics will result in the fastest reaction time.
The experiment consisted of five sub-trials per condition per subject. The subjects were informed how the experiment would run and instructed on how to use an online reaction time tester. The software simulates a car at a red light and records one's reaction time to the change in light color. After completing a set of sub-trials, the average was found for the condition and recorded in a table that would be used to compare all the average condition reaction times.
The analysis of the data revealed many findings in regard to the experiment. Music without lyrics proved to result in the fastest average reaction time after removing the outlier subject from the group. A limitation of the experiment is that due to safety reasons, a real car and stop light could not be used for testing. To improve the experiment, executing the experiment in a controlled environment using a car and stop lights would result in more realistic finds. The final results of the experiment conclude that the condition that produces the fastest average reaction times is music without lyrics. The data supports the hypothesis, as the results show that music without lyrics produces the fastest average reaction time. Future research for this experiment would be to test more conditions.

F2 Do People of Different Ages Have Different Fears?

Behavioral Science
Mary Woods
Bishop Feehan High School

Fear is one of two things that move the world. It is felt by all sentient beings and motivated their decisions. It originates in the amygdala, a part of the brain. Understanding fear and how it evolves over age can lead to breakthroughs in psychology and neuroscience. This experiment tests whether or not people of different ages fear different things. To test this, participants of a variety of ages filled out a survey asking their age and whether they were most afraid of heights, snake/spiders, the feeling or being trapped, rejection, or humiliation. The prediction was that participants ages 13- 20 would be more afraid of rejection and humiliation that participants in other age groups. After all the surveys were collected, the results showed that the leading fear in teenagers was rejection, which was the least common fear in participants ages 0-12 and 21 and up. The same number of participants ages 13-10 and 21 and up were afraid of rejection. Overall, the hypothesis was proven correct. The most common fear of participants ages 0-12 was snakes/spiders. Participants ages 21 and up were most afraid of the feeling of being trapped. 25% percent of all participants were afraid of snakes/spiders. The same amount voted for the feeling of being trapped. Humiliation was the least feared overall, with 17% of the total vote.

F11 The Solar Powered Sea Slug

Behavioral Science
Mila Manic
Plymouth South High School

How does the amount of time spent in light or darkness affect the circadian rhythms of Elysia chlorotica? This lab analyzes how changing the amount of time Elysia chlorotica sea slugs are under a fluorescent light or in complete darkness during the day affect their circadian rhythms. The circadian rhythms of this sea slug are measured through their parapodial lobe movement based off a rank system. This rank system determines how open or closed their parapodia are in correlation with the amount of surface area being exposed to light. The more open and flattened out the parapodia is, the more light access each chloroplast has, determining the amount of energy synthesized. When natural light times and intensity become manipulated and reversed, the circadian rhythms of E. chlorotica should change; the pattern of movement amongst the parapodial lobe will be abnormal. By analyzing natural light, light to dark using a fluorescent light, and dark to light using a synthetic black curtain over a span of 3 weeks, scientists determined if the circadian rhythms of E. chlorotica would change. Recording parapodia position from each different light regime and then comparing it concluded if this could occur. During this lab it was confirmed that the circadian rhythms of E. chlorotica could indeed be changed and altered when the amount of time spent in light or darkness was manipulated. If a photosynthetic sea slugs circadian rhythms can be manipulated in 3 weeks, imagine the impact our own artificial lighting has has on our bodies for our entire life span.

F27 Effect of Gun Control on Mass Shootings

Behavioral Science
Rohan Krishnan
Worcester Academy

The purpose of this project to show a strong correlation between domestic violence and mass shootings through a thorough analysis of these two issues. Data from multiple sources such as FBI supplementary reports, Congressional Research Reports, Everytown,and Mother Jones reports on mass shootings in the last 20 years(1998-2017) was extensively analyzed. The analysis leads to the conclusion that roughly 36% of these mass shootings had a strong correlation to domestic violence meaning that the shooting itself was either a case of domestic violence or the shooter had previously been reported for domestic violence against a spouse or family member. in order to address this serious issue, a package of legislative proposals already implemented successfully in several states, is proposed as a part of this research. These include the following: (1) ERPO (Extreme Risk Protection Order), a bill that essentially allows family members to notify police if a gun owner exhibits dangerous aggressive behavior that may put themselves or others around them in danger and thereby allows law enforcement to confiscate their guns for a temporary period of time; (2) 'Closing the boyfriend loophole' in the Lautenberg Amendment that allows boyfriends who have a restraining order against them to obtain a firearm without any restrictions because the law only applies to marital relationships and (3) legislation that allows law enforcement and the judicial courts to remove firearms from domestic violence offenders. Currently domestic violence offenders are prohibited from buying guns, but some states do not confiscate previously owned firearms. These common sense legislative approaches, which enjoy bipartisan support can significantly reduce mass shootings in America.

G1 Pen and Paper vs. iPad and Stylus

Behavioral Science
Ricky Stanton
Bishop Feehan High School

The purpose of this experiment was to see if there is a difference in performance on quizzes between handwriting notes on paper or handwriting notes on an iPad. If a student chooses to hand write notes on an iPad rather than on paper, then they will experience the same benefits of taking notes on paper, and will also finish their notes and quizzes quicker. If one were to do this experiment, first they would gain consent from a student. Then, they would give them two sheets of notes and have them take notes either on paper or an iPad, with a time limit of 25 minutes. Following a 20 minute break in between notes and the quiz, the student will have 15 minutes to complete a short two page quiz on the subject they just took notes on. The expected outcome is that the average grade on the quiz of people who took notes on paper versus those who took notes on an iPad will be within two points of each other, and that the ones who took notes on an iPad will also finish the notes and quizzes faster than the paper note-takers. Some significant results are that the average grade of paper note-takers is 52.02%, while the average grade of iPad note-takers is 51.6%. Furthermore, the iPad note-takers finish taking notes with an average of 7:34.26 left, while the paper note-takers finish with an average of 6:45.64 left.

H12 What Is To Blame For Depression?

Behavioral Science
Dania Halak
Revere High School

To slow down the rapid increase of depression rates that have been occurring in the last few decades, more research is needed. For that, my project focuses on the accuracy of the polygenic risk score in predicting depressive symptoms; more specifically questioning whether the polygenic risk score can predict those symptoms better with environmental factors or on its own. Considering that previous research has concluded that genetics account for only 44% of depressive symptoms, my hypothesis was that, at 8 years old, environmental factors help to predict risk for depressive symptoms along with a polygenetic risk score better than the polygenetic risk score alone. To explore the question, two models were built: the first one did not include environmental factors while the second one included a variety. The models were compared by running linear regressions. First, data of 8-year-old children that filled out the Strength and Difficulties Questionnaire -used to assess depressive symptoms - was collected from ALSPAC. Second, that data was filtered to make sure all samples had the variables in the models. Third, A linear regression was run of their SDQ scores by their base (PRS, race, sex), and then a second set of linear regression was run including the environmental factors. Lastly, an r-squared and p-value were recorded for each model run. Results showed that all models had a p-value less than 0.001 indicating that the results of the models were significant. Therefore, the models were compared by r-squared. Model 1's r-squared value was 2.10%, while Model 2's r-squared value jumped to 8.68 %, thus clearly supporting my hypothesis of the polygenic risk score predicting depressive risks more accurately with environmental factors than without.

H13 Effects of Stress on Neuroanatomical Functionality

Behavioral Science
Meredith Blaise
Bishop Feehan High School

Stress, from chronic mild to acute severe conditions, has extreme negative consequences. The purpose of this study is to explore the psychosomatic and pathological consequences of stress on the brain by observing neurochemical and spatial patterns while testing cognitive processes, both social and functional, thereby exploring its impact and attempting to develop remedial and restorative therapy treatments. My research question is as follows: how does the neuropathology of stress affect neuroanatomical functionality and subsequent cognitive performance and behavior? The hypothesis stipulates that if stress is exerting significant chronic or acute detrimental feedback on the brain, then cognitive processes will be inhibited and negative implicit and explicit behaviors will be augmented. Following experimentation, it was concluded that the sustained frequencies of hi-beta waves contributed to a decrease cognitive performance and increased proclivity to make negative implicit associations.

H16 Memory: Encoding to Retrieval

Behavioral Science
Hirni Patel
North Attleboro High School

Memory is encoded, stored and retrieved with the help of neurons. First, senses (encodings) are received, and then passed as an impulse through neurons. Next it goes into memory storage. If a part of that memory is triggered then the same neuron pathway will activate, retrieving the memory. The question of the experiment is: Which encoding, visual, acoustic, or tactile has a higher recall percentage? The hypothesis of the experiment was: People using acoustic encoding, to collect information and move into memory storage, will have a higher recall percentage because acoustic encoded memories can be strengthened by repetition more easily than visual or tactile encoded memories. The materials for this experiment are 10 pictures, words, objects, a blindfold and a timer. For each participant, their gender and age will be taken. For the visual encoding test, the subjects will be shown a set of 10 pictures, 3 times. After waiting 2 minutes, the participant will have 20 seconds to put the pictures in the correct order. For the acoustic encoding test, the subjects will hear 10 words, 3 times. After 2 minutes, the participant will have 20 seconds to say the words back in the correct order. For the tactile encoding test, the participants will be blindfolded as they touch 10 objects, 3 times. After 2 minutes, the subjects will be un-blindfolded and will have 20 seconds to touch the objects and put them in order. The number of objects they got in the correct order, for each test, will be recorded. Afterwards, the average for each test will be found. The overall average for the recall percentage of visual encoding was 81.2%. For acoustic encoding, it was 49.2 %. For tactile encoding, the overall average was 60%. This means that visual encoding has a higher recall percentage.

K11 Accuracy of Eyewitness Testimony

Behavioral Science
Emily Colon
Taunton High School

Eyewitness Testimony is a very complex thing that is often seen as something it's not. There is a lot of misconception out there by the general public about eyewitness testimony, which is frightening due to the fact that juries are made up of the general public. Our memory is not stored 100% accurately but stored in a way that our brains can comprehend and remember. Also some factors that can throw off the accuracy of our own memory are: anxiety, stress, motivation, reconstructive memory, weapon focus, and leading questions. The purpose of this experiment is to prove eyewitness testimony should not be admissible in court. The hypothesis is that the more time that passes between an event and when asked to recall it, the more susceptible you are to misconception about that event. To conduct this experiment I gathered 45 teenagers close to the same age and I randomly split them into 3 groups. All 3 groups watched the exact same video. One group was asked questions about the video immediately afterwards, another group waited a full 24 hour period to answer the questions, and the last group waited an exact week to answer the questions. I found that the group who took the questions immediately outperformed any other group. The group who took the questions a week later had the lowest scores.

K19 An Analysis of Social Media and Subjective Well Being in Adolescents

Behavioral Science
Freya Proudman, Daniel Proudman
Hopkinton High School

The purpose of this experiment was to determine the effect that different actions: likes, more likes than usual, comments, shares, and tags have on adolescents', ages 13 to 18, subjective well beings across Facebook, Instagram, and Twitter. An underlying goal of this study is to analyze whether a certain action on one social media platform effects subjective well being differently than the same action performed on another platform. This study will attempt to determine whether Facebook, Instagram, or Twitter has the greatest impact on an adolescent's subjective well being. 50 volunteers between the ages of 13 to 18 years and of various demographics participated in a brief survey in which they were asked to rank themselves on a Likert scale of agreement to various affirmative statements regarding their social media usage and feelings of happiness. The results of the study indicate that Instagram has a greater impact than Facebook or Twitter on adolescents' subjective well being which could potentially be explained by the differences in reasons for using the platforms that was identified through analysis of keywords in participant responses. No action was found to have a greater impact on adolescents' happiness than another as the action that had the largest impact on adolescents' well being was different for each platform.

N10 Effects of Static and Dynamic Stretching in Athletes

Behavioral Science
Mary Hayes
Taconic High School

There are two basic categories of stretching; static, isometric stretching involving pulling muscles for extended time to loosen them, and dynamic, aerobic stretching involving warming up muscles through active motions. The purpose of this research is to determine which variation of stretching is most beneficial to distance runners in optimizing performance and reducing injury potential. The hypothesis is; both categories of stretching will prove useful in these aspects however, dynamic will be most beneficial as it better mimics motions used in the sport. Independent variables include; dynamic, static, and combination stretching regimens. Dependent variables include; run duration, mile averages, and individual muscle soreness. The control group followed no stretching regimen. Following procedure, subject ran and timed a five mile run after completing a single stretching regimen. Eight trials were completed and recorded for each regimen, including control. In the day following each workout subject also rated and recorded soreness in five different leg muscles on a scale of one to ten.
Data analysis determined that run duration and mile average were optimal after following the dynamic stretching regimen, followed by the control group, static stretching, and finally combined stretching. Also determined was; after following dynamic stretching muscle soreness was rated lowest, followed by static stretching, combined stretching, and finally the control group.
In conclusion, dynamic stretching produced the best performance results while combined stretching resulted in the worst. Dynamic stretching also resulted in the least amount of muscle soreness, while following no stretching produced the greatest amount of muscle soreness.

N24 Physiological Analysis of Stress Response on Individuals

Behavioral Science
Steve Dillon, Teyah Davis, Sophia Bereus
Jeremiah E. Burke H.S. - Dorchester

Our primary objective was to study how stress affects people's responses to a stressful and a non-stressful situation. We subjected a group of random subjects to a variety of stressful and non-stressful situations and measured the variations in their responses across multiple parameters. We expected that people who struggled with their coping skills would react to the stressful stimuli and that their vital signs would decrease after the happy stimuli. Our project studies showed that current stress levels and abilities to manage stress impacts how participants psychologically react to difficult stimuli. We found that people with better coping skills would positively respond to “Happy” stimuli, with a decrease in elevated vitals after the “Stressful” stimuli.

P2 The Problem With Google

Behavioral Science
Serena Veilleux
Shepherd Hill Reg. H. S.

When teenagers have a problem, they will either ask their friends, or most likely they will google it. However, much of this information will be false. Teens will rarely seek help from an adult if they need it. If there is an entire generation of people who do not know how to solve life problems, can it be solved with a simple app?
The app was constructed with questions and answers using MIT App Inventor II. The questions were compiled from personal as well as peer experiences. The answers were found through valid google sites. A survey was given to participants before and after using the app.
The results of the survey distributed before viewing the app showed that almost all people will use google find an answer. Most people also answered “sometimes” when asked if they ever find themselves in a situation where they have no idea what to do. The results of the the survey distributed after viewing the app showed that more than half the participants would use the app more than half the days in a week. Everyone said the app would help them to some extent.
With more money and a better platform, the app could be made more useful/professional. Google is the number one way a teen will try to solve a problem. The age of talking to one’s parents is gone, and with it some common sense. The app constructed would be of great help to today’s generation.

P16 Do Parents Text and Drive with Children in Their Cars?

Behavioral Science
Jennifer Gliklich
Gann Academy

Introduction: People text and drive. About 330,000 car crashes each year are due to texting while driving. That translates to 1 in every 4 car accidents are the result of texting and driving. That is about 904 texting related accidents every single day in the United States. ”Answering a text takes away your attention for about 5 seconds. Traveling 55mph, that’s enough time to travel the length of a football field. Texting while driving is 6x more likely to cause an accident than driving drunk.”
Methods: Survey questions were developed and distributed to a national panel of parents with children under age 14. The questions focused on evaluating whether and to what degree parents text and drive with and without kids in their cars. The data was collected and analyzed.
Results: 430 parents were surveyed from 45 states. 67% of parents did read texts while driving and 56% had written texts while driving in the past 30 days.
Conclusions: Pediatricians should consider speaking to parents and patients about texting and driving.

P23 Monochromatic Colors

Behavioral Science
Joshua Rivera, Joselyn Rosario, Daiana Osorio
Madison Park Tech Voc HS

Colors are important in people's lives. They are so important that one color can change someone's mood or even the way someone acts. We read that emotions involve chemical changes in the brain, physical changes in the body, and emotional behaviors. Also, colors can carry important meaning and can have an important impact on people's affect, cognition, and behavior. This means that color may also influence a person's mental or physical state. For example, studies have shown that some people looking at red resulted in an increased heart rate.
We wanted to see what colors can affect a person's emotion. Our hypothesis was that the warm colors will have a happy feeling but also make some people mad. Cool colors will have a sad and also scared feeling. For our experiment, we made seven different scenes, put them in a survey, and sent them to people to see what they think of it.
We selected a grayscale scene and put color on it to see what emotions people had towards the scene. Then we made a pie chart to make comparisons for our hypothesis. Our hypothesis was somewhat right. We think red and yellow are powerful colors.

Engineering

Engineering

A5 Pressure-Assisted Bioprinting
A6 Air Warming Device for Asthmatics
A9 Brace for Impact! A Joint-Bleed Detection Device for Hemophiliacs
A12 Advancements in the Staging of Rockets to Better Utilize Thrust
A13 Hexapod Robot
A14 Aim Flex Run: Engineering a New Pepper Spray Device
A21 Untethered Firefly Synchronization
A24 Robot Navigation for the Exploration of Lunar and Planetary Surfaces
A25 Fighting Fire with... Sound?
B6 TheraLux: Engineering Light-Based Approaches to Treat Acne
B8 Seeing for the Blind
B11 Gray Water Recycler
B12 Harnessing IoT to Autonomously Alert Emergency Services
B14 A Study in Mechanics and Processing for Chess
B18 Magnetic vs. Electromagnetic Helmets
B19 Maximizing Wind Power Efficiency Using Nosecones
B21 Building a Robotic Hand That Can Do Sign Language
B24 Prototypical Real-Time Simultaneous Air/Sea Acoustic Monitoring System
B25 Apotheca 2.0
C1 Helio Tracker
C2 Designing a Lead Test Kit: A Solution to the Shortcomings of Others
C8 Analysis of Morphing Wings to Enhance Aircraft Efficiency
C9 Hyperloop Vehicle Levitation Using Circular Halbach Arrays
C11 Designing a Combined Solar-Hydroelectric Power System
C13 Vex Robotics: In the Zone
C19 A Pop of Life
C25 Creating a Rocket Platform to Improve Data Acquisition & Reusability
C27 Bringing the Heat
D12 Robotic Hand
D16 The Purifying Effect of Graphene Coated Sand on Water Samples
D23 Wireless Outlet Control
D28 Handriod

F22 Keys to Dyslexia
F26 An Effective Solution to the Clean Water Crisis in Developing Nations
F28 TEA Laser
G3 Face Fits
G7 Integrating a Hamilton Water Jet Engine with a Tesla Turbine
G10 Universal Earbud Case
G28 Hand Charger
H6 Forget Me Knot: The Effect of Thermal Bonding on Suture Strength
H17 A Noninvasive Hand Tremors Reduction Device
H23 Pain, Pain Go Away
J5 Making Battery Life Efficient
J18 Dealing with Diabetes: The Road to Developing an Artificial Pancreas
K1 Can Robot Technology Help the Visually Impaired Navigate Independently
K9 Modifying Respiratory Medical Tubes to Reduce Microbial Adhesion
K23 Space Expedition - Beyond The System
N2 Increasing the Accesibility of Hydroelectric Energy
N9 Resistive Heating of Commuter Bicycle Mitts
N17 Developing an Automatic Watering System Using Microprocessing
P5 Stackable Shelters for Natural Disaster Victims and Refugees
P6 Biodegradable Water Bottles
P7 Hinged Counterweight Trebuchet
P19 Sound the Alarm!

A5 Pressure-Assisted Bioprinting

Engineering
Jiwon Choi
St. Mark's School

Three-dimensional (3D) bioprinting is conventionally based on additive manufacturing of carbohydrate-based materials such as hydrogel and cellulose. These materials, often referred to as bio-inks or biomaterials, must meet certain mechanical and biological properties both before, during, and after extrusion. As 3D bioprinting is still a nascent field, limitations exist to the range of biomaterials available and appropriate for bioprinting. Advancements in this field would allow bioprinting to be established as a stable source of artificial organs that could meet the ever increasing demands of organ transplants. In this research, two types of protein: bovine vitreous humor and chicken albumin were evaluated as potential biomaterials through the investigation of their mechanical properties, especially viscosity. Furthermore, prototypes of systems that could prove and evaluate the potential of vitreous humor and albumin as biomaterials were developed, tested, and improved. Different prototypes were designed to perform specific tests and their printabilities were evaluated based on set criteria, including print speed, resolution, and ability to solidify the bioink for structural integrity post-extrusion.

A6 Air Warming Device for Asthmatics

Engineering
Rishab Mehta
Mass. Academy of Math & Science

Over 300 million people in the world have asthma. This chronic inflammatory disease affects seven to ten percent of all children and seven to nine percent of all adults. One of the major triggers of an asthma attack is exercise, and eighty to ninety percent of all asthmatics experience exercise induced asthma. Exercising in cold air causes respiratory conditions to worsen. The purpose of this project is to build a device that will warm air before it is inhaled by the asthmatic individual. To explore possible solutions initial devices were modeled in SolidWorks, a CAD software, and analyzed using fluid dynamics simulations. Prototypes of the most effective models were built and experimental temperature data was obtained. The device was then iteratively refined to include additional safety measures, such as a temperature switch that will stop the device from heating to unsafe temperatures. The device will enable asthmatics to engage in physical activities outside with reduced respiratory issues.

A9 Brace for Impact! A Joint-Bleed Detection Device for Hemophiliacs

Engineering
Sreshtaa Rajesh
Mass. Academy of Math & Science

Over 70% of internal bleeding episodes in hemophiliacs occur in synovial joints. After 24-48 hours, inflammation in the joint can cause early onset of synovitis, irreversible cartilage degradation, and permanent joint damage. Hemophiliacs who are unaware of their joint status often wait until physical symptoms of bleeds manifest before seeking medical attention, leading to postponed treatment and an increased risk of permanent damage. This study aimed to engineer a brace capable of monitoring early symptoms of joint bleeds, including raised skin temperature and limited joint mobility. Sensor measurements were compared to control values for validation; sensor results were not significantly different from control values ($p = 0.9243$). In order for the device to recognize possible joint bleeds, a program was written on Arduino IDE that compared the sensor readings against hardcoded parameters. If the symptoms registered as concerns, an LED light relayed the possibility of a bleed to the user.

A12 Advancements in the Staging of Rockets to Better Utilize Thrust

Engineering
Albert Farah
Medford High School

In examining the manner in which rockets undergo staging during flight, a new approach to this process was considered that could enable such vehicles to utilize that whole of their thrust force by strategically applying said thrust to specific areas and stages of the rocket. The intention was to allow for the conservation of propellant material, and, by extension, the preservation of wealth used to attain it. This approach describes a two-stage rocket system in which the first and second stages are not truly connected, but are propelled by their own separate propulsion systems. Powering the first stage would be a solid motor providing thrust that is exclusive to the first stage and its components. Powering the second stage would be a set of detachable hybrid rocket engines, each of which carrying their own solid paraffin fuel but oxidized by oxygen contained within the body of the first stage, which travels close behind the first stage. In short, the first stage would be propelled by engines that are not burdened with the weight of their own oxidizer (which is nearly 3.5 times that of their solid paraffin fuel). The goal of this phase of this research was to determine the efficiency of this concept alongside that of the traditional multi-staged rocket. This was accomplished in the form of a series of calculation-based simulations that took the thrust of the hybrids required to propel the second stage at a given target velocity and combined it with the thrust necessary to propel the first stage at given target velocity, then examined the resulting final velocity of this thrust as if it were present in the first stage of a traditional multi-stage rocket, and compared it to the final velocity of the second stage as calculated in the concept.

A13 Hexapod Robot

Engineering
Xiandong Lin
Stoneleigh-Burnham School

A novel low-cost platform for hexapod robot research is proposed in this work. By utilizing common on-the-shelf materials (wood board, angle aluminum…), parts (such as servos, Arduino UNO micro-controller…), and tools (including laser cutting machine, screw driver…), we design and construct a low-cost hexapod robot. In addition, we successfully experiment the hexapod with basic triangle gait as well as autonomous obstacle avoidance, demonstrating its effectiveness as a platform for the hexapod R&D community.

A14 Aim Flex Run: Engineering a New Pepper Spray Device

Engineering
Marissa Langille
Mass. Academy of Math & Science

In 2015, 38.6 percent of the 15,883 murders in the United States occurred as a result of attacks on single victims by single aggressors. Although anyone can be attacked, fatigue and low visibility make runners particularly vulnerable. In 2017, 7 percent of respondents to an American survey claimed to regularly carry pepper spray, a non-lethal substance able to deter an aggressor, while running. The goal of this project was to engineer a comfortable, discreet, wearable device capable of dispensing the same amount of pepper spray with similar spraying dimensions as safety practice devices. The new device is attached to a watch and requires one free hand. To test the comfort of each prototype, a group of runners (n = 17) wore the device for the duration of their workout and then filled out a survey to gather their feedback. The efficiency of the device was tested by comparing the prototype's spray patterns to those of the practice devices. A t-test and a sign test comparing the practice device and the new device indicated that there was no significant difference between horizontal distance ($p = 0.10406$) and vertical distance ($p = 0.13218$) of the spray pattern. The new device should increase the amount of runners carrying pepper spray, improving their safety.

A21 Untethered Firefly Synchronization

Engineering
John Defay, Benjamin Defay
Lexington High School

Last year we developed a wired platform for autonomous Arduinos to communicate and synchronize. This year we are extending this work by building in wireless communication. After extensive study and debate, we agreed on using packet radio communication. The first successful example of this work was "Firefly Hats," where we synchronized independent Arduinos, and coupled them to a bright flash and an audible signal to allow synchronized movement. From this success, we aimed to create a more robust platform that could use synchronization for a variety of purposes. The iterative process was crucial in attaining this goal, as we were able to work towards defined design criteria to refine our prototype. This platform needed to be straightforward to use, wireless, able to detect multiple Arduinos in a swarm and have some measure of distance. After prototyping a large number of different solutions, we have developed a synchronizing solution capable of a number of practical applications, such as keeping track of a group in a crowd, and making sure that none of the group is separated from the others.

A24 Robot Navigation for the Exploration of Lunar and Planetary Surfaces

Engineering
Zoe Rudnick
Shrewsbury High School

There has been a recent, worldwide interest in exploring the solar system and beyond, but progress has been held back by the slow rate of missions and the outdated technology used in land rovers. Missions on the moon or Mars usually involve a single large robot with the purpose of investigating many different properties. This is critical for the initial exploration of a new celestial body but is not necessary when this information has already been determined. By using multiple smaller, less complex robots that specialize in navigating and finding only necessary data, such as water levels in soil or changes in the atmosphere, space exploration can progress faster. This system requires robots that can autonomously navigate around rough and jagged surfaces in between waypoints set by human operators. A new algorithm was developed using Java that utilizes the most efficient parts of a greedy maze router algorithm, a greedy line probe algorithm, and simulated annealing. It was tested against the greedy maze router to compare the number of steps taken between start and end points with a range of numbers and sizes of obstacles. From the results of the simulations, it was determined that the new algorithm performs significantly better than the greedy maze router in terrain with more and larger obstacles. The new algorithm was then implemented and tested on a Roomba robot using a Raspberry Pi. In the future, the new algorithm will be developed for specific types of terrain and robots.

A25 Fighting Fire with... Sound?

Engineering
Nikhil Krishnan, James He
Shrewsbury High School

Uncontrolled Fires fires can be hazardous to both life and property due to due their destructive nature. The current methods of firefighting have remained unchanged for 50 years, and have several flaws. Previous research have shown the possibility of using sound waves in order to extinguish a fire; however, there needs to be a significant improvement in performance before it can be considered a viable alternative to current methods.
The immediate objective of this research was to investigate the performance of sonic fire extinguishers, measured by the speed at which they extinguish fires, by varying the design of the collimator, the funnel used to direct the sound waves. It is hypothesized that as the conicity of the collimator increases, the time taken to extinguish the fire will decrease. A total of 20 trials were conducted on each of the 7 different collimator designs.
The results confirmed the hypothesis and indicated that the average time to extinguish the flame decreased as the degree of conicity increased though it was found beyond a certain point, the outlet became too small to have any effect on the flame.
The idea that sound waves can be controlled to extinguish a fire is relatively new. These results possibly introduce an entirely new method to improve sonic fire extinguishers. With more research and testing, the use of a sonic fire extinguisher may be used in any fire-related scenario, ranging from a compact portable sonic fire extinguisher in homes and schools, to combating a raging forest fire.

B6 TheraLux: Engineering Light-Based Approaches to Treat Acne

Engineering
Yashasvi Raj
Lexington High School

Acne affects nearly ten percent of the global population. Approximately 80 percent of all individuals experience acne at one point in their lives. It deeply affects an individual's confidence and may lead to occasional isolation and depression. Acne is caused by the clogging of pores through excess of oil (sebum) production, collection of dead skin cells in pores, and their inflammation due to growth of bacteria, Propionibacterium acnes. Application of topical creams has been somewhat successful, but these are expensive, need frequent replacement and some show adverse reaction. Light therapy, however, has proved to be a safe and effective alternative approach to treat acne. Existing light therapy options are expensive, some costing over $3000.00. Low budget models (e.g., Neutrogena Light Therapy Mask), are pricey and have a fixed usage. My engineering goal was to design and build an affordable and versatile light therapy mask that would utilize proven effective wavelengths to reduce the inflammation in acne sites as well as inhibit the growth of acne causing bacteria. After several iterations, my present model, "TheraLux" is five-times cheaper than the Neutrogena Mask and consists of more LED's. TheraLux matches the wavelengths that have been proven to be effective in addressing the goals previously stated. The TheraLux mask allows the user to obtain the same results as other commercially available light-therapies, and also control the areas of application, while not limiting the number of usages as well as lowering the cost of the treatment.

B8 Seeing for the Blind

Engineering
Sidharth Anantha
Lexington High School

Over 285 million people are either fully or legally blind, meaning they have little to know vision. This makes navigation especially difficult for the blind. This product aims to help the blind, by creating an artificial sense of navigation. This product uses sonars to measure the distance between the user and obstacles in front, processes the data in a computer, and outputs the data through sound and vibration. Data is plotted on a spectrum, and from that data frequency, duration of frequency, and vibration duration are modulated to effectively convey distance to the user about objects in their surroundings. Measurements are taken from both eye level on glasses, and ground level on shoes. With both levels of measurement, this integrated system is able to effectively convey distance and create a sense of spatial awareness to aid the blind with navigation.

B11 Gray Water Recycler

Engineering
Emily LaBelle
Wachusett Regional High School

This project aimed to lower the water usage of houses by designing a water recycler system to be used in California. This is because California has experienced long term droughts every 20-50 years. These droughts have caused a decrease in water available for residential use. Water recyclers have been employed in rest stops and schools to take used water and bring it to plants in greenhouses. Previous designs have not been developed that bring used water back into the house, which this Gray Water Recycler includes. The Recycler serves to decrease the amount of water that houses use to help conserve available water sources.
In this design, water exits the house from the appliances and travels to a holding tank underground. The holding tank is monitored by a pH sensor and water level float switches. From that tank, water can go into an irrigation system, then to the indoor garden, and lastly to a second holding tank. The second holding tank supplies water back to the toilets in the house.
The system decreases water usage by bringing reused water to irrigation and toilets, rather than bringing it in from an outside source. A working schematic and tests were conducted to confirm the efficiency of the system, which decrease water usage by around 10%. Upon completing the construction of the project, the system was computer automated and prototype testing was conducted.

B12 Harnessing IoT to Autonomously Alert Emergency Services

Engineering
Muneeb Syed, Saad Mufti
St. John's High School

Problem-People in critical health conditions need access to instantaneous communication as soon as they are injured.
Goals-Design a small wearable capable of instantaneously alerting medical personnel when the wearer is in a state of critical health.
The device must have onboard sensors capable of detecting hazardous materials in the environment, such as fire, gas, and extreme temperatures. It also takes into account the user's vital conditions like pulse and heart rate.
Procedures-To create a device capable of detecting hazardous conditions, a variety of sensors were used, including the:
YG1006 Flame sensor
Mq-7 Gas sensor
LM35 Thermistor
Pulse Sensor
SIM808 GPS/GSM Chip
These sensors gave values to a microprocessor called an Arduino Nano. The Arduino Nano is a small computer capable of receiving data from external hardware which helps it learn about its surrounding environment. A breadboard was also used for the purpose of being able to change the wire connections to the sensors.

B14 A Study in Mechanics and Processing for Chess

Engineering
Andrew Adiletta
Worcester Academy

I started this project trying to combine my passion. One of my passions is programming for programming for quite a long time now and I also really like robotics and I also like chess so I decided I would make a robotic chess player. So what would my robotic chess player be able to do? WelI, I wanted the chess player to be able to play a game of chess against person eventually, but this is kind of a long term goal. I wanted it to be a training tool. I wanted it to be able to watch two players playing game of chess and make sure they're not breaking any rules or anything. I also thought it would be cool to use this mechanism to teach certain strategies or different chess formations that you could take during the game. Lastly you could also use this to show famous games that occurred between famous people that might be interesting for persons learning how to play chess to watch in real life.
How am I going to go about creating a robotic chess player? I've used Arduinos in the past and I decided that an Arduino-based robot will be really useful. This robot needs to be able to manipulate pieces on the board. One way you could go about doing that is by possibly building an entire robotic arm to go and pick up pieces, but that would be a lot of work and it would be very difficult to implement. There has to be a simpler solution. What I decided was, I would use magnets to manipulate the pieces. For the intelligence to make smart moves, I would use some sort of AI or Heuristics engine, and for the user interface, a touchscreen of some kind could be mounted on the front.

B18 Magnetic vs. Electromagnetic Helmets

Engineering
Jackson Diltz, Eric Bone
Westfield High School

This project was intended to show how electromagnets could provide a better cushion when implemented into sports helmets. Since we found that magnets had the ability to reduce the force when we tested previously, our group decided to see if a more powerful electromagnet would provide a better option to preventing 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 to 90 degrees and one at 45 degrees. Trials were done without magnets, with 2 magnets/in2 (36 per helmet), and using an electromagnet in each helmet. A board was placed behind the helmets measuring every 2 cm. Data was recorded via videos of how far the helmet was hit.
After a total of 60 trials, we took the averages of our trials and the standard deviation so we could put error bars on our averages. These error bars did not end up overlapping which meant that the data we collected could be considered significantly different. This means that the electromagnet was successful in being the most effective in reducing force of impact.
Based on our results, electromagnets have the potential to prevent damage to the brain when it faces a force. Concussions can vary in degrees of intensity, but they have the potential to leave someone with life changing side effects. Although the electromagnets show promise, the size of the battery is not feasible in the design of the helmet so normal magnets have a better potential.

B19 Maximizing Wind Power Efficiency Using Nosecones

Engineering
Zachary Medeiros, Liam Coffey
Westfield High School

The most difficult and impactful challenge the world is facing today is climate change and global warming due to greenhouse gas emissions.The source for a majority of the world's carbon dioxide output is the burning of fossil for energy.If the world continues to emit CO2 at the rate we are now then we are doomed to a future of extreme weather, increased health risks, and a decimated environment. A cleaner alternative energy source is wind power. We wanted to develop a wind turbine and a set of domes and nose cones we will test against the turbine without a nose cone and with a standard nose cone to see if the any design will meet a 3% improvement in rotations per second over the controls. The designs which we found to be successful through performance testing were designs 4, 9, 13, and 14 when compared to a propellor setup that had no nose cone. Through t-testing, the p-values for average angular speed of the propellor with each nose cone design respectively were 0.06, 0.46, 0.09, and 0.0008. These p values indicate that the successful results for designs 4, 9, and 13 were likely a result of random variation, and thus the observed increases in average angular speed are not statistically significant. The p value of 0.0008 for design 14 is far lower than all common alpha-levels, indicating that the observed results were not a result of random variation. We were successful in creating four nose cones that increased the average angular speed of the turbine compared to the control and two new designs that increased angular speed greater than the commonly used cone. Cone 13 beat the standard cone by 7.1% and cone 14 was the most successful with a 27.8% increase.

B21 Building a Robotic Hand That Can Do Sign Language

Engineering
Jack Adiletta
Worcester Academy

A study in human anatomy and robotics to produce a robotic hand that can accurately reproduce the function of a human hand to perform American Sign Language. The hand was designed, assembled and programmed over the course of five months and built using 3D printed parts which I designed after multiple iterations and feasibility studies. The robotic hand uses the same general structure as a human hand, and is made with parts printed by a 3D printer. The hand is controlled by an Arduino and actuated by servo motors to move each joint precisely and quickly to accurately mimic the movements of the human hand. The hand is programmed to perform the 26 letters of the ASL alphabet and some additional gestures.

B24 Prototypical Real-Time Simultaneous Air/Sea Acoustic Monitoring System

Engineering
Grace Kwon
Falmouth High School

Offshore wind turbines are an emerging form of green energy that are popular for creating minimal pollution and not taking up valuable area on land. However, there is a possibility that offshore wind farms can harm fish and marine mammals due to the noise that the turbines produce in operation. The goal of this project was to build a device that is capable of simultaneously measuring noise levels in air and water, then streaming the data to a server in real time. To build such an acoustic monitoring system, I used off-the-shelf components that were both compact and relatively cheap. The monitoring system measures data through a microphone and hydrophone at the same time, then streams the data in real time using cell service. Once the raw data is in the main server, it can be made into wav files using some python programs, after which the files can be heard and analyzed. A preliminary field test has been performed to test the monitoring system, and it has been confirmed that all the components work as designed. The test data revealed high-frequency sounds penetrating water to a certain extent, but not low-frequency noises. With the monitoring system, further tests will be run in the future to determine the potential environmental impact of offshore wind farms.

B25 Apotheca 2.0

Engineering
Sophia Klessel, Maya De Luis
Newton Country Day Sch/Sacred Heart

In 2015, 33,000 people died of accidental drug overdoses. The goal of Apotheca 2.0 was to develop a machine that dispensed and verified medicine and provided a notification when medicine was taken. This machine was built using Mindstorms EV3 and Arduino Uno.The Mindstorms EV3 and the Arduino UNO communicated with each other through an LED and a color sensor. The LED turned on when a touch sensor on the bottom of the tray that held the pills was touched notifying the machine that the medicine had been taken. The Arduino also sent out emails to two people to notify them that the medicine had been taken. During testing, the machine was able to successfully dispense and check a pill and send two emails each time it was tested. The goal of the project was achieved.

C1 Helio Tracker

Engineering
Jason Gustafson
Westfield High School

This project in its present form is the result of an engineering prototype that seeks to use the heat of the sun to more efficiently gather sunlight for a solar panel by adjusting its angles. The idea was to have a piston system that would be powered by a pressure system cause by the evaporation and condensation of isopropyl alcohol. This would then, in turn, cause a system of syringes to rise and fall to angle the solar panel directly towards the sunlight.
The efficiency of the device was determined by how long the charge of the solar powered battery would last each testing trial in powering a light. This time interval would be recorded in minutes from when the switch was activated until the light went completely dark. The light and heat source was positioned in different angles of 0, 45, 90, 135, and 180 degrees. The control group was doing this but without the syringes being able to move the panel and it being always horizontally angled.
After seven trials of both experimental and control group testing, the average length of time the helio-tracker powered the light was 29.3 minutes while the control group had an average time interval of 26 minutes. After conducting a two sample t test of means, the t value was about four and produced a p value of 0.0008. This indicates that the difference in the averages of the two groups was not due to sampling variability nor coincidence and that the system was actually more efficient than the control group.
This experiment was done without high tech machinery or precise software, but done by natural reactions created by nature. The alcohol reacted to the warmth and caused a chain reaction to shift the positioning angle of the solar panel. With simple materials a person can construct their own.

C2 Designing a Lead Test Kit: A Solution to the Shortcomings of Others

Engineering
Adrian Orszulak, Kristen Stawasz
Westfield High School

This project aimed to create a lead test kit that was easy-to-use, inexpensive, and have a high accuracy of at least ninety-five percent.
The design was based on a precipitate reaction occurring when a lead-contaminated water sample was drawn into a syringe. The volume of the theoretical yield for the legal limit of lead (15 ppm) was calculated and a line was drawn on each syringe at this volume. Sodium iodide was added into the syringe; then the sample was taken into the syringe and swirled by one experimenter. If the precipitate was above the line, the water sample contained dangerous levels of lead; if it was below, the water was safe to drink. To test this design, a single blind experiment was conducted, testing water with lead concentrations of 0 ppm, 5 ppm, 15 ppm, and 30 ppm, with five trials per concentration. After one experimenter determined the test's reading, the other experimenter recorded the concentration of the sample, the reading, and whether or not the reading was accurate.
The design did not meet a success rate of ninety-five percent. It was difficult to accurately see the volume of the precipitate formed at a macro level. However, one-tailed one-proportion z-tests were used to demonstrate that the test was significantly more accurate than what is expected by random variability, proving the tests had a moderate degree of accuracy, with the highest accuracy rate yielded at sixty percent.
In conclusion, the project presents a design for a lead test kit that was very inexpensive, easy-to-use and had a moderate accuracy rate. This design is an important basis which can develop to become marketable. A variation on the design could optimize the color change with the implementation of Beer's law or collect a larger sample to increase the lead ions.

C8 Analysis of Morphing Wings to Enhance Aircraft Efficiency

Engineering
Charlie Fenske
Falmouth Academy

Typical airplane flights consist of several phases including takeoff, climb, cruise, slow flight, descent, and landing, all requiring different wing geometries in order to operate at peak efficiency. Traditional trailing edge flaps were invented to solve this problem, but their rigid and discontinuous structure limits their efficiency. As a solution, a structurally compliant morphing wing was designed with variable camber, twist, and chord. Almost every part in the wing was custom built from carbon fiber in order to maximise range of motion and functionality. Invented during this project, the single corrugated composite structure makes advanced wing morphing possible with few parts. The morphing wing has the potential to optimize its shape for the desired flight profile, always operating at L/Dmax. In addition to improving aircraft wing performance and versatility, this design could be applied to automotive spoilers, wind turbines, helicopter blades, rocket fins, underwater vehicles, and any other application that uses aerodynamic control surfaces. The morphing wing's twist function can also be used to eliminate separate ailerons and flaps, combining them into a single, lighter, and more versatile control surface. According to wind tunnel data, even when compared with the most efficient wing shape tested, on average, the morphing wing increased the L/D ratio by 37%. If combined with a flight computer that measures airspeed, air density, and angle of attack, the morphing wing could automatically improve flight performance without pilot intervention. The result is a robust aircraft that is inexpensive to manufacture, that can perform more diverse missions, fly longer distances, operate more safely, and have a wider speed envelope, all while using less fuel.

C9 Hyperloop Vehicle Levitation Using Circular Halbach Arrays

Engineering
Troy Otter
Falmouth High School

Hyperloop pods, vehicles that operate in tubes at near vacuum, similar to pneumatic tube transport systems often seen in banks and some offices. Hyperloops can be used to transport people or cargo vast distances at high speeds. To help reduce drag, hyperloop pods must be magnetically levitated over the track. Various methods of magnetic levitation exist, however the most promising method for the hyperloop is through spinning halbach arrays. By moving magnets over a non magnetic metal, such as copper, the magnets induce an opposite electric current in the metal, and the magnet levitates. The halbach arrays concentrate the magnetic field on one side of the magnets, by alternating the direction of the magnetic poles. By spinning the magnets, it is possible to create that motion without moving the cart over the track, allowing levitation in place. Using strong neodymium magnets and two revisions of the pod design, it was possible to achieve magnetic levitation over the copper plates.

C11 Designing a Combined Solar-Hydroelectric Power System

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

In this project, I successfully created a combined solar-hydroelectric power system, which can produce environmentally friendly energy regardless of whether conditions. The field of utilizing multiple renewable energy sources in tandem is only recently developing; one of the first dams to make use of both solar and hydroelectric power, Alto Rabagão, added solar panels only in October of last year. I constructed my prototype using a combination of a premade solar panel, custom built hydroelectric generator, and self-engineered supporting structure. The device proved capable of producing significant amounts of power, measured using a multimeter. This project, while limited in real world application due to scale, represents a functional proof of concept for what I plan to engineer at a larger scale.

C13 Vex Robotics: In the Zone

Engineering
Andrew Elfman
Southeastern Reg. Voc-Tech. H S

My project is the Vex Robotics Competition In The Zone. You have to stack cones, or move the base cones into an area for points. You have to build a robot out of Vex parts. My robot is based off of a half track, with wheels in the front and treads in the back. The robot performed very well in the competition. It could stack okay, but it moved the base cones very well.

C19 A Pop of Life

Engineering
Kiiyah Hargraves-Johnson
Taconic High School

While coming up with the project it was known that there is a need to detect acid based drug GHB specifically. A few goals of this project were to have a successful indicator object as well as making it portable and non evident will in use. So with that in mind a product put it on a popsocket which is a popular phone accessory, and with this the person that will use this can take their straw and place a couple drops on top of the popsocket where the indicator plastice will be located at. During the experience there were several different prototypes of bioplastic with and without indicator produced until the best ratio of materials were found. During the project it was learned that one has to stay consistent while making the plastic and try to stay as close to the best formulation.

C25 Creating a Rocket Platform to Improve Data Acquisition & Reusability

Engineering
Evan Brodie, Bennett Helfrich
Falmouth High School

Rockets are used for many things, including fireworks, missiles and hobbyist models. However, most importantly, rockets are used to put satellites and humans into space. Until very recently, these rockets would be used and then would crash land into the ocean, never to be used again. Jeff Bezos, the founder of Amazon and the rocket company Blue Origin, has compared the wastefulness of using the rockets only once to flying a jetliner from the East Coast to Los Angeles, and then disposing of the airframe upon arrival.
In recent years, companies such as SpaceX, Blue Origin and Masten Space Systems have been developing rockets that may be launched, serve their purpose, and then land so that they may be reused easily. These rockets will allow individuals and organizations to access space more affordably and more frequently than they have been able to up until now. There is a need for people to be able to explore space, which will become a possibility once doing so becomes more accessible.
For our project, we will design and build a rocket that will be able to launch, reach apogee, and then land vertically. We will also physics to demonstrate the rocket's flight characteristics, allowing us to check the data that is logged by the flight computer for accuracy. To determine whether or not the rocket is successful, we will assess the percent error in the distance from the predicted apogee, as well as whether or not it lands vertically. Success in the landing location prediction will require a less than 5% error in the distance from our predicted maximum altitude. For the vertical landing component, if it does not land vertical it will be deemed unsuccessful.

C27 Bringing the Heat

Engineering
Colby August
St. John Paul ll High School

During the winter one of the most expensive costs is heating ones house. In the United States the average monthly heating bill as of 2016 was 112.59 USD per month resulting in an annual cost of about 1350 USD. One of the largest sources of heat in our galaxy is the sun, and it has been harnessed before to create energy in the form of electricity. People can also harness the heat of the sun in order heat their houses. By using a solar air collector, people can generate large amounts of heat for a fraction of the cost. There are many different types of solar heaters, such as a screen heater, box heater, or a can heater. The type of heater being displayed is a can heater. It works by taking in air from a source such as outside, or from inside a house, running it through the cans, which collect heat from the sun, and heat up the air to send it back into the house in order to heat the house. In testing, the design which was used was able to create a change in the air which entered from the outside. Due to poor testing conditions, the heater change wasn’t very much, as well by using the outside air it made the work of the heater harder because if using air from inside, it would have started at a higher base temperature. In the future other designs could be tested in order to find which one is the most efficient, as well to see if creates pressure inside the heater to create a slower airflow with more air in the box with create a higher average heat. The design which was built is still effective enough to make a change in a small house or workshop due to its size. With better conditions the effects could be more prominent.

D12 Robotic Hand

Engineering
Deep Kumar
Upper Cape Cod Voc-Tec. H. S.

The Robotic hand is a senior capstone project that encompasses the major components that were taught in the engineering shop. The project consists of a mechanical 3D printed hand that is controlled by servos. A power glove is used to send data to the servos to make the hand mimic the motions of a human hand. The project uses a new technology called the Flex Sensor in determining positional data. The robotic hand has electrical components to it such as the drive system and there were many computer models and simulations to determine if the hand would work. The issues and troubleshooting had to be done with many of the components to allow for the robotic hand to function. In the end the robotic hand meet its requirements that were set and continues to be worked on.

D16 The Purifying Effect of Graphene Coated Sand on Water Samples

Engineering
Donald Chang
Westfield High School

Global clean water is a global issue that affects all continents, and the general method for treating wastewater is a flawed process. The organic solids decay in wastewater, while metals, dyes, and bacteria in water are treated through types of chemical plants. Industrial plants are difficult to handle as they produce harmful byproducts when treating water and are costly to maintain.
Graphene oxide sand is a potential solution for treating wastewater because it has the ability to filter bacteria, heavy metals, and dyes through natural processes. In this investigation, the use of Graphene oxide sand is used on Red 40 and Yellow 5 Dyes to examine the filtration power of graphene oxide. To inspect this problem a filtrate system of sand at 2 ml and 4 ml will be used as a standard experiment while GO sand is created to be the unknown variable. Through spectrometry the data shows there is a 3:1 ratio of % dye removal of red 40 for sand and Go sand respectively, while a 2:1 % dye removal of yellow 5 for sand and GO sand. From the data, a conclusion that GO bonds with red 40 molecularly better than yellow 5 due to possible factors such as the ion groups at the ends of red 40 or the oxygen sites that are readily able to bond with in yellow 5.

D23 Wireless Outlet Control

Engineering
Joshua Sheputa
Calvary Chapel Academy

The objective of this project was to construct a system to wirelessly control a wall outlet. The problem that was hoped to be solved was that you could not control electrical outlets from a distance. A NodeMCU was connected to a relay that was connected to the hot line of an outlet. The NodeMCU was then programed to control the relay via input of specific URL parameters. The results of testing showed that the device worked 100% of the time regardless of distance.

D28 Handriod

Engineering
Irene Terpstra
Lincoln-Sudbury Reg. H. S.

A dancer has little hope of improvement without the help of a teacher or coach that is able to analyze their movements and provide feedback. However, many dancers do not have access to highly trained instructors to help them at all times. Due to the incredible range of motion in the human body, motion is difficult to accurately capture and analyze. The purpose of this project is to use motion sensors to record the movement of dancers and use machine learning algorithms to identify and evaluate those motions. The objective of this project is to capture the expertise of a professional dance instructor and make it accessible to all dancers at all times. In my project, I created a sensory glove that is able to record the movement of an arm by using gyroscope, accelerometer, and compass sensors to find absolute orientation information and flex sensors to record to bend of a finger. This information is then sent into two different machine learning algorithms that are able to learn the features of a movement and use that to identify and qualify new movements. I conducted three different experiments to test the accuracy of system: motions that were completely unique, motions that mirrored each other, and finally the same motion performed in slightly different ways. When these trials were run though the machine learning algorithms, independent test of the trained models showed that the two algorithms were able to learn and evaluate a variety of data sets and were able to perform correct classifications on new data sets for almost all of the samples tested. Through the motion information collected by the sensors and the finesse that they capture, this project would allow a person with a bionic arm to be able to participate in ballet rehabilitation.

F22 Keys to Dyslexia

Engineering
Parker Riley, Rose Pecci
Tantasqua Reg. H. S.

For the project, a keyboard was designed that would aide dyslexic individuals. The keyboard fixes the struggle that dyslexic individuals face when using the classic keyboard because this keyboard focuses on the specific needs of the dyslexic individual. The letter keys and number keys have been raised and slightly enlarged so that the person using the keyboard can clearly see each letter. The letters were also raised so that the individual could physically feel the outline of the letters and the numbers on the surface of the keys. The use of two different senses can help in the memorization process and the user can navigate the keyboard with more ease. The raised letters also help the dyslexic individual feel where the keys are without actually having to look down at the keyboard. In order to improve our keyboard, small amounts of color were added to make the letters, that people with dyslexia struggle with the most, stand out. After the test was completed, the dyslexic individuals that were originally interviewed were asked once again to test it out and give feedback on the new keyboard. After the test, it was discovered that most of the individuals wanted the letters to be in alphabetical order the letters were reorganized and the individuals were retested. We found that putting the keys in alphabetical order was successful and ultimately improved the invention. In the end, the invention proved successful.

F26 An Effective Solution to the Clean Water Crisis in Developing Nations

Engineering
Mariah Mansoor
Boston Latin School

The problem I address through my project is the lack of access to clean water for refugees in developing countries. As of 2017, there are 22.3 million refugees, and many of them receive water from rivers, streams, or governmental organizations that can jeopardize their health. My goal is to answer the question how to best ensure that refugees in developing countries have access to clean water? My objective for this project is to utilize solar thermal energy to purify water-from rivers, streams, and ponds-of all kinds of waste chemicals, detergents, pesticides, and diseases. So that purified water is made available to refugees around those water sources.
My model demonstrates a smaller scale model of infrastructure that would be implemented near refugee camps around bodies of water. The scale model can be scaled up for a small-medium sized refugee camp near a river or stream. However, the dimensions can be changed for varying sizes of refugee camps and bodies of water. The model will have water piped into an open bed that mirrors a parabolic trough. The water will then be heated because the trough directs all its heat into the center where the water is due to its parabolic shape. The water vapor will hit the plastic cover and then slide down into another pipe. Which is directed away from the heat of the trough, so the water will condense and go into a tank to be collected. All that is left in the open bed are impurities and dirty water that can be used for farming.
The results I found are that compared with filtering technology, this technology innovatively uses sunlight, a green energy, which is abundant in those areas due to global warming. The impacts of this model is that is economically efficient and less expensive than other models.

F28 TEA Laser

Engineering
Charlie Kleindinst
Upper Cape Cod Voc-Tec. H. S.

It was hypothesized that the TEA laser would work under one atmosphere of pressure and would run off of air because of the amount of nitrogen (~75%) in the air. TEA Laser stands for Transverse Electrical discharge in gas at Atmospheric pressures or Transversely Excited Atmospheric for short.
This project was built using very common items except for the neon sign transformer and the electronic components that were boat from Digikey. The first steps were to design the circuit and determine what kind of power was to be used and then build the circuit on perfboard. The next steps were to build the capacitors, spark gap and laser gap. Two types of laser gaps were made after the fist did not work because it was anodized.
Even with the setback from the laser gap the lasers still exceeded the expectation. The data that was recorded described the measurements that was what happened and how far apart the spark gap was set to and how far apart the laser gap was set. These showed a trend and proved that the distance of the spark gap did not affect the distance of the laser gap just the frequency that triggered the laser.
The importance of the TEA laser experiment is that lasers are used in lots of sensors today and are one of the most common problems with lasers for people designing and building them is that in most lasers sets of mirrors are used and have to be aligned very precisely and take time to make them work. TEA lasers do not need to have mirrors, but they still can be used on them. This type of laser is going to be incredibly useful in new types of light technology and how people use lasers.

G3 Face Fits

Engineering
Carlia Dabel, Jamir Sobers , Onasis Soto
Edward M. Kennedy Academy for Health Careers

After overlooking many ideas, we decided to design a pair of glasses that could accurately measure the dimensions of someone's face by inserting a cog in the temples of the glasses frame and a push in-out mechanism on the bridge, labeled with numbers in millimeters. To do this we first had to consider the best material to print in and consider the factors that came with it, then we had to create a practical design that would enable the glasses to perform such duties. Using Tinkercad, a 3D printing program, we designed and printed multiple prototypes and found that after all Polylactic Acid (PLA) best suited the glasses frames.

G7 Integrating a Hamilton Water Jet Engine with a Tesla Turbine

Engineering
Brian Thompson
Mary Lyon Pilot High School

Water propulsion over the last two centuries has greatly improved from man powered to the early 19th centuries of steam powered to the modern propulsion of mainly diesel engine. As stated before, the diesel engine is the most common form of water propulsion in the marine world. The diesel engine has its own shares of advantages and disadvantages. One advantage the diesel engine has that has made it successful over the years was the efficiency over the presiding steam engine. Diesel engines offered more control over power usage by gearbox and more power densities. One crucial disadvantage in the modern world of diesel engine is the emission of pollutants such as greenhouse gases which affect marine life and cause drastic weather changes. To eliminate the greenhouse gas, the diesel engine has to be abandoned completely and be replaced with an engine with zero emissions of pollutants. The water engine or more specifically the hamilton jet engine has a plethora of advantages over the diesel engine. One advantage over the diesel engine is the control and direction of power. An impeller draws water from the ocean and directed through a nozzle. This method increases the speed and power output of the boat and offers much more maneuvering for the vessel. The water jet can be coupled with any power input source but in this experiment an electric motor and a battery is used to achieve green energy. A vessel with a water jet engine driven by an electric motor can stay operational for a decent amount of time depending on the charge the battery can hold. To extend the life of the battery and the operation of the boat, a tesla turbine is introduced to the system to transfer some of the impelled water to the tesla turbine to generate electrical energy for longer operation of a vessel.

G10 Universal Earbud Case

Engineering
Rudy Alvarez, John Richard OBryant
Edward M. Kennedy Academy for Health Careers

The goal of this project was to prove that it is possible to produce a case for standard earbuds, using a 3D printer, that can serve as a more capable substitute for the earbud case that is provided with Apple earbuds. Such a case would be judged on ease of use, durability, and the ability to hold small accessories. The earbud case that was designed was proven to be better than the apple case in each of the tested criteria.

G28 Hand Charger

Engineering
Augustine Asumadu
Taconic High School

The hand charger that I have built, is a phone Charger that makes use of kinetic energy to charge a phone. Its purpose is to be used for emergency purposes when any power source isn't available and one needs to make an important call such as to the emergency services but has a dead phone in that circumstance.
I had the idea to build something of that sort due to the recent devastating fires in California and the hurricanes in Puerto Rico. The report was that the main way in which victims were contacted was through phone calls however, some people had dead phones, making rescue even more tedious. That was when I decided to address that problem in my science project by building something that could help in such situations and practical in everyday situations that an individual would not like their phone's battery to be depleted; thus, the hand charger.
My first prototype was make from a hand-shake flashlight, the second from a hand cranked radio and the third, which I am currently building, is from a circuit board I am making myself so it fit in a special phone case, so it will be practical in an everyday situation.

H6 Forget Me Knot: The Effect of Thermal Bonding on Suture Strength

Engineering
Emma Whitehead
Shepherd Hill Reg. H. S.

Suturing is a common method of wound closure. The greatest drawback of sutures is their affinity for knot failure. This can delay and obstruct wound healing, and in severe cases, cause catastrophic bleeding. Sutures are either monofilament or multifilament. Multifilament sutures have greater knot security, but they also have increased rates of infection and display more tissue drag. While the security of a knot formed with monofilament suture material can be increased by the addition of throws, this also increases the bulk of the knot and tissue reactivity. The goal of this project is to determine if partially melting a suture knot increases its strength and security. Two groups of suture loops (n=50) were assed for tensile strength. The way in which the loops failed was also examined. The first group was traditionally knotted using a surgeon's square knot. The second group was tied with the surgeon's square knot and then partially melted. The tensile strength of the completed loops was determined with a tensiometer, and the type of failure was visually assessed. The results showed that the partially melted knots had a significantly higher tensile strength. They also had a very different pattern of failure that tended toward breakage and slippage with memory, over slippage without memory. These findings suggest that partial melting increased the knot security and tensile strength of the sutures. This new method is seemingly superior to the traditional practice of knot tying, and potentially could replace it as the standard convention.

H17 A Noninvasive Hand Tremors Reduction Device

Engineering
Emily Taylor
Berkshire Arts & Technology Charter Public School

The intention of this science fair experiment is to reduce the size of the original glove as well as ultimately find a practical and comfortable alternative to medication. If I incorporate electrical elements into the glove, then the glove will be able to reduce hand tremors more effectively and comfortably for a longer period of time compared to a glove with all nonelectrical parts. To test this, I bought a mini TENS (Transcutaneous electrical nerve stimulation) device and an arthritis glove. Through an app, I took five trials and came up with significantly lower results; meaning the hand tremors reduced in severity. The subject's hand tremors improved visually. In conclusion, the mini TENS device could easily be used as a stand alone method to help reduce hand tremors for a short period of time. From previous knowledge from last year, the arthritis glove was not a stand alone element of an effective glove. This TENS device can be used with people who have hand tremors of all severities due to the different modes. With this data, a new experiment could be conducted to incorporate a smaller TENS device into a glove to make it more practical for people in a rush.

H23 Pain, Pain Go Away

Engineering
Ngoc Tram Nguyen
Miss Hall's School

The healing process for burn patients is both a long a painful process. In folk Asian medicine, Callisia fragrans is famous for treating burns for expediting healing process from being packed full of steroids, serving as an antimicrobial, a pain reliever and it's fast reproductive rate leading to low prices. However, this plant is not found in non-tropical regions. Aiming to provide accessibility this cheap and effective medicine, different classes of topical medicine were created to treated different degrees of burns based on the plant extract.

J5 Making Battery Life Efficient

Engineering
Sadie Jude
Burncoat Senior H.S.

The purpose of my project was to create an efficient way to charge and maintain a cell phone battery. I mainly wanted to focus on the charging aspect. If I could find a greater way of charging a phone that would in turn maintain the charge of the phone. I believed the best way to achieve this was to use a natural resource. A resource like the body's heat. I wanted to harvest the natural body heat and convert it to electricity. Enough electricity to charge a cell phone. This would be very difficult but I planned on using a peltier plate that works off of a temperature difference.

J18 Dealing with Diabetes: The Road to Developing an Artificial Pancreas

Engineering
Grace Leopold
Calvary Chapel Academy

In this project, I investigated the challenges of developing an artificial pancreas by testing the efficiency of a homemade circuit. After analyzing my results, I compared the challenges that I faced with the problems scientists are encountering today while the artificial pancreas is in development.
For this model to be deemed efficient, there are three requirements that need to be met. First, it is required that the model pumps 100 milliliters of vinegar into the baking soda bowl to neutralize the solution. The conductivity sensor needs to work properly in order to neutralize the "pancreas". The neutralized bowl must be neutralized, meaning its pH level should be 7.
After applying modifications to Model 2, the highest accuracy was achieved in Trial 3, at 92.5%. Overall, the theory behind this project was supported but there are variables that need to be controlled to reach 100% accuracy. The challenges I faced in testing this model are similar and different from the challenges faced in designing a real and accurate artificial pancreas. Similar issues include the dispersion rate of insulin in the bloodstream and the calibration of the sensor.

K1 Can Robot Technology Help the Visually Impaired Navigate Independently

Engineering
Dylan Kullas
Taunton High School

Research has shown that technology can help people with medical issues (Hodgins, D., 2004) and that people are comfortable with this type of assistance (Hersh, M., & Johnson, M., 2010). Since the visually impaired are unable to navigate independently without intrusive material assistance, such as white canes or guide dogs, technology can be utilized to assist with this problem. A robot can be built and programmed to avoid objects that cross its path. The robot can be programmed to turn whenever it approaches an object. This was tested by building the robot, programming the robot and then running the program ten times, for one minute, within a closed area. The robot was placed in the same starting spot each time and effectively avoided objects during its trials. On average it hit less than one object over the ten trials, while making 61 turns overall. This technology can then be used to develop other more compact devices that can be worn to help the visually impaired navigate independently without intrusive material assistance.

K9 Modifying Respiratory Medical Tubes to Reduce Microbial Adhesion

Engineering
Lida Johansen
Assabet Valley Voc. H. S.

Will micrococcus luteus and branhanella adhere to common medical tubing specifically nasal cannula? If so, is it possible to create an antibacterial plastic coating?

K23 Space Expedition - Beyond The System

Engineering

Conner Bogle, Noah Rosenzweig, Ben Simmons
Marlborough High School

Our group created a project based on the idea of going to Mars and coming back to Earth with a manned mission. Meaning that the rocket would have to go to Mars, humans would have to get off and go to the surface of the planet, then, return to the rocket and go back to Earth. While all of this is happening, the humans would be mining fuel on the surface of Mars and collecting a multitude of samples. The group also designed and 3d printed a rocket and "pod" to show realistic models of the designs.

N2 Increasing the Accesibility of Hydroelectric Energy

Engineering

Esther Ng, Shreya Balaji, Madison Dorazio
Grafton Memorial Senior H. S.

Fossil fuels are heavily relied on as a convenient source of energy, but will inevitably run out due to their rapid rate of consumption. To combat this, it is necessary for people to turn to renewable energy sources, which are far less costly and far less harmful to the environment. Hydroelectric energy is an abundant renewable energy source that can serve as a fossil fuel alternative. With the proper materials and design, harnessing hydroelectric energy can be made accessible to all. The goal of this project was to engineer a hydroelectric turbine; one that boasts a simple, yet effective design. The majority of this turbine was built from everyday household items such as plastic spoons, a cork, and a plastic jug. Not only is the design easy for the average person to make, but it is also practical and efficient enough to produce decent amounts of energy. During test trials, the turbine was able to produce approximately half the voltage of a AAA battery. A practical use for this turbine is to place it at the downspout of a gutter, which will allow water to power the turbine during rainstorms. Although the turbine does not generate substantial amounts of energy, it can drastically decrease fossil fuel consumption with the use of multiple turbines for an extended period of time. Our project aims to show how simple it is to harness hydroelectric energy and in turn, reduce fossil fuel use.

N9 Resistive Heating of Commuter Bicycle Mitts

Engineering

Isabel Koran
Foxborough Regional Charter School

The purpose of this project is to design a system for warming a cyclist’s hands through the use of self-powered resistive heating and insulating, weather-resistant materials, thereby both allowing for user dexterity and providing comfort while riding on cold winter days. Heating was accomplished by sewing 26 AWG Nichrome-80 wire into a fleece cover that fit snugly over the grips on the handlebars of the bike, and wiring this resistive element to a bicycle dynamo. To insulate and protect the user’s hands from the elements, a mitt design was implemented that fit over the handlebars of the bike and had openings for the user’s hands, with the handlebar grip cover attached inside. The mitts consisted of three fabric layers: ripstop nylon on the outside for wind resistance and protection against precipitation and road conditions, an insulating layer of Insul-Bright, and fleece lining the inside for user comfort. In testing, the temperature was found to increase by an average of 5.2 degrees Fahrenheit from the resistive element alone when powered by a 6-volt, 3-watt dynamo – a noticeable temperature difference, but posing no danger to the user through extreme temperature changes. The materials used were determined to be windproof and waterproof. Future design elements might include repositioning of the Velcro that secured the mitts to the bicycle handlebars and a slight enlargement of the grip covers, as well as improved sustainability through the use of recycled material sources.

N17 Developing an Automatic Watering System Using Microprocessing

Engineering
Mya Cohen, Mary Schmitt
Bourne High School

Water waste is a major world issue that can be solved by using a moisture sensor to trigger a water pump that deploys the minimum amount of water needed by the plant. Soil moisture plays a very important role in the growth of plants, and therefore, monitoring of how much moisture is in the soil is helpful to anyone growing plants. Fewer plants will be killed if forgetful gardeners or farmers have an automatic water pump, and if the water pump knows the exact amount of water to use, water is not wasted since plants will no longer be under watered or over watered. For this project, we added code for the moisture sensor's analog data to trigger the pump to water at a moisture level specified by the user. We approached this by trying different prototypes and different codes until we developed a working prototype. As part of this process, we had to find the correlation between millivolts and percentages of humidity level so that we could make a chart for users to be able to plug in the percentage of humidity they want the soil to maintain. We met our objectives as the prototype has succeeded in pumping water when the plant is in need with the least amount of water for the plant. This could be a major contribution to farmers, home gardeners, and horticulturalists.

P5 Stackable Shelters for Natural Disaster Victims and Refugees

Engineering
Alexander Ireland
Quincy High School

This project demonstrates how to save housing space in a post-disaster environment. Thousands of refugees are flooding new countries and the area available to house these people is insufficient. Additionally, people who have lost their homes in natural disasters 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 shelters shaped as truncated octahedrons. By stacking these shelters, it is possible to save up to 72.9% of space when compared to conventional methods. Drawings depicting the design of the shelter, as well as a whole "community," have been created. This project shows how to reduce the area required to house those who have lost their homes.

P6 Biodegradable Water Bottles

Engineering
Christina Le, Sofia Vallejo
Burncoat Senior H.S.

Plastic bottles are consists of synthetic or semi-synthetic organic solid materials created in a process called polymerization or PET. In the last decade, plastic has affected the environment negatively. Our goal is to create water bottles that can decompose naturally. The bottle has to be safe for the consumer to drink from and can hold water for a while. We decided to alternatively mold bottles by using silicone. Silicone is used a lot because it is non-stick and heat-resist. We decided to create our water bottles out of red algae, starch, and banana peels. Each of them will have different procedures with additional ingredients. The procedure for each will be changed as we create these bioplastics. We are hoping to perfect a recipe for bioplastic that will produce a durable water bottle. Making safer water bottles that are biodegradable will definitely benefit the environment in many ways; polluting the environment much less than it already is.

P7 Hinged Counterweight Trebuchet

Engineering
Brandon Preble, Patrick Sullivan, Andreas Simon
Winthrop Sr. High School

The purpose of this project was to see if a team of students could build an original design of a medieval siege weapon, the hinged counterweight trebuchet, and make it fully functional. With a limited budget and a small team it took about six months to completely finish and test the trebuchet. At six feet in height, it is capable of throwing a baseball about 80 feet with a counter weight of 55 pounds.

P19 Sound the Alarm!

Engineering
Alexander Currie
Taconic High School

In this project an alarm clock was developed. The goal was to circumvent the issue of being able to sleep through an alarm due to habituation. Habituation is the diminishing of a physiological response to a frequently repeated stimulus. To do this, the alarm clock was designed to have a randomized alarm tone, function as a normal alarm clock, be an appropriate size to fit on a nightstand, and have a low cost to produce. Using an Arduino Uno chip and various other electronics, a circuit was created that could function as an alarm clock. The chip was then programmed to do so over two prototypes. With the second prototype, more buttons and switches were added to the circuit to accommodate for more functions such as a snooze button and independent time and alarm set buttons. To house the electronics, a CAD model was made and 3D printed. It was too small to fit the circuit, so a second, larger model was created. This second model was then printed, and is now used to house the electronics. The clock was tested, and proved to work well for its intended purpose. The randomized alarm provoked a quicker response time than a normal alarm when tested.

Computers

Computers

A7 EmerSave: A Novel Crowdsourcing Emergency Response Application

Computers
Vishnu Penubarthi
Mass. Academy of Math & Science

In America, only 30 percent of calls made to emergency medical services (EMS) require medical attention, and in cases where EMS is not required or not available, others can help. Furthermore, the 9-1-1 service has indicated that it is not always able to reach people in emergencies due to factors such as overloaded call-centers or geographic distance. Other applications attempt to address this issue but can be impractical because panicked users are often unable to spend time tapping buttons on their phone during an emergency. EmerSave is an Android application developed with Android Studio and Firebase, which sends hands-free distress messages to contacts within a specified radius. The application allows the user to call for help manually or with voice recognition and can even be accessed when the phone is locked. Contacts within a specified radius receive a notification that the user needs help. With a tap on the notification, a Google Maps page is opened providing directions to the user. One of the unique features of this app, the radius-based system, was tested to determine its accuracy and had a 100% percent success rate within the messaging-radius.

A19 Developing An Algorithm for Feature Detection in Noisy Medical Images

Computers
Krish Nathan
Mass. Academy of Math & Science

Medical images are the first resource doctors use to make a diagnosis. Automatic feature detection enables faster diagnoses by highlighting important structures. However, feature detection algorithms are less accurate when noise is introduced into images. A histogram based thresholding algorithm was applied to noisy images. Edge maps were created from the thresholded images, using Canny edge detection. Gray level co occurrence matrices were generated to calculate entropy in noisy chest x ray images. The calculated entropy was used to threshold the image while accounting for noise. A traditional snake model was then applied to the original noiseless images to produce reference edges. Edge accuracy from histogram and GLCM-based thresholding was measured by finding the distance between predicted edges and reference edges. GLCM based thresholding yielded lower distance than histogram based thresholding, indicating more accurate edge detection on noisy images.

A20 Dewey Wins: Predicting United States Presidential Elections

Computers
Hava Kantrowitz
Mass. Academy of Math & Science

The election of Donald Trump was a major political surprise for citizens of the United States because for months the American public had been told by polling-based predictive methods that Trump had no chance of winning the presidency. This project was developed to create a more accurate prediction method by avoiding reliance on volatile polls of public opinion, and instead making a prediction based on the only semi-constant in politics: money. The candidate's individual contributions, PAC contributions, and personal assets were taken into consideration. This data, obtained open-source from the CRP Open Secrets website, was coded into a Bayesian analysis module on Python. After analysis of each dataset, the results were averaged to form a final prediction of the vote percentages for each candidate. This algorithm correctly predicted the outcome of the election in four out of the five presidential elections held between 2000 and 2016.

A28 Deep Learning Analysis of Mammograms

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

According to the CDC, 1 in 8 U.S. women (about 12%) will develop invasive breast cancer over the course of their lifetime. As it grows, it can metastasize throughout the body causing serious health issues and death in many cases. Mammography remains the most effective means available to detect cancer in its earliest stages. However, overdiagnosis and overtreatment are two prevalent risks of mammography screening. These risks cause unnecessary mental and physical pain in addition to exorbitant cost as almost 4 billion dollars are spent on correcting misdiagnoses (CNBC). These adverse consequences can be mitigated by more accurate diagnosis of breast cancer using machine learning, specifically deep learning. This paper utilized deep learning to classify the nature of breast tumors gathered from the Curated Breast Imaging Subset of the Digital Database for Screening Mammography (CBIS-DDSM). The dataset consisted of multiple views of 3567 patient mammograms with full pathologies and annotations. Factors such as resolution, affinity, and contrast were artificially augmented for each image, to account for the various acquisition methods of mammograms as well as to better assess the neural network's predictions. The neural network achieved a validation accuracy of 82% in predicting the pathology of the tumor using a resolution of 200x200, as well as a contrast ratio of 2.0 and different affine transformation. Using this algorithm, issues regarding the overdiagnosis and overtreatment of breast tumors can be greatly mitigated and hence allowing for accurate diagnosis. Future work includes proving the generalizability of this model by testing it on other publicly available datasets as well as utilizing transferred learning via deeper neural network structures to improve accuracy.

B9 Networking of a Cellular Communications Mesh-Net

Computers
Vincent Lomino
Wachusett Regional High School

The goal of this computer project was to create an android application for phones that uses the cellular radio frequencies of the phone to create a mesh network for sending text messages (single packet) and making calls (constant stream of packets). Cell phones have the capability to communicate in a frequency range that is unused in the USA. The mesh-net network architecture will allow the phones to act as routers for one another, where packet traffic bounces from phone to phone in a determined path. Mesh-nets are also self-healing, because there is no single point of failure in the network.
The process of the app works as follows. The device searches for other devices to connect to. Any device that is found joins the device ledger which is broadcasted out to every device, making sure that all devices know who they can communicate with. Each device ledger is broadcasted out whenever it changes. The users can choose any given device that is on the ledger to connect to. If a chat is sent without a specific path, then it is broadcasted to all connected devices until it makes it to the designated receiver based on the phone’s MAC address.
The underlying theory behind this app is for initially the creation of a chat app, that works without wifi and forms a cellular frequency mesh-net instead. Through the development up to this point, the only stable version works with wifi. Further development is in progress.

B22 MelaNOma: Application-Based Melanoma Detection Using Machine Learning

Computers
Joyce Fang
Mass. Academy of Math & Science

Melanoma, the most serious type of skin cancer, affects over 200,000 people annually in the United States. Early detection is vital because melanoma is 99% treatable in early stages. Current applications lack mole assessment features, and current detection technology is not accessible to the public. The goal of this project was to develop a melanoma detection application for mobile devices that was easy to use with accuracy compared to current networks. An artificial neural network, with a test accuracy of 79.3%, was trained on over 3,000 images using transfer learning on Inception v3 from TensorFlow. The network was optimized for mobile development and implemented into an application in Android Studio. The optimized network was validated using 100 unfamiliar images and achieved 74% accuracy, with a classification probability of 60.05±8%, indicating that the network still maintained reasonable accuracy after optimization. Compared to Stanford's automated dermatologist's accuracy of 72.1±0.9% and Doctor Hazel's accuracy of 74%, the network was comparable in accuracy. This application could save many lives through early detection of melanoma before it metastasizes.

B23 Predicting Response of Visual Neurons with Machine Learning Techniques

Computers
Taehoon Han
Northfield-Mt.Hermon School

The sensory neurons in the brain produce rapid fluctuations of their membrane voltage, which is known as action potentials, in response to stimuli. The collective activity of a population of neurons determines the sensory experience. Machine learning is a subfield of computer science, and it provides various computational algorithms for finding patterns in data. In this project, logistic regression and multi-layer artificial neural network algorithms are employed to classify and predict the responses of model visual neurons, using cross-validation to avoid overfitting of data. Both algorithms yielded good classification performance, sometime yielding 99% accuracy in the case of logistic regression. For the more realistic model using normalized neural responses, the classification performance was reduced in comparison to simplified Gabor model. This study suggests that it is possible to analyze the neural responses with machine learning algorithms, but it is necessary to develop more sophisticated models to capitulate the realistic neuronal activities.

B26 Impact of Smartphone Use on Traffic Flow

Computers
Avery Woolbert
Newton Country Day Sch/Sacred Heart

This project is inspired by drivers' inclination to check their smartphones while driving, and the effect this has on traffic flow. The engineering goal of this project was to code a computerized simulation to measure the effect of smartphone use on traffic flow. Two independent variables were tested: the percentage of phone-checking drivers out of total drivers on the road at once and the acceleration delay that results from drivers checking their smartphones while driving. The dependent variable was the flow rate of cars on the road, measured in number of cars per hour past a specific location on the road. The hypothesis was that if the effects of both the percentage of phone-checking drivers on the road and the acceleration delay that came as a result of those drivers checking their smartphones in traffic, then the more influential factor of smartphone use on traffic flow will be the percentage of phone-checkers on the road. In order to replicate as accurately as possible real-life traffic scenarios and driver decisions, this project incorporated the Intelligent Driver Model mathematical traffic model. The IDM is a microscopic traffic flow model in which a vehicle's decision to accelerate or decelerate is dependent on its own position and speed, and on the position and speed of the vehicle directly in front of it. This model was used specifically because it allows for any parameter to be easily tested. As shown in the resulting data, a higher percentage of phone-checkering drivers and a longer acceleration delay resulted in a smaller flow rate. This signifies that the effect of cell phone use does, indeed, decrease the rate of traffic flow. This project met its engineering goal. However, the hypothesis of this project was not supported.

C5 Reinforcement Learning Used For Aggressive Maneuvers On Quadcopters

Computers
Elan Rosen
Hopkinton High School

The focus of this project was on advancing quadcopter movements and autonomy by using reinforcement learning in a simulated environment. This new method of developing aggressive quadcopter motion was attained by utilizing a proximity policy optimization algorithm in order to train the model. The simulation was created within the Unity 3d engine and the model was trained with Google TensorFlow resources. Most maneuver research in quadcopters has either been achieved with color/object detection algorithms and a heuristic decision tree or an abundance of high-speed cameras for tracking trajectory and imposing a flight plan. These forms of autonomous movement lack adaptability as they are only useful for limited tasks. In addition, they lack scalability as the software written cannot be easily transferred to other tasks. By generating an implementable control model that can determine its own trajectory without pre-existing algorithms, it can adapt to a more dynamic environment. The methods used in this project bring newfound scalability to aggressive maneuvers as increasingly complex environments and tasks can be modeled and programmed while still using similar parameters.

C21 On the Development of Efficient Append-Only Authenticated Dictionaries

Computers
Vivek Bhupatiraju
Lexington High School

In this paper, we present a novel cryptographic primitive called an append-only authenticated dictionary (AAD). The AAD formalizes the notion of a transparency log, which has important applications in secure public-key directories, certificate authorities, and software transparency. An AAD is managed by an untrusted server, and is audited by clients to make sure it maintains the append-only property: each key's value is set once and is never changed or removed. To prove this, the server computes cryptographic proofs that the client can verify.
When applied to the AAD model, past authenticated dictionaries provide solutions that are computationally efficient for the server but bandwidth expensive for the clients. As bandwidth for clients is generally far more expensive than computation for servers, we explore the opposite trade-off, developing three novel schemes that provide bandwidth efficient solutions. The main result, polyAAD, is based on constant-sized polynomial commitments. It provides proofs with O(1) bandwidth at the cost of O(nlogn) computation where n is the total number of key-value pairs in the dictionary. The construction thus demonstrates that bandwidth efficient AADs exist. We then extended the polyAAD to two other schemes: the binary polyAAD and the linear polyAAD. Each extension reduces computation at the cost of bandwidth: the binary polyAAD lowers computation cost slightly, while the linear polyAAD nearly balances computation and bandwidth.

D10 A Recurrent Approach to Artificial General Intelligence Algorithms

Computers
Aedan Cullen
Hopkins Academy

This project addresses the growing field of machine learning and artificial intelligence by suggesting a new approach to the question of whether or not a so-called "general intelligence" or "strong AI" is possible. It investigates the currently-suggested abstractions for the concept of computationally modeling a mathematical relationship, and develops a unique approach based on the definition of intelligence as a "lack of randomness" in problem-solving. An solution based on the concept of a Neural Turing Machine is used, where one configuration of the machine's parameters is allowed to be changed by another machine instance. The machine modifying the parameters of the other is given a set of "practice" problems on which to evaluate the performance of the machine being modified. The practice problems are equivalent to the "training set" of data used in traditional machine learning. The goal is that the machine being modified eventually exceeds the score achieved by its predecessor on this dataset, and is then put to work modifying its own parameters in order to produce another machine which is a more effective "general optimizer" of its own parameters. The hope is that an exponentially-improving optimizer can be produced; however, it is to be expected that there may be shortcomings introduced by this approach or certain factors that make this approach too computationally expensive to be practical. The intent of this project is to discover those shortcomings, if they exist.

D11 Predicting Long Term Stock Price Movement Through Machine Learning

Computers
Nabil Kebichi
Lexington High School

Stock price prediction is a very difficult problem to solve because of the many factors that affect the price of a stock. In this project, I put Machine Learning (ML) to the test to see how accurate it can be at this task. ML is a technic from artificial intelligence which consists in building an artificial neural network (ANN) to learn from a set of data so it can be used to estimate the value of the model for newer data. ANNs are highly parallel structures made of cells whose function are 'S' shaped like 'htan' function. These cells are organized in several layers, where each layer feeds data to the next. They mimic how the brain works. Their power reside in their ability to extract the underlying non-linear model that associates a set of inputs to a set of outputs. I will use PyCharm environment along with 'scikit learn' machine learning library. As part of this work, I will upload training data from the internet, I will split it into 70% for training and 30% for testing. I will experiment with toggling neural network parameters to see how accurate I can get.

D14 Accurate and Affordable Device for Skin Condition Diagnosis

Computers
Daniel Tian
Berkshire School

In this study, I created an accurate, affordable, and immediate method of diagnosing childhood skin condition for parents right on their phone. Indeed, with the projected growth of 6.3 billion mobile phones world-wide by 2021, mobile apps outfitted with A.I. algorithms such as the one described in this research will prove to be an effective tool to extend low-cost, universal medical health care to a wider audience than ever. Furthermore, from a technical point of view, this research also examines several key application details. First, I verified that the effectiveness of transfer learning in a completely different, low-data domain. Second, I also provided analysis and precautions to overfitting, a universal problem in A.I. training; this includes, dividing training set into smaller sets of more similar properties, data-augmentation in training pipelines, and decreasing training batch size.

D22 System for Consumer Controlled Credit History on Blockchain

Computers
Faateh Mohammad
Hopkinton High School

This is a system that allows consumers to be able to access, control, manage, and eventually own their credit histories without any middlemen. This solves the current problems of hacks and identity theft with credit bureaus. This system is a decentralized application which stores its data on a blockchain, uses cryptography to secure the data, and uses economics to incentivize lenders and consumers to use the system.

D24 Intelligent Cloud-Based Medication Dispensing and Scheduling System

Computers

Himanshu Minocha, Rohan Minocha
Hopkinton High School

The United States faces an epidemic people dying as a result of unintentional and accidental overdosing on Opioids. In Massachusetts alone, in the past 15 years, over 11,000 people have died solely from accidental and unintentional overdosing. In the United States, drug overdosing is the number one cause of accidental death. Amongst the elderly, a staggering 40 to 75% of all seniors do not strictly comply with prescription medication schedules. As a result, the amount of people that die as a result of unintentional overdosing has quadrupled since 1999. There is no system that exists which can reduce the number accidental and unintentional overdoses.
The Intelligent Cloud-Based Medication Dispensing and Scheduling System(ICMD) seeks to reduce the number of accidental overdosages by reducing the number of people who build a tolerance to medication. ICMD is a hardware and software solution. The hardware is a connected pill bottle which utilizes technology like Bluetooth to connect to an application system. The hardware has two compartments which allow for two different medications to be stored in the bottle. There are two applications for two different roles: patients and caretakers. The patient application allows a patient to dispense medication from the bottle and is connected to a server system which validates whether medication can be dispensed safely based on factors like the type of medication, the day and the time. If the validation of whether medication should be dispensed fails, an override request is sent to the caretaker portal. There a caretaker can look at all interactions with the bottle in a log and choose whether to override the validation and automatically dispense the pill from its respective compartment.

D26 JARVIS, My Homemade Digital Assistant

Computers

Justice Torkornoo
Worcester Technical High School

I created Jarvis to see if I could replicate the programming and software shown in the Marvel movies. Jarvis was created using JAVA and Python programming languages. He will be able to do certain functions that are useful to everyday people like telling you the weather and navigation. He will also be able to connect to computers on a network and do basic tasks with them.

F3 Using Twitter to Predict Influenza Outbreaks

Computers
Jeremy Schneider
Marian High School

Background: Influenza is a dangerous virus that spreads rapidly. It has an economic impact of $80 billion annually. Twitter is a social media platform that can be utilized for surveillance due to the sheer amount of daily tweets on various subjects.
Purpose: To see if data retrieved from Twitter can track and predict influenza activity accurately as compared to government influenza data.
Methods: I collected data from Twitter, with a mention of 'Flu' or 'Influenza', for a period of 20 days. Weekly influenza Tweets were compared to weekly influenza government data at the Metrowest, Massachusetts, and USA levels using the Pearson correlation coefficient.
Results: Correlation was 0.80, 0.94, and 0.99 for Metrowest, Massachusetts and USA levels, respectively.

F7 Cybersecurity: How Quickly Can Your Password be Cracked?

Computers
Menaja Raja
Tahanto Regional High School

This project explores the basics of computer hacking using Python Programming. The program is composed of 4 different methods. Method one uses digits, method two uses alphanumeric characters. Method three uses a list of the 500 most commonly used words. Finally, method four uses commonly used words along with special characters.

F13 Remote Sensing Using Drone and Machine Learning Algorithms

Computers
Neel Bhalla
Lexington High School

Forest deforestation is a major driver of biodiversity loss and greenhouse gas emissions. Remote sensing data and images can be used to assess changes in forest cover, species distributions and understand the impact of deforestation. Image classification for remote sensing can be time consuming and typically require algorithm development with human expertise to classify images. The remote sensing classification task can be automated by relying on machine learning algorithms. Sensor imagery can be stitched together to produce temporal geo-referenced land use/cover maps of surveyed areas. Using machine learning the aerial photographs can be classified in real time. This system can be used for environmental and conservation applications, which include near real-time mapping of local land cover, monitoring of human forest activities, and surveying of animal species.
In this project I am proposing to build a remote sensing surveillance system that will collect and classify images using machine learning algorithm. This project will be a software and all the modules will be programmed in Java, C and Python. The images will be stored in a database and machine learning algorithms will be developed and trained on the collected images.

F14 Detection of Malignant Melanoma Using Machine Learning Algorithms

Computers

Ashwin Padaki, Shiv Khandelwal
Lexington High School

We specifically chose to address the problem of the skin cancer known as Malignant Melanoma, because one of my close family friends had recently passed away because of it, and because of its devastating impact in the U.S; a predicted 9,320 people will die from this disease in 2018. We found that the survival rate for early-stage Melanoma was 98%, yet only 18% of people survive from late-stage melanoma. When we realized that we could help save lives, we immediately went about finding a way to instantaneously diagnose Malignant Melanoma. This would allow users to easily obtain a diagnosis of their condition, which is an effective and rapid alternative to consulting a dermatologist.

We found that the vast majority of the deaths from malignant melanoma can be prevented if diagnosed and treated early. We strove to solve this problem using machine learning and the implementation of an image classification model. This provides a rapid diagnosis of the user's condition, allowing early awareness and sufficient time to get it treated.

After testing our model, we found that it had a validation accuracy of 98.75%, and a validation loss of 0.0634. We determined the validation accuracy and loss metric by evaluating the model's accuracy with a data set of 4,501 images. This tells us that our model can accurately classify real-world images of melanoma moles as either malignant or benign, proving its utility in real-world applications.

We created an accurate and effective way to diagnose the condition of a case of melanoma, through the classification of an input image of a melanoma mole. We were successful in implementing our project into an Android application, which makes it accessible to more than 2 billion people, making our contribution valuable.

F21 Using Machine Learning to Predict Where a Reddit User Posts Most

Computers

Benjamin Chen
Weston High School

The goal of this project was to create and train a neural network to correctly classify what subreddit, or category, a reddit user most often posts in. A convolutional neural network was used to predict this. The differences between subreddits and what words made an author more likely to post in a certain subreddit were studied. The model gave very good results, usually obtaining an accuracy of at least 95% on test datasets, much better than random guessing (50%). This shows that, given data, equipment, and time, a computer can predict human behavior on social media.

F24 Assistance for the Ethical Hacker

Computers

Carlisle Beach
Wareham High School

Coding has become a gigantic field in the past few years, with the rise of the internet. My project to coding itself.Coding languages were created years before the internet and were used to create it. One coding language created was Java, which I used to create my project. In my project, I wrote a program to guess a set password and theorized that it could be accomplished in under one minute. This project was created in Eclipse. Eclipse is a software for writing and editing code. (particularly Java) I used my old i3 Toshiba Satellite laptop for this project. My project guessed from zero to a set number (ie: 10,000) counting one up each time. When the wrong number was found, the console prints “sorry, wrong pin!”. When the correct answer is found, the console prints “Correct!” I used a random string password generator to create all my passwords. The passwords I tested were 4,5,6, and 7 digits in length. I tested the speed of each digit 9 times, overall a total of 45 times. The averages for the 4,5,6,7 and 8-digit passwords are as follows,0.002959227111 seconds for 4 digits, 0.01810922089 seconds for 5 digits,0.07987411222 for 6 digits,0.4149217904 seconds for 7 digits, and 3.535116771 seconds for 8 digits. My project was a huge success. It guessed the passwords in far less time than I had imagined it would’ve.

G16 Machine Learning to Find Correlations Between Diseases and Habits

Computers

Tyler Rhodes, Advait Nene
Hopkinton High School

People want to know how the choices they make on a daily basis impact their health. Currently, there is no program that allows an individual to input their actions and discover their risk for developing diseases. The goal of this project was to develop an iterative machine learning algorithm that applies logistic regression to data sets based on human behavior and lifestyle factors in order to determine correlations between an individual's actions and a specified disease. In this case, heart disease was chosen to be analyzed. Answers to the Center for Disease Control's yearly “Behavioral Risk Factor Surveillance System” survey were used to train the algorithm. The algorithm quantified the correlation between each question in the survey and heart disease. The correlations given by the algorithm were proven to be accurate through comparison with research previously done by organizations such as the CDC and the American Heart Association. These values were then used to create a "Heart Disease Risk Calculator". Now, people can answer a series of yes or no questions and receive a percentage risk for having heart disease later in their life. This provides society with a tool to see how actions people take impact their health.

G23 Visualizing Ground-Based VLF Transmissions Using RPI Data

Computers
Anjalie Kini
Phillips Academy

The Van Allen radiation belts are a collection of electrically charged particles that have accumulated in the Earth's magnetosphere. The electrons that are trapped in these radiation belts can damage satellites and cause spacecraft failures. The Radio Plasma Imager (RPI), which is a low-power radar instrument, collects plasma data from the magnetosphere. There are VLF ground transmission stations around the globe, the waves they generate propagate into the magnetosphere, interact with trapped electrons and remove them. Since any signals between a satellite and the ground must pass through this region of the atmosphere, studying these VLF waves provides us with important information about the potential for communication outages. The objective of this project was to study the electron densities at the frequencies corresponding to different VLF ground transmitters. Observations were aggregated from areas of the atmosphere in proximity to these locations, as well as the magnetic conjugate points. Data visualization techniques were used to gain an understanding of seasonal variations. It was hypothesized that the electron densities would be higher during summer because thunderstorm activity along with the accompanying lightning is much more intense in summer. On a map of the earth, these densities were plotted along with the magnetic equator and conjugate points. The data was analyzed via graphs, and visualization techniques (interpolation and contour plotting functions) were used to clarify patterns. It was observed that electron densities are higher during the summer months as was hypothesized. Future steps include studying additional ground-based VLF transmitters and taking solar conditions into account.

J10 Building a Novel Autism Classifier with Machine Learning Approaches

Computers
Elizabeth Ding
Lexington High School

The purpose of this project is to build a novel classifier by using machine learning techniques to improve the accuracy of diagnosis of autism based on their clinical and genetic data. All data were obtained from public data resources that have been widely used by other scholars. I constructed an integrated file that include clinical and genetics data with appropriate assignment of scores. Then I processed the data using four machine learning algorithms (NN, Bayes, J48, and SVM) from the WEKA workbench. The results show that by I was able to build a more accurate predictive classification model that not only increases the accuracy of predicting by 15% and above comparing to the diagnosis given by clinicians, but also significantly shorten the time for the diagnostic conclusion to few seconds.

J25 Using Machine Learning to Predict the Stock Market

Computers
Thomas Smith
Stoughton High School

Can a recurrent neural network utilizing long-term short-term memory architecture with the TensorFlow library, and a Keras wrapper, predict future market values with an accuracy higher than 50%? My program would analyze past information from the stock market over the course of 50 years, and from that develop trends from information to predict future market prices. Specifically, it would be utilizing the TensorFlow library, and a Keras wrapper, to develop a recurrent neural network that utilizes the long-term short-term memory abilities to better analyze past data. This neural net will be two prong in its predictive capabilities. The first part that will be developed will be a neural net that is trained on just the stock prices, this will allow the program to develop the basic principles of analytical stock trading. This if proven successful at predicting with a relative accuracy, but not necessarily 50%, will be paired with another neural net, that uses the analyzing side of natural language processing methods provided by TensorFlow, to read articles for the last 50 years, in financial news and world news, to create a relationship between the events of the real world and the stock value, thus theoretically increasing the predictive power of the overall program, because it utilizes two types of predictive sources. These neural networks work by training on data that is freely available. In this case, the first neural network will look through about 1 month of stock market values from a previous year for the top ten fortune 500 companies. I was able to redeploy the program without further training to predict the outcome of the gains and losses of the cryptocurrency Ethereum, illustrating the robustness of machine learning, and specifically deep learning.

J26 Plant Disease Identification Using Deep Learning

Computers
Kevin Qi
Boston Latin School

Plant diseases are a major threat to food security that can cause famine and major economic loss in a region. My objective was to train multiple pre-constructed Convolutional Neural Networks using healthy and diseased images from a corn image dataset found on the Plantvillage website.
Initially, the neural networks were expected to perform at around 80% accuracy. However, the actual results were disappointing. The network based on the AlexNet architecture only got 27% of the testing images correct. This can be attributed to the lack of training images used to train the network. Ideally, a computer with a GPU would be used to process the data, but I only had access to my laptop. Thus in order, to complete the project on time, I had to significantly reduce the number of images used, creating partially-trained networks.
In order to improve on this project, I need to gain access to computer with a GPU to produce better networks. If done well, the networks can be integrated into apps and websites that will allow farmers to submit phone images of a diseased plant and receive and immediate diagnosis.

P12 Cracking Ciphers

Computers
Joy Kalinowsky
Berkshire Arts & Technology Charter Public School

Which method deciphers a Caesar cipher encrypted code the fastest? The hypothesis states that two-letter analysis will enable a participant to decode a Caesar-cipher encrypted code the fastest. We gave six participants the code, and tested how long it would take to decipher the code using three different methods. This hypothesis was refuted, as the substitution analysis turned out to be the fastest method. After the experiment was complete the most efficient method to crack a Caesar cipher without technology was proven to be trying every possible combination. This experiment only involved six participants, but could be improved by including more than fifty participants.

P15 KeyChat: Secure Messaging via Bitcoin

Computers
Robert Chen, John Kuszmaul, Yiming Zheng
Lexington High School

We present KeyChat, a secure messaging system leveraging the Bitcoin blockchain. Secure messaging across a network of many clients remains a difficult challenge. If a public key directory is compromised by a malicious adversary, then this adversary can equivocate about the public key directory to different clients. Thus, an adversary can impersonate a client. We use Keybase, a public key directory, to implement a secure chatting application for users with Keybase accounts. Keybase periodically publishes its digest to the Bitcoin blockchain. This makes equivocation as difficult as forking the Bitcoin blockchain, which is believed to be hard. However, Keybase currently publishes its digest in an inefficient-to-verify manner. We use Catena, an efficient Bitcoin-witnessing scheme, to make the Keybase directory publicly and efficiently auditable for non-equivocation, thus making KeyChat more secure. Consequently, KeyChat allows for the efficient exchange of secure messages across a network of many clients. To the extent of our knowledge, we are the first to implement a Catena log for a deployed public key directory. Furthermore, we believe that we are the first to design a secure messaging system resistant to equivocation attacks by the public key directory, though we are still in the process of implementing it.

Biology

Biology

A8	Implications of Epigenetic Mechanisms in Heritable Fertility Trends
A15	Oxidative Stress and Neurodegeneration in Alzheimer's Disease
A16	Identifying Proteins Associated with Mitotic Defects in pRB Pathway
A17	Alternate Allergy Testing for Eosinophilic Esophagitis
A22	The Effect of Temperature Stimulus on Drosophila Melanogaster Activity Level and Reproduction Rate
B4	Germination of Mung Bean and Maize at Low Pressure
B7	Activity of the Basal Ganglia in Schizophrenia and Bipolar Disorder
B10	The Effect of Tangerine Citric Acid on Pogonomyrmex Barbatus
B20	Analysis of Microbes Cultured From Keys of a Computer
C4	The Effects of Temperature on Mealworm Metabolism of Plastic
C6	How Much Bacteria is Growing in Your Pouf?
C7	Bioprospecting for Benthic Fungi and Their Bactericidal Antibiotics
C12	The Effect of Barometric Pressure on Joints
C20	The Effect of pH on Plant Growth
C22	Memory Retention and Structure Changes in Planarian After Regeneration
C28	Environmental Factors on Cellular Respiration Rates
D3	The Effects of Ibuprofen on Motor Function in Drosophila Melanogaster
D8	What Are You Eating?
D9	Protein Structure Prediction with Recurrent Neural Networks
D17	Effect of Curcumin Based Biosynthetic System on Growth Rate of P acnes
D18	Effect of Melatonin on Tachycardia in Daphnia Magna
D20	Al, NaF, and C4H6O2 Impacts on Learning and Memory in D. melanogaster
F12	RepeatFinder: A Trinucleotide Repeat Search Tool
F15	Analyzing Effect of Nitrogen Starvation vs Carbon on Microalgal Lipids
F16	The Effect of Growth Hormone on Daphnia magna Reproduction
F18	Bacterial Transformation
F19	Neural Networks and Colon Polyp Detection
F25	Applying Machine Learning to Predictive Gene Data Analysis Tools
G5	Innovative & Affordable Smart Syringe to Contain Epidemic for Billions
G12	The Effect of Ginger and Zingiberene on the Lysozyme Activity of the Bombyx mori
G13	The Effect of Carbon Dioxide on Plant Growth and Nutritional Value
G15	Does Dehydration Affect Your Innate Imune System?

G18 The Effect of Guarana, Ginseng, and Vitamin C on Daphnia Magna Heart
G22 Effect of Glucose on the Sex Ratio of Drosophila Melanogaster
G24 Fibonacci in Nature: Investigation on Mathematical Patterns in Plants
G25 Expression of Carbonic Anhydrase Ion Channels in Ameloblasts
G27 Using SNP Correlation to Find the Risk of Developing a Genetic Disease
H1 Where Did All The Males Go?
H3 Creamery Sanitation Method Efficacies Relative to Creamery Surfaces
H7 Effect of Baking Soda on a Pancake
H9 Comparing Effectiveness of Bacteria and E. hortensis to Degrade PCBs
H19 Effects of Alcohol and Nicotine on Fecundity in D. melanogaster
H20 Blocking Multidrug Resistance in Cancer Cells with MicroRNA Mimics
H26 Can You Go "All Natural" With Antibiotics?
H27 The Effect of Different Anti-Fungal Agents Have On Yeast Infection
H28 Bacterial Communities Kitchen Sponges
J2 Survey of Critical and Lethal Temperature Range of Achetus domesticus
J3 The Use of Enhanced Image Processing to Detect Bovine Rumen Acidosis
J4 How Acne Medications Affect Bacterial Growth
J11 Charles River - Dangerous or Not: Identify and Characterize Bacteria
J13 The Effects of PH Level within a Designated Range on Hydra Populations
J20 The Effects of CO2 on Plant Growth
J21 A Comparison of Meat Freshness upon Different Thawing Methods
J22 The Tell-Tale Hearts
J23 Nutrition of Drosophila on Sex-Linked Inheritance of l(2)gl Mutation.
J24 Deep Learning Approach for Classifying Motor Imagery EEG
J27 The Effect of Household Products on Staphylococcus epidermidis
J28 Effect of Pesticides on Lotus Rhizome's Antibacterial Ability
K6 Effects of Agricultural Antibiotics on Bacterial Antibiotic Resistance
K7 The Effects of Arbuscular Mycorrhizal Fungi and Rhizobacteria on Peas
K10 Transgenesis in Drosophila Using Caffeine
K12 Dietary Effects on Immunosuppressant Cytokines in Drosophila
K14 Drugs & Genetics
K15 The Effect of pH on Fluorescence

K17 The Use of Essential Oils to Fight Fire Blight in Fruit Trees
K21 GenEon Spray Solution Kill Bacteria?
K24 What's in the Balance?
K28 NGS Analysis of Multiplex Programmable DNA Assemblies
N3 Occurence of Symbiosis in the Deep-Sea
N4 Accelerating Zika Virus Drug Discovery Using Chemogenomic Approaches
N8 How Do Changes in pH Affect Plants in an Aquatic Environment
N11 A Novel Approach to Transplantation without Immunosuppression
N13 Inflammation and TWEAK
N14 Nrf2b’s Regulation of Oxidative Stress Response Genes in Zebrafish
N15 Phytohormone Manipulation
N18 Improving Efficacy of Ultrasonic Nutraceutical Liposomal Delivery
N20 Enzymatic Browning
N23 Microbial Sensitivity and Resistance to Antibiotics between Subjects
P8 Does Feeding Animals GMO Foods Affect Their DNA?
P9 Impact of Temperature on Coral Symbioses
P10 The Effect of Spices to Inhibit Bacterial Growth
P11 Do Different Dilutions of Disinfectants Affect Bacterial Resistance?
P17 Effect of Cytokines on the Function of the Salivary Glands
P24 An Inquiry on the Evolution of Candidate Genes in the Origins of Span
P25 Bubble-ology

A8 Implications of Epigenetic Mechanisms in Heritable Fertility Trends

Biology
Evan Mizerak
Wachusett Regional High School

The global rate of infertility stands at an all-time high and nutrition has been discussed as an impactful factor in such skewed trends. Stable oogenesis is continually threatened by genotoxic stress stemming from DNA damage, much of which is inflicted by transposition at the germline. Using Drosophila melanogaster as a biological model, this study successfully identified multiple heritable mechanisms that govern nutritionally malleable response to DNA damage and infertility at the molecular level, including piRNA and, downstream, checkpoint kinases such as ATR, CHK1, and CHK2.
The image analysis applications ImageJ and Icy were used to quantify increased intermediate stage development and and pole plasm area in the high-fat fly germarium. Next-generation sequencing (NGS) was used to holistically profile the cellular transcriptome of wild-type and mutant D. melanogaster, uniquely elucidating the role of kinase-mediated DNA damage response pathways in the context of genotoxic insults and further identifying the PIWI-interacting RNA (piRNA) pathway, a mammalian homologue, as a safeguard against genomic instability in response to variable dietary intake. This study also identified MT-ND3, MT-ND4, and MT-ND5 as potentially implicated genes in piRNA localization. Presented herein is a previously nonexistent model for further experimental analysis of the heritable properties of DNA damage repression that could be used in the development of methods to address underlying intrinsic mutations fueling the burgeoning fertility crisis.

A15 Oxidative Stress and Neurodegeneration in Alzheimer's Disease

Biology
Sada Nichols-Worley, Sophie Haugen
St. Mark's School

Alzheimer’s Disease (AD) is a progressive neurodegenerative disease that causes devastating memory loss and cognitive decline in humans. There is no current cure for AD. Research studies show that oxidative stress is correlated to and possibly a cause of this neurodegeneration. Because antioxidants such as melatonin have been found to reduce oxidative stress, melatonin could alleviate neurodegeneration and serve as an effective dietary supplement for people with with AD. In this experiment, a tauopathy Drosophila melanogaster mutant that expresses human tau (MAPT) under gal4 in neurons was used to model AD in humans. This study measured learning and memory of the Drosophila through an olfactory vortex learning assay in a t-maze. Groups of flies with and without melatonin supplementation were tested in the t-maze. Following experimentation and data collection, preliminary results from this study suggest, but do not confirm, that melatonin reduces memory loss and improves cognitive function in a Drosophila AD model. Further trials are needed to confirm the suggested results.

A16 Identifying Proteins Associated with Mitotic Defects in pRB Pathway

Biology
Piyusha Kundu
Mass. Academy of Math & Science

The RB tumor suppressor gene is mutated in many cancers including lung cancer, breast cancer, and melanoma. Mutations in tumor suppressor genes contribute to misregulation of cyclins and CDKs, which can lead to mitotic defects and tumor formation. In this study, image analysis was performed on groups of WT and RB-KO human cell images to connect defects to their likely cause: specific differentially regulated proteins. The images were scored, and the total number of cells in each group was found to be significantly different (p=0.0001). CDC20 emerged as a putative cause of excess cell proliferation. CDC28 was overexpressed in S. cerevisiae to determine if the CDC20/CDC28 interaction could rescue the growth phenotype of RB-KO cells. The overexpression of CDC28 partially rescued the phenotype and increased the rate of growth in S. cerevisiae. The results imply the possible enzyme/substrate interaction between CDC20 and CDC28 is important in the RB pathway.

A17 Alternate Allergy Testing for Eosinophilic Esophagitis

Biology
Sydney Hobson
Mass. Academy of Math & Science

Eosinophilic Esophagitis (EoE) is a chronic, antigen-driven immune disease that causes a delayed inflammation in the esophagus, resulting in food impaction. Routine allergy testing methods, time-consuming food elimination diets, and invasive and frequent endoscopies are used to find the cause of the inflammation. This study involving a patient with dairy-induced EoE and his sister, focuses on a less invasive saliva-based allergy testing method that reduces the number of endoscopies and amount of time needed to find the cause of EoE. Saliva samples taken from the patient and his sister were exposed to either dairy or wheat. An ELISA kit was used to quantify the salivary concentration of IL-13 cytokines, proteins involved in EoE. For the EoE patient, the first test showed an increase of cytokine levels in the wheat sample (p-value = 4.25*10^-08), and a decrease in the dairy sample (p-value = 1.37*10^-15). The second test showed different trends in the data and more variable results. Therefore, additional testing needs to be completed in order to determine if saliva is viable for EoE allergy testing.

A22 The Effect of Temperature Stimulus on Drosophila Melanogaster Activity Level and Reproduction Rate

Biology
Elizabeth Regnier, Catherine Morrissey
Westfield High School

This project is to help our population understand how temperature stimulus affects Drosophila melanogaster activity level and reproduction rate. Due to our environment experiencing climate change, we wanted to test whether the varying temperatures could affect the D. Melanogaster lifecycle and could disrupt the flow of the food chain. The D. Melanogaster were tested in three temperatures, optimal temperature (22°C), below optimal temperature (10°C), and above optimal temperature (35-40°C) to see if temperature (independent variable) affects activity level and reproduction rate (dependent variables). Our hypothesis was, if the temperature is increased or decreased beyond optimal temperature then D. melanogaster activity level and reproduction rate will decrease. The data collected and analyzed from this experiment supported our hypothesis because it showed that the activity level of D. melanogaster was at its highest when these organisms were kept at an optimal temperature of 22°C. In regards to reproduction rate, there were no statistically significant differences between the various temperatures. However, when the D. melanogaster was kept at optimal temperature, the rate of reproduction was limited.

B4 Germination of Mung Bean and Maize at Low Pressure

Biology
Mo Liu
St. Mark's School

The current study focuses on investigating the impact of a low-pressure atmosphere — a feature of planet Mars that differs from our own planet — on the germination sequence of mung bean (Vigna radiata) and maize (Zea mays) seedlings. The goal of this investigation is to provide findings that could help determine the feasibility of cultivating crops in a Martian greenhouse and potential reasons that cause the phenomena appearing under low pressure. Therefore, the variable in this experiment is the pressure of the experimental chamber, while the controls include temperature, the absence of light, and availability of water. To achieve that goal, I set several more specific objectives: record the time to emergence of hypocotyl/root/true leaf; record the percentage of hypocotyl/root/true leaf emergence; record the length of germinated hypocotyl and root; record the average fresh and dry weight of the seedlings; and finally, describe the overall performance of the seedlings with qualitative data. My experiment data, as illustrated and explained below, suggest that there exists a difference between seedlings of the two experimental species grown in a low-pressure environment and those grown in an ambient pressure environment. A low-pressure environment, as I had postulated, has a negative impact on the germination sequence of the seedlings as well as the vigor of germinated seedlings. This negative impact could be the result of either one of two potential causes or a combination of both: the change in water potential and the diminished availability of oxygen. I aim to further my experiment by introducing an oxygen supply that would test out whether the lack of oxygen has an influence on the seedlings.

B7 Activity of the Basal Ganglia in Schizophrenia and Bipolar Disorder

Biology
Gayathri Nandyalam
Mass. Academy of Math & Science

Schizophrenia, bipolar disorder, and schizoaffective disorder are three common, yet uncured, neurological disorders. The majority of research investigating the pathology and etiology of these diseases is conducted directly on patients in laboratory settings. Few studies have used neuroimaging to study potential areas of cause of the disorders. In this study, neuroimaging techniques were utilized to investigate activity levels in the basal ganglia, the region of the brain primarily responsible for motor control, executive function, behavior, and emotion. Similar brain activity was expected in the basal ganglia because of the mood similarities among patients with these disorders. Statistical parametric mapping was used to extract parametric data from the voxels located in the regions of interest (ROIs). Data was exported for a one-way ANOVA, yielding a p-value of 1.7612E-07; there was a significant difference between patient groups. Activity levels may not correspond to potential areas of common root cause. However, these disorders could still share genetic similarities and future
work would investigate commonalities between the distribution of neuronal signaling chemical regulators.

B10 The Effect of Tangerine Citric Acid on Pogonomyrmex Barbatus

Biology
Rianna Massoni-Nesman
Wachusett Regional High School

The purpose of this experiment was to investigate tangerine citric acid's ability to function as a natural pesticide. The d-limonene in tangerine peels is thought to be toxic to ants. It was predicted that with an increased concentration it would result in higher lethality deaths and more deterrence from the solution source.
A T-maze was built for this experiment. Celery coated in four concentrations of citric acid (0%, 25%, 35%, and 50%) were placed on the right and celery coated in water was placed on the left. Ten minutes after the ants were placed in the T-maze, the walls were dropped and the number on each side was recorded. Over three days, the number of ants that died on each side was recorded.
When the concentration of the solution increased, more ants tended to die and more of them turned away from the solution. There was a significant difference between the number of ants dying on the first day and the number dying on the second and third days. There was also a significant difference between the number of ants turning towards and away from the solution in most trials.
It was found that the ants died faster and turned away from the solution in a T-maze. The 50% solution was the best solution at killing and deterring the ants. In conclusion, tangerine citric acid could be used as a natural pesticide to kill ants.

B20 Analysis of Microbes Cultured From Keys of a Computer

Biology
Aiden Chisholm, Brendan Morrissey
Westfield High School

This project was a microbiology experimentation designed for the purpose of measuring the amount of bacterial colonies on certain computer keys and determining which key is popular among the four tested. Specifically the keys that will be used are the e key, spacebar, backspace and control key as they are the most popular. (Yarow 2013)
The actual experiment involved using Agar coated petri dishes, distilled water and disposable swabs. A small fraction of the key was swabbed and then smeared onto the petri dishes. This occured in the library, computer lab, and on computer lab computers. The colonies were then placed in an incubator for two days. After this they were transferred to MAC, PEA and MSA petri dishes to measure for Gram+, Gram- or Staph.
After the conclusion of the experiments the "e" key was the most popular over all 3 location with approx. 30% of the total colonies coming from it. The same applies to the spacebar. The control key and backspace key both had outliers which raise their percentage like the control key in the library having around 30%. A later test was done to analyze whether a colony was Gram+, Gram- or Staph. In total there were 6 Gram+ colonies and 17 Gram- colonies and zero staph. This mean Gram- dominated 50% of the total 34 sample size count.
In this project generally speaking our hypothesis is supported. One outlier would be the the control key as the computer cart had a total of 61 colonies which would be a potential outlier. The "e" key was the most popular though. These results also stress that schools need to be concerned about the health of their students. Since 50% of the colonies tested were Gram-, this leads to the conclusion that staff really needs to focus on disinfecting computers as they contain harmful bacteria.

C4 The Effects of Temperature on Mealworm Metabolism of Plastic

Biology
Sufana Noorwez
Shrewsbury High School

Plastic waste is a growing problem around the world, and it is quickly becoming one of the largest contributors towards pollution and other potentially irreversible negative effects to the environment. Its non biodegradable nature presents scientists with no way to rid the world of it, and a solution must be found. A study has helped show that mealworms, the larval form of the beetle Tenebrio molitor are able to safely consume and degrade certain forms of plastic, specifically Polystyrene and Polyethylene. However, the rate at which they consume plastic is extremely slow, and a way to speed it up must be identified. In order to try to procure such a solution, this study tested the rate of consumption of plastic by mealworms at different temperatures: 18ºC (the control room temperature), 21ºC, 25ºC and 30ºC. The mealworms were allowed to consume Polystyrene for 6 days and the decrease of mass of the Styrofoam was calculated each day. Two trials were conducted, and the average decrease by temperature was calculated. A T-test was then conducted and it was found that there was only a significant difference between the rates of consumption between the control group and the 21ºC group and the control group and the 30ºC group. The real-world implications of these results have the potential to be very important. If mealworms are proven to degrade plastic faster at higher temperatures, the mealworms themselves or the biological processes they use to degrade the plastic can be used to find a solution to the worldwide plastic problem.

C6 How Much Bacteria is Growing in Your Pouf?

Biology
John Peloquin
Westfield High School

Through this experiment, one is trying to determine the amount of bacteria in shower poufs over a 24-day period of time, and determining the most effective way to keep them clean of dead skin and bacteria. This research has a significant societal impact because the growing bacteria on a shower pouf could be a main cause for skin infections, which can be serious, especially for people who shower with open wounds or cuts, or even after a fresh shave on the body or face. Over a 24-day period, one used 4 identical shower poufs, one per day, to scrub each arm, leg and the torso 15 times. After 8 days of using each pouf twice, a specific cleaning method was used on each pouf to test for the best cleaning method. After 24 days, one used nutrient agar petri dishes and sterile cotton swabs to test for the amount of bacteria grown on each pouf. One must allow the bacteria to grow in the dish for 48 hours to observe accurate results. As stated earlier the hypothesis is, “If distilled white vinegar is used to clean a shower pouf then the amount of bacteria on the shower pouf will be reduced significantly more than the other cleaning methods”. This hypothesis is proven incorrect by this data. Every cleaning method worked to their own degree, however, the bleach and water cleaning solution worked the most effectively. A total of 157 bacterial colonies grew in the nutrient agar petri dish in comparison to the 1,682.The data discovered is medically important because the unidentified growing bacteria on a shower pouf could be a main cause for skin infections, which can be serious, especially for people who shower with open wounds or cuts, or even after a fresh shave on the body or face. Children, who have not developed as many antibodies as adults are more prone to diseases from poufs.

C7 Bioprospecting for Benthic Fungi and Their Bactericidal Antibiotics

Biology
Emma Keeler
Falmouth Academy

The increasing global threat of antibiotic resistance and the exhaustion of terrestrial sources of microorganisms with antimicrobial properties necessitates efforts to augment the current arsenal of antibiotic compounds. The productivity of, and microbial density in hydrothermal environments make them a promising hunting ground for clinically significant molecules. This study assessed the bactericidal properties of fungal isolates derived from the Guaymas Basin and related to seven fungal species: Penicillium commune, Penicillium expansum, Penicillium verrucosum, Cadophora malorum, Ramularia eucalypti, Rhodotorula mucilaginosa, and Ramularia glennii. These isolates were obtained from off-axis and hydrothermal sediments, cultured using conventional methods, isolated, taxonomically identified using modern molecular techniques, and screened for antimicrobial activity against two human pathogens, Staphylococcus aureus and Escherichia coli. The antimicrobial screening revealed that 6 out of the 7 isolates (different media and culture age) synthesized bioactive compounds against at least one of the pathogens. Six of the isolates displayed antagonistic activity against S. aureus, while only P. commune inhibited the growth of E. coli. 82% of observed inhibitions were complete within the visual inhibition zone, indicating that the compounds produced were bacteriocidal. Only the species C. malorum has been studied in the context of bioprospecting. The results of this study contribute to the ongoing scientific effort toward recovery of novel fungal taxa from distinct ecological niches and suggest that deep-sea fungi may be promising targets for new sources of antibiotics. Continuing analyses will focus on identification of the antibacterial molecules produced by these isolates.

C12 The Effect of Barometric Pressure on Joints

Biology
Ashlinn Hoffmeister
St. John Paul ll High School

Numerous complaints regarding joint pain and swelling have been blamed on weather conditions. However, the question is, if this is true or if it is just a myth? Synovial joints are the pivot, hinge, saddle, plane, condyloid, and ball-and-socket joints. Three ten day surveys were conducted to compare daily joint pain levels to barometric pressure. The participants rated their pain on a scale 1-10 each day and the results were then compared to how high or low the atmospheric pressure was on that particular day.Therefore, this information was used to hypothesize that lower air pressure pushes against the body, allowing tissues to expand and cause pain. Four balloons were put inside a pressure chamber to resemble joints. A vacuum pump took out pressure in the chamber where a pressure pump increased the pressure level. Each balloon; one filled with water, one empty, one water and air, and finally one with just air were observed with both high and low pressures. Around 10 in Hg, the air and water filled balloons expanded. By observing how the water and air balloon expanded with less pressure and shrunk with added pressure, the hypothesis was supported. In conclusion, when there is less atmospheric pressure, the tissue, or in this case the balloon, expands allowing the buildup of fluid, also known as swelling.

C20 The Effect of pH on Plant Growth

Biology
Kimberly Chen , Emily Lam
Boston Latin Academy

The question for this experiment was to see how different pH levels affect plant growth. This was done by testing three different pH levels, which were pH 4, 6, and 9. It was decided to do the experiment based on pH because knowing more about how natural occurrences, such as acid rain can affect living organisms, is interesting and important.
To test this question, three different pHs were used. pH 4 represented acid rain, pH 6 represented regular rainwater, and pH 9 represented alkaline rain. Mung beans were planted in containers and were watered them with pH buffers of 4, 6, and 9 daily. Observations and also the data of the height of the plants were measured along with the roots of the plants at the end of the trial.
In all of the trials, the plants watered with pH 6 grew the tallest, followed by pH 9, and then pH 4. The plants watered with pH 6 also had the longest roots, followed by pH 9 and pH 4.
It was concluded based on the data that pH 6 was the most suitable pH level for plant growth while more acidic and basic pHs will cause a stunt in growth for the plants. Based off the background research, acid rain is a major issue because it can harm crops and plants due to the acidity, and can also lead to other major real world issues such as food shortages.

C22 Memory Retention and Structure Changes in Planarian After Regeneration

Biology
Zhengde Liu, Meng Zimu
St. John Paul ll High School

Planarian can be regenerated after been cut to two parts, The nervous cord and transverse nervous is located in the entire body of Planarian, two brains of Planarian locate in the head, near the eyespot. The purpose of this research is to help us better understanding the nervous system and body structures of Planarian. Our study question are : “Do regenerated Planarians remain the ability to find the food under the stimulation of light from the original Planarian? ” and “how do structures of Planaria change during and after regeneration, or when water flow in certain speeds? ” Our Hypotheses are that both head-regenerated Planarian and tail-regenerated Planarian have ability to remain their memory from original Planarian after regeneration, also the Planarian which got vertical head-cut will have two individual heads after regeneration and the Planarian which got vertical tail-cut will have two individual heads after regeneration. In this research, all five trained head-regenerated Planarian remained the ability of finding food under the light, three of five trained tail-regenerated Planarians remained the ability of finding food under the light. In comparison, only one of five untrained head-regenerated Planarian found the food under the light and one of five untrained tail-regenerated Planaria found the food under the light. The result of the research support the idea that the regenerated Planarian remain the memory from the original Planarian, but it reject the idea that Planarian which received incomplete vertical head-cut will regenerate two individual head and Planarian which received incomplete vertical tail-cut will regenerate two individual tail. The memory retention and regeneration of Planarian can play an important role in genetic study in the future.

C28 Environmental Factors on Cellular Respiration Rates

Biology
Alice Wong
Taunton High School

In order for organisms to survive and reproduce, one important biological process needs to occur: cellular respiration, specifically aerobic respiration. Depending on where an organism lives, their rate of cellular respiration can differ. One environmental factor that leads to this change is temperature. The temperature of an organism's surrounding greatly impacts how it reacts externally but also on a molecular level. Cellular respiration is a process that goes in to look at how substrates glucose and oxygen are used to produce carbon dioxide, water, and energy. In this experiment, crickets were used as the subjects to test how temperature affects their rate of cellular respiration. Pertaining to the ecological environment, examining at how an increase or decrease in temperature can affect cellular respiration rates may help researchers understand the relationship between climates in certain habitats and survival levels of different organisms. A respirometer was used to calculate how much oxygen is taken in by the crickets under different temperatures of water. The rates were measured at five minute intervals. At the end of the experiment, the data indicates that there is a positive association between temperature and cellular respiration rates. As the temperature increased, the crickets took in more oxygen, thus increasing their cellular respiration rates. With an increase in cellular respiration rates, it can be inferred that their metabolic rate increased as well. In the end, the data collected and analyzed supports the hypothesis that increasing temperature increases cellular respiration rates.

D3 The Effects of Ibuprofen on Motor Function in Drosophila Melanogaster

Biology
Neha Perumal
Westborough High School

As humans age, they experience many deficits such as fatigue, bone weakness, and memory loss. Among these, motor skills also begin to decline at a devastating rate: things such as walking, showering, and writing become harder to do. This can be caused by many things, such as neurodegeneration, cell senescence, DNA damage, or oxidative stress (Leaf, 2017). Ibuprofen is drug that falls under the category of nonsteroidal anti-inflammatory drugs (NSAID). Recent studies on the drug have resolved that it has anti-aging benefits, as it was shown to extend lifespan by 12%. However, this study focused on how ibuprofen affects the decline in motor function through age. D. melanogaster were used as they are a model organism in developmental and aging studies. It was hypothesized that the decline in measurable motor function will progress at a slower rate in those Drosophila exposed to ibuprofen, and that the dosage will be inversely correlated with this rate of decline. Experimental groups were given either 200 or 400 mg doses of ibuprofen since the pupal phase. Over the course of 4 weeks, 7 trials of the RING protocol and 3 trials of the locomotor assay were taken. The RING protocol exploited a learned motor ability, while the locomotor assay tested for changes in the Drosophila gait and speed. The loss of learned motor ability progressed at a slower rate in those flies exposed to ibuprofen; however, their overall climbing height was comparatively lower. The locomotor assay found that exposure to ibuprofen may have discouraged walking and movement, but inconclusively remains.

D8 What Are You Eating?

Biology
Ariana Wold-Grover, Amber Watson
Southeastern Reg. Voc-Tech. H S

As a customer, we expect that what we are being served from restaurants and fastfood restaurants alike is clean from any bacteria that may pose harm to our immune systems. We trust in the restaurant's ability to keep their food clean and safe to consume. However, it is widely unknown what exactly we are consuming when we go to enjoy our two dollar burger from our favorite fast food restaurant. Considering bacteria is one of the most common causes of food poisoning(foodsafety.gov), we don't truly know if what we are consuming is safe for our health in terms of bacterial substances. The purpose of this experiment is to see how safe the fast food restaurants really are. Millions of people eat at these places every single day, but when you eat that burger what else are you consuming?

D9 Protein Structure Prediction with Recurrent Neural Networks

Biology
Ian Bulovic, Evan Weissburg
Lexington High School

We present a novel method to predict protein secondary structure using Neural Machine Translation (NMT), a machine learning framework researched by Google. Our NMT model functions similarly to Google Translate, converting from a protein's sequence of amino acids (analogous to English words) to a sequence of bends and folds in the protein's secondary structure (a foreign language). It couples two LSTM-type Recurrent Neural Networks, one functioning as a universal encoder and the latter as a universal decoder. The model chooses between 8 secondary fold configurations as a target language and is trained using a similarity-filtered dataset sourced from CullPDB. The model is competitive to current structure prediction that involve fast sequence alignment computation, such as JPred with 82% Q3 accuracy.

D17 Effect of Curcumin Based Biosynthetic System on Growth Rate of P acnes

Biology
Rukia Nur
Excel High

The purpose of this study is to find the best topical biosynthetic solution to prevent and combat the growth and presence of propionibacterium acnes.

D18 Effect of Melatonin on Tachycardia in Daphnia Magna

Biology
Timmarie Gallagher
Wachusett Regional High School

Tachycardia is a cardiac condition defined as an increase in resting heart rate (HR). In adults, tachycardia is on average >100 beats per minute and age-dependent in children, affecting ~570,000 American adults. Melatonin, an neuroendocrine hormone secreted by the pineal gland, is known for regulating sleep and circadian rhythm. The purpose of this study was to investigate melatonin as an additive treatment for tachycardia. D. magna were used to study cardiac function due to their physical transparency and similar susceptibility to cardioactive drugs which are known to affect the human heart.
It was hypothesized that if D. magna are exposed to the stimulant guarana, their HR will increase to tachycardia, and the intake of melatonin will reduce and stabilize D. magna HR. D. magna HR was observed thirty and sixty minutes after guarana was added, generating tachycardia. Melatonin was then administered and D. magna HR was observed after thirty and sixty minutes.
Exposure to guarana for thirty minutes caused a significant increase in HR, by ~2 beats per second (bps). Exposure to melatonin for thirty minutes, following one hour guarana exposure, caused a significant decrease in HR, by ~2.5 bps. Younger D. magna had higher initial HRs, of 7.5±1.5 bps, as opposed to adult D. magna, of 6±1 bps. The HR of younger D. magna remained higher after exposure to guarana and melatonin. These findings indicate that melatonin would be beneficial to the treatment of tachycardia but should be administered at different age dependent levels.

D20 Al, NaF, and C4H6O2 Impacts on Learning and Memory in D. melanogaster

Biology
Hugo Barberis
Wachusett Regional High School

The purpose of this experiment is to inform humans of the effects common chemicals such as aluminum, butanedione, and sodium fluoride have on learning and memory. And therefore, how they can alter consumption in order to avoid risks of Alzheimer's Disease. Aluminum and butanedione are thought to increase the risk of developing Alzheimer's Disease, while sodium fluoride is thought to prevent the aluminum from having its negative effects.
To test learning, once a day for 7 days, the 10 groups of 20 flies were given their respective amounts of respective independent variables, vortexed for 30 seconds, and placed into the learning and memory apparatus to record data. To test memory, once a day for 7 days 10 groups of 20 flies were given their respective amounts of respective independent variables and placed on the vortex for 30 seconds. Once a day for the following 7 days, each group of flies was placed in the learning and memory apparatus to record data.
The results of the experiment demonstrate that the 2 and 3 gram supplements of aluminum significantly decreased the fly's ability to both learn and remember. In addition, all amounts of sodium fluoride eliminated the negative effects that aluminum had on both learning and memory. However, there was no change in learning and memory abilities with the supplement of the butanedione in any amount.

F12 RepeatFinder: A Trinucleotide Repeat Search Tool

Biology
Aadharsh Pannirselvam
Lexington High School

Trinucleotide diseases are late-onset diseases that stem from a simple error in DNA replication, where a certain triplet sequence is repeated too many times consecutively. My program seeks to read inputted DNA sequences and to determine the disease status for each of the inputted samples. First, I established a baseline for trinucleotide repeats of 20 different genes through my program. So as to validate my program, I simulated repeats and input them into my program, recording the results. Once I had my results, I calculated sensitivity, specificity, positive, and negative predictive value, finding that my program had a perfect sensitivity, which is the key statistic in terms of creating a reliable diagnostic tool. Then I evaluated 5 clinical HTT samples from Harvard in the form of FASTQ files directly out of a NGS (Next Generation Sequencing) Machine. Over time, I adapted my program to read these FASTQ files directly, turning tens of thousands of lines of DNA into a single diagnosis, along with a graphic to indicate abnormal repeat lengths. After running these unlabeled samples and reporting my results back to Harvard, I was able to come to the conclusion that my program was consistently able to differentiate control samples and patient samples. I was able to differential normal and HTT patients gene sequences where normal patients showed one peak around 17 CAG length whereas HTT sequences showed two peak CAG repeat lengths, one around 14 and another peak at around 41 repeats whereas there was no difference in the CGG (internal control) repeat length.

F15 Analyzing Effect of Nitrogen Starvation vs Carbon on Microalgal Lipids

Biology
Christopher Dwyer
Wachusett Regional High School

Modern society requires an energy source that is renewable, non-pollutant, efficient and compatible with most machinery. Algal biofuel, a liquid fuel synthesized from the lipid produced by microalgae grown in a photobioreactor, meets these criteria. However, current biofuel companies lack the efficiency to produce enough fuel to compete economically.

Previous experimentation suggested aeration, an expensive and widely utilized growth aid, is not as crucial as companies believe. This experiment challenged the utility of nitrogen deprivation, a meticulous two-stage process that increases lipid production but requires increased processes and time. It was hypothesized that increasing organic carbon supplied to Nannochloropsis oculata would induce an increase in lipid production comparable to nitrogen deprivation, as more carbon would be available for lipid storage and colonial growth.

Algae colonies were grown in a homemade photobioreactor, consisting of 4 groups to test the two methods: with or without nitrogen deprivation and with or without added carbon. Additionally, multiple carbon sources were explored.

After 2 growth periods, algal growth was homologous in all groups. Final lipid content varied widely. The group with added carbon increased lipid production similarly to the group deprived of nitrogen, which both contained far more lipid than the control group.

These results suggest that increased carbon can substitute for nitrogen deprivation, and it would be more feasible to increase carbon without nitrogen deprivation. If this trend is proven on an industrial scale, important advancements in efficiency could be achieved by rejecting nitrogen deprivation in favor of more efficient, equally effective methods.

F16 The Effect of Growth Hormone on Daphnia magna Reproduction

Biology
Natalie Matis
Wachusett Regional High School

The purpose of this project was to determine how an increase of growth hormone administered to Daphnia magna would affect their reproduction. An increase of egg production in the organism could indicate an increase of human fertility as well. Growth hormone typically promotes muscle mass and bone density growth, but has recently been found to have a potential link to reproductive organs.
Daphnia magna were separated into four large containers each containing 10 Daphnia. The control group received one Daphnia food pellet. The second group received one Daphnia food pellet and 1 mL of a somatotropin and water solution. The third group received one Daphnia food pellet and 3 mL of a somatotropin and water solution. The final container received one Daphnia food pellet and 5 mL of a somatotropin and water solution. Egg counts and growth was observed every three days, the average amount of time it takes Daphnia eggs to develop. Egg production was observed throughout 3 generations.
The results of the experiment suggested an increase in egg production due to the increase of growth hormone. Statistical analysis suggested significant differences between the egg production with and without the increased presence of somatotropin. However, the third generation of Daphnia magna produced infertile eggs and had physiological differences, suggesting a mutation in the DNA produced by the increase of growth hormone, and potential health risks for mothers, and their children, who are utilising growth hormone as a fertility drug.

F18 Bacterial Transformation

Biology
Juliana Vazquez
East Boston High School

My objective is to see if we can improve (or enhance) the expression of insulin in bacteria cells by expressing the molecule as a single peptide. Today, insulin is extremely expensive, mostly because of the way it is made and the amount of time the process takes. Winsulin is the synthetic insulin I made that is represented as a single peptide.
I transformed E.coli cells with plasmids that expressed either Proinsulin or Winsulin. I confirmed that the E.coli cells took up the plasmid by growing the colonies on Nutrient agar that had Ampicillin in it. Only E.coli that took up the plasmid would be Ampicillin resistant. The others would die in the presence of the antibiotic. So the colonies seen on the plate represent E.coli that now contain one of the plasmids.
Next I took one of the colonies and inoculated it in liquid Nutrient broth with Ampicillin and let it grow up overnight at 37C. The next morning I added an inducing agent, IPTG (Isopropyl β-D-1-thiogalactopyranoside) and let the cells grow for 6 more hours. The IPTG "induces" or encourages the cells to express the gene of interest off the plasmid. In our case this was either ProInsulin or Winsulin. I then lysed the cells and tried to purify it on a Nickel-NTA column (because the insulin proteins we made had a 6 Histidine tag on it and this binds to Nickel).
In Both UI lanes for both Proinsulin and Winsulin we do not see the wanted protein, and we shouldn't. In Both "I" lanes for both we do see the protein, so that tells us that the induction worked and we made the E.coli machine make our protein, but we can't quantify that because there is no way to measure how much is there. Also, we see all the other proteins in the cell because I have not yet purified my protein away from the others.

F19 Neural Networks and Colon Polyp Detection

Biology
Inthat Boonpongmanee
Deerfield Academy

Each year about 50,000 patients die from colon cancer – it is the second leading cause of cancer death in the United States. Colon cancer usually develops from polyps, which are growths on the interior of the colon. Colon cancer is preventable if detected early and colonoscopy has been effective in reducing incidences of colon cancer. However, colonoscopy is an operator-dependent procedure. In tandem colonoscopy, average miss rates of 22% were found. Computer aided detection (CAD) may help to reduce miss rates.
The objectives of this study were to use machine learning techniques to segment polyp stills taken from colonoscopy for the purpose of accelerating detection and treatment. The project included assembling the datasets, setting up a workstation, and applying different convolutional neural networks. Image data and labels were taken from the polyp database CVC-ColonDB. 380 images from 15 different colonoscopies were available. My project used convolutional neural networks (CNN) in a colon polyp binary segmentation task. I programmed my neural networks in Python using Caffe and NVIDIA DIGITS.
In this study, the learning rates of the Alexnet network were changed. The accuracy and loss metrics were encouraging, however the dice metric showed that the high accuracy and low loss values were a result of overfitting.

F25 Applying Machine Learning to Predictive Gene Data Analysis Tools

Biology
Wesley Lo
Concord Academy

Gene therapy can be an effective supplement for chemotherapy for targeting cancer cells, however, it is not effective for everyone. My goal in working on this project is to develop a tool that can identify specific genes and patterns that are correlated to be expressed within patients that respond well, but also poorly to certain gene therapies. Gaining information like that will hopefully provide new insights into which gene therapies will work well for different people before the gene therapies are administered to them.
Typically, linear regression models and the fold change of gene expression or RNA sequencing data are used to identify specific genes of interest. However, by using machine learning algorithms such as neural networks, the possibility of discovering more complex patterns that humans wouldn't identify on their own by looking at datasheets or from algorithms such as linear regression models, becomes available. For example, supervised learning algorithms such as convolutional neural networks can be programmed to use human classifications to find patterns, or unsupervised learning algorithms such as clustering can find patterns on their own, which may generate more complex classifications. With machine learning, the options are virtually limitless.

G5 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 million people 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% reuse of syringes. In 2015, WHO(World Health Org) 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 disposable syringes are recycled and reused. The “smart” syringes available so far do not fully deter the syringe reuse. In addition, they are also expensive, so there is a need for cheaper alternatives without these pitfalls, which is a challenge for WHO to replace in such a massive scale. The innovative smart syringe(say Type-A) that was designed and modelled in phase-1 of this project, could be implemented within 6% of the 500 million dollars additionally required for the nearest possible “smart” syringe solution to replace the simple disposable syringes. The net cost of Type-B model innovative smart syringe implementation is just equivalent to the widely used simple disposable syringe that is often reused. The Type-B model created this year in phase-2 of this project eliminates the need for plunger retraction and allows only to be pushed with a finned plunger head by an independent stem. By coming with the dispensable medicine pre-filled with accurate dosages, Type-B also eliminates the need of a medicine container and its contamination from syringes and air pockets to squirt out. Type-C model combines Type-A and Type-B, making the plunger head non-salvageable.

G12 The Effect of Ginger and Zingiberene on the Lysozyme Activity of the Bombyx mori

Biology
Chaimaa Hossaini
Pioneer Charter School of Science

The mysteries of how the immune system protects itself against bacteria and viruses have raised questions in medicine. A variety of insects have been used to test this, especially the Bombyx mori. During this undertaking, the Bombyx mori was exposed to pure ginger at 0.5g, 0.75 g, and 1g and to zingiberene at the same amounts in order to see whether or not ginger is a feasible solution towards immunity. It was hypothesized that both solutions would increase the reaction rate of the lysozyme. The silkworm was surgically cut open in order to retrieve the protein from the stomach tissue. After two days of using the buffering solutions, a CCD measures the rate of the reaction in terms of moles per minute. Based off of the data, the reaction rate did increase as the substrate concentration increased but only for the ginger experiment. The Zingiberene experiment failed due to the amount of toxicity it has in its purest form and so in the future, when a small dosage is used, the anatomy of the silkworm can be able to handle it. To conclude, the hypothesis for the ginger experiment was accepted. The intention is to see the function of each phytochemical in ginger and how they contribute to the immune system.

G13 The Effect of Carbon Dioxide on Plant Growth and Nutritional Value

Biology
Hannah Murphy
Quincy High School

Fossil fuel usage has led to a rise in carbon dioxide levels. In photosynthesis, CO2 and water are converted into oxygen and carbohydrate molecules to store chemical energy. Studies have concluded that plants exposed to elevated CO2 levels have higher yields and faster carbohydrate production, but protein synthesis and mineral absorption do not increase accordingly. In poorer countries this could lead to less protein and minerals in staple crops like rice or potatoes and increased risk of anemia and zinc deficiency. Heart disease and obesity could be risks in countries where carbohydrate consumption is already high. This experiment attempted to determine how CO2 levels affect plant growth rate and nutrient balance. To test the variable of increased CO2 levels , onions and carrots were grown in two separate planters in an indoor greenhouse with normal CO2 levels. In another greenhouse, two more planters were exposed to elevated CO2 levels. After 30 days, the height of the plants and the average carbohydrate content (measured using a refractometer to determine the percentage of nutrients in a liquid sample) were found. Results showed that in both plant types, the average height was greater for those grown in normal levels of CO2, and that, while the average carbohydrate content was greater in the carrots grown in elevated levels of CO2, it was the opposite for the onions. The average carbohydrate content was higher for the onions grown at a normal CO2 level. These findings help to understand how plants react to increased CO2 levels. Future experimental repetitions will focus on stabilizing the experiment environment, as further research indicated that inconsistent temperature, nitrogen levels or water levels could stunt plant growth when exposed to higher CO2 levels.

G15 Does Dehydration Affect Your Innate Imune System?

Biology
Yomari Rivera
Worcester Technical High School

The innate immune system is the immediate defense mechanism in humans and it acts when a foreign antigen appears in the body. Lysozyme is a part of the innate immune system. It is an enzyme that is destructive to bacteria and thus acts as an antiseptic (1). Lysozyme is found in tears, mucus, and egg whites. Water also has an essential role in the body. It keeps us hydrated, and helps our immune system function by removing toxins from the body(2). Here we ask how dehydration affects one aspect of the innate immune system. We created an assay to test how hydration level affects lysozyme activity. We used paper disks dipped in saliva as our source of lysozyme. These were then placed onto a petri dish spread with the Gram positive bacteria, Geobacillus thermophilus. We incubated the cultures overnight and measured bacteria death the next day.

G18 The Effect of Guarana, Ginseng, and Vitamin C on Daphnia Magna Heart

Biology
Patricia Simaku
North Quincy High School

Daphnia magna are sea creatures usually used in scientific experiments when measuring rates like heart rates. With the addition of substances like caffeine, vitamins, or other substances that are often used in energy drinks, the heart rate of Daphnia magna can be seen as it increases, due to its translucent body. The experiment that is going to be conducted in this project is measuring the effects of guarana, ginseng, and vitamin C on said heart rates. This has a societal impact because it may show how the increase in heart rates of the creature mimics that of humans, in which consume products which contain substances that increase heart rate. How do different substances, such as guarana, ginseng, and vitamin C, affect Daphnia magna heart rate? In this project, the goal of what will be accomplished is to test whether substances usually found in caffeinated beverages have an effect, if any, on the heart rate of Daphnia magna.

G22 Effect of Glucose on the Sex Ratio of Drosophila Melanogaster

Biology
John Lin
Boston Latin School

Many would-be parents eagerly wait to find out if their baby is male or female. What if a doctor could accurately predict the sex of the baby instantly by measuring the blood glucose levels of the parents and inputting the measurements into an algorithm, which would give the probability for a male or a female baby?
In this experiment, Drosophila melanogaster was used as a model organism to examine the effects of additional glucose on the sex ratio of offspring. To do this, male and female flies were separated into two vials for each gender: one vial contained 2.5 mg more glucose than the other vial. After a few days, the flies were placed into four vials, each vial contained either males that had been in additional glucose or males in normal glucose as well as females that had been in additional glucose or females without additional glucose.
The results show that there were significantly more female offspring than male offspring in vials that had parent(s) that were originally from a vial with additional glucose added to the food medium. Specifically, in a vial that had either or both parents from a vial with additional glucose, the average number of females to the total number of offspring was 59.3 percent females, which is statistically significant from the 48.1 percent population average with a standard error of 2.2. Hence, this experiment indicates that if either or both parents have a higher intake of glucose, there is a higher likelihood of their offspring being female.
Future works include identifying genes that act as nutrient sensors and that determine the sex of the offspring as well as developing a model that predicts the sex of an offspring based on parental glucose levels.

G24 Fibonacci in Nature: Investigation on Mathematical Patterns in Plants

Biology
Advika Sonti
Tahanto Regional High School

The Fibonacci Sequence is a sequence of numbers where the following number is derived from adding the previous two numbers (0, 1, 1, 2, 3, 5, 8…). The purpose of this project was to detect whether or not different plants in nature follow this mathematical sequence and to calculate the percentage of plants that do so. 25 different plants were used for this investigation with three samples of each plant. This was to allow a more accurate result overall. For each plant, a table was made which consisted of the numberings of various plant parts in all three samples (leaves, veins, blades, flowers, petals, and stamen). From there, the data was analyzed by finding the median number for each plant part, of all three samples, so that it came down to one number per each part. From there, it was simply stated whether or not that number followed the Fibonacci Sequence (yes or no). The results were derived from this data by calculating the percentage of individual plants parts that followed the Fibonacci Sequence. Another method of categorization, aside from the varying plants parts, was grouping the plants into ones with leaves and/ or ones with flowers and finding the percentage of those. The average of all these statistics was then calculated to determine a single percentage of all plants, in general, that follow the Fibonacci Sequence. The overall number and probability was 86.46% (by one method of calculation) and therefore it can be concluded that most plants in nature follow the Fibonacci Sequence.

G25 Expression of Carbonic Anhydrase Ion Channels in Ameloblasts

Biology
Zifeng Liang
Miss Hall's School

The aim of this project is to examined the interplay of amelogenin and carbonic anhydrases ion channels in the three phases of tooth enamel development.During secretory stage, the organic matrix, made up of amelogenin and other proteins, is secreted while the mineral starts to form. During enamel maturation stage, ameloblasts' functions include ion transport, acid-base balance, and enamel matrix proteins debris removal. During the formation of enamel crystals, protons are released in the microenvironment. The export and accumulation of protons at the apical end of ameloblasts could significant lower local pH, causing acidification. Acid must be buffered so that it would not dissolve the newly-formed enamel during enamel formation, just as it decays teeth in the oral cavity after tooth eruption.Carbonic anhydrases are enzymes that catalyze the reversible hydration of carbon dioxide to bicarbonate. They also participate in pH homeostasis and CO2 and HCO3- transport. Carbonic anhydrase II is the mostly widely expressed isozyme localized to the cytoplasm of many cells. Carbonic anhydrase VI is the only carbonic anhydrase isozyme that is secreted from cells. High expression of carbonic anhydrase VI in enamel cells, especially in the maturation-stage ameloblasts has been confirmed. The function of carbonic anhydrase VI in maturation is mainly associated with local buffering, supplying bicarbonate ions or recycling excess levels of carbonic acid.

G27 Using SNP Correlation to Find the Risk of Developing a Genetic Disease

Biology
Nikhita Athipathy
Advanced Math and Science Academy

Scientists are constantly trying to improve and lengthen the quality of human life, however, genetic diseases have always caused major setbacks in their research. Previously, tracking gene inheritance and locating specific variations or mutations would be almost impossible. Now, after the completion of the Human Genome Project, these records are readily available. Using bioinformatics, I have conducted a research project centered around the idea of whether we can use SNP correlation to find the risk of someone developing a certain genetic disease. Through the collection of extensive data and thorough database mining, I have found that we certainly can, as the magnitude of damage that the SNP causes to the protein it codes is almost always directly proportional to the likelihood of somebody contracting that genetic disease. This research will provide a foundation for future projects, such as preventative therapy and personalized medication.

H1 Where Did All The Males Go?

Biology
Alexandra Laufer
Weston High School

BPA is a chemical in plastic that leaks into bodies of water from the abundance of pollution. This experiment was conducted to determine if exposure to Bisphenol A (BPA) during different stages of development affects the gender ratio of Platy fish. This is the first randomized, blinded, controlled trial of the effects of BPA on freshwater live bearing tropical fish.
The experiment used different concentrations of BPA at 0, 60, 200, 600 µg/L. Adult Platy fish dropped fry in non-experimental water, and the fry were then exposed to one of the four solutions for the first 30 days of life. After 30 days, the fry were put into non-experimental water. The fish were visually inspected in an attempt to be determine gender after six months.
The results from this experiment showed that when compared with a statistical analysis test the ratio of male to female fish had almost no correlation with the concentrations of BPA.
This experiment shows that the development of Platy fish is not affected by the concentrations tested, although statistical analysis indicated that the sample size was too small to properly make conclusions. Further experimentation with larger sample sizes and possibly different BPA concentrations would be the next step in the process.

H3 Creamery Sanitation Method Efficacies Relative to Creamery Surfaces

Biology
Noah Glasgow
Falmouth Academy

The purpose of this experiment was to determine the most effective method of sanitation in a creamery environment, and inversely to determine what surface was the easiest to sanitize. Creameries are complex environments filled with a plethora of different surfaces, all of which must be sanitized to avoid bacterial contamination. In this project, the surfaces tested were polypropylene, stainless steel, copper, and epoxy flooring. In this project, three chemical sanitation methods were tested, as was oxidation, hot water, and manual cleaning. Staph. epi., an analog for foodborne pathogen Staph. aureus, was used to test the efficacies of the sanitizers. This project's hypothesis was two-part: it was believed that hot water sanitation would be the most effective sanitation method; additionally, it was believed that stainless steel would be the easiest surface to sanitize. During experimentation, surface samples were cleaned, contaminated with Staph. epi, then sanitized, swabbed, spread of a petri dish of nutrient agar and incubated. Once incubated, the number of colonies on each petri dish was counted. The results showed that for stainless steel and copper, the most effective sanitizer was manual cleaning (no colonies post-sanitation), yet copper was also equally sanitized by oxidation. While optimal for colony growth, both hot water and peracetic acid were able to completely sanitize Dur-A-Flex. The results for polypropylene were inconclusive. Overall, the sanitation method found most effective was peracetic acid, followed closely by hot water. Although this secondary conclusion is tentative and only partially supported, Dur-A-Flex was the easiest surface to sanitize.

H7 Effect of Baking Soda on a Pancake

Biology
Maria Theodoridou, Iseliz Diaz
Edward M. Kennedy Academy for Health Careers

The topic of our experiment was to test the amount of effects, that increased baking soda has on the porosity and the height of a pancake. We decided to run this experiment because baking soda is used as a leavening agent, so we wanted to see how thick we could make our pancakes. We ran a total of three different experiments. In the first experiment (control), we tested the difference between a pancake with zero teaspoons of baking soda and a pancake with ½ teaspoon of baking soda. In the second experiment, we tested the effect of baking soda on a pancake's porosity. A total of four pancakes were made, each with increasing amounts going from 1 tablespoon to 4 tablespoons. In the third experiment, we tested the effect of increasing amounts of baking soda on a pancake's height. Once again, a total of 4 pancakes were made each with an increasing amount of baking soda going from 1 tablespoon to 4 tablespoons. Through this procedure, we were able to see that there was not a big difference of height in the varying amounts of baking soda, it almost did not affect the pancake at all. However we observed that the varying amounts did affect the pancakes porosity. There was also a big difference between the pancake without baking soda and with baking soda (Speaking general)

H9 Comparing Effectiveness of Bacteria and E. hortensis to Degrade PCBs

Biology
Driss Bourzgui , Kylie Taylor
Berkshire Arts & Technology Charter Public School

Research showed polychlorinated biphenyls in soil can possibly be broken down by a special species of worms that aerate soil at a faster rate. The hypothesis established was that the ability of the E. hortensis earthworms to dechlorinate PCBs will surpass the effectiveness of E. coli in degrading them in soil, bacteria was used as a comparison. This was proven by going to three sites: control, suspected contaminated location, and a known contaminated location, testing for PCBs and putting an equal amount of worms into each dirt bin for approximately 65 days to see chemical evidence diminished, the procedure was the same for bacteria. The results showed the species of worms E. hortensis proved effective in breaking down PCBs, and the bacteria E. coli was not effective. The data supported supported the hypothesis by showing evidence of dechlorinate. Another experiment that could be performed on the same topic is widening the locations of PCB contaminants to extend the range of soils tested to gain more info on the subject.

H19 Effects of Alcohol and Nicotine on Fecundity in D. melanogaster

Biology
Anvitha Addanki
Canton High School

This study was conducted to observe effects of alcohol and nicotine on fecundity, eclosion, and body temperature in Drosophila melanogaster and identify herbal remedies that can mitigate these effects. Effects were tested in three ambient temperature conditions using constant diets with different concentrations of alcohol or nicotine in each diet. Each of the twelve experimental vials contained Drosophila that received alcohol or nicotine in specific proportions under specific ambient temperatures. Certain vials received milk thistle or passion flower extracts to see if they mitigate negative effects of alcohol and nicotine. Data suggested that increase in alcohol and nicotine consumption resulted in a significant decrease in fecundity, delay in eclosion, and lower body temperature. Data revealed that milk thistle and passion flower extracts completely restored fecundity, eclosion, and body temperature when Drosophila were treated with lower concentrations of alcohol or nicotine, and partially restored them at higher concentrations. Explanations for these findings include negative effects of alcohol and nicotine on GABA receptors and their subsequent negative effect on GnRH neurons which stimulate the fertility hormones, and increase in oxidative stress, resulting in sperm DNA damage and negatively influence female oocyte development. Milk thistle and passion flower extracts reduce oxidative stress, and keep GABA levels stable, potentially stimulating fertility hormones positively. Findings show that negative effects of alcohol and nicotine consumed moderately in early years of life can be mitigated by herbal remedies, thereby decreasing chances of harmful effects on fertility in later years. This procedure can be extended to test effects of other controlled substances.

H20 Blocking Multidrug Resistance in Cancer Cells with MicroRNA Mimics

Biology
Seo-Hyun Yoo
Lexington High School

Chemotherapy, a major cancer treatment approach, suffers seriously from multidrug resistance (MDR), generally caused by innate DNA repair proteins or transmembrane efflux proteins that remove chemotherapeutics. This project focused on finding microRNAs that can regulate MDR proteins by managing corresponding mRNA levels through post-transcriptional regulation. Screening was done with bioinformatics databases for unpublished/unexplored microRNAs with high nucleotide sequence correspondence to two representative MDR proteins, MGMT (a DNA repair protein) and ABCB1 (an efflux protein), revealing microRNA-4539 and microRNA-4261 respectively. T98G (glioblastoma) cell line – with high levels of MGMT - was administered varying concentrations of Temozolomide and microRNA-4261, while MDA-MB-231-luc (triple-negative breast cancer) cell line – with high levels of ABCB1 - was administered varying concentrations of doxorubicin and microRNA-4539. First, fluorescent light imaging was used to show the uptake of nanoparticles with microRNA into cancer cells and found them clustered around the nuclei, ensuring effective microRNA delivery. The cytotoxicity of various combinations of chemotherapeutic dosages and microRNA concentrations was evaluated with an MTT assay. Finally, the suppression of ABCB1 and MGMT expression with an increase in microRNA concentration was also confirmed by Western blotting. The downregulation of MDR proteins enhanced the response to anti-cancer therapeutics and effective cell death, proving that the selected microRNAs could be used to assist anti-cancer therapeutics for the prevention of MDR, and that the nucleotide sequence matching of microRNA and targeted mRNA can lead to the experimentally shown regulation of protein expression.

H26 Can You Go "All Natural" With Antibiotics?

Biology
Tess Billo
Stoughton High School

In the project “Can You Go “All Natural” with Antibiotics”, research was conducted to explore the antibacterial properties of garlic in comparison to the man made and widely used antibiotic, ampicillin. It was hypothesized that if the E. coli was exposed to ampicillin and garlic, then the ampicillin would prevent the growth of E. coli in a larger area than the garlic, forming a larger “zone of inhibition” with no bacterial growth. It would do this because ampicillin is a widely used antibiotic that has been chemically altered to prevent bacterial growth, while garlic is a natural substance that was not specifically engineered to fight bacteria like E. coli. This hypothesis was tested by placing a disk with either garlic or ampicillin on it in a petri dish with E. coli and letting it grow to see how much of the growth could be prevented by the antibiotics. The results of the experiment proved the hypothesis to be false, because the galic was able to create an area surrounding it that had significantly less dense amounts of bacteria than the rest of the petri dish, but the ampicillin was able to kill all of the bacteria within the area around it. Though the garlic did not technically have a zone of inhibition with no bacterial growth around it, the area it created was larger than the zone of inhibition of the ampicillin, showing that although ampicillin is the more potent antibiotic, garlic still had antimicrobial properties.

H27 The Effect of Different Anti-Fungal Agents Have On Yeast Infection

Biology
Chuxian Feng
Revere High School

Purpose: The purpose of this experiment is the test the effectiveness of different antifungal medicines. It will help clarify the constant believe of “the doctor prescribed this medicine so it must be the most effective.” People who need an antifungal medicine but cannot find the one recommended by the doctor can feel safer to use a different one because they have similar effectiveness.
Procedure: First build a CO2 trapper. Use a graduated cylinder, fill it up with water, and put it upside down so the amount of water displaced can be measured. Then grow yeast by feeding them and then mixing in antifungal medicine. If the amount of water displaced is low, then the medicine is effective.
Results and Conclusions: All three antifungal medications have similar effects as the average amount of water displaced for terbinafine was 75.67 mL, for for tolnaftate it was 75.33 mL, and for clotrimazole it was 72.33 mL. Therefore the reason behind a doctor’s recommendation or prescription of an antifungal medicine is not because of its effectiveness, but because of its function.

H28 Bacterial Communities Kitchen Sponges

Biology
Celeste Newman, Abraham Lineaweaver
Falmouth High School

Our project was to test and compare the microbial growth on antibacterial versus untreated kitchen sponges to see if there was a significant difference in the bacterial growth between the different types. We used five types of sponges for two weeks and then dipped them on agar plates to let the bacteria grow. We monitored the growth and took pictures every day. After the bacteria was done growing we performed a series of tests to help better identify the bacteria. We performed the KOH test and also the CLASI- FISH test. We also tried to help identify what chemicals were found in the sponge by performing a gas chromatography test to identify the compounds found in the different types of sponges. While it is hard to differentiate the specific growth between all the different agars, we found that all the sponges marketed as antibacterial or antimicrobial still grew bacteria. We also learned that the FDA’s recommended cleaning method of sponges through microwaving was ineffective and only get rid of the fast growing bacteria and a more colorful and varied set of bacteria grew instead.

J2 Survey of Critical and Lethal Temperature Range of Achetus domesticus

Biology
Chris Liazos
Marian High School

Achetus domesticus (House Crickets) are a field cricket species that originated from Southwest Asia and is now present throughout the Eastern United States and California. Many companies and small businesses breed colonies of house crickets to supply the diets of both pets and humans. However, organizations loose revenue from crickets dying from improper thermal environments when in transport or in stores. Understanding maximum critical and lethal temperature ranges in house crickets can help reduce high mortality rates in house crickets colonies.

J3 The Use of Enhanced Image Processing to Detect Bovine Rumen Acidosis

Biology
Aneeha Dalal, Chloe Deveney
Grafton Memorial Senior H. S.

Milk production by cattle is of critical importance to food security, especially in the developing world, where milk is a source of high quality protein. Cattle are dependent on their digestive organ, the rumen, to obtain the energy sources that then allow them to produce milk. The rumen represents a complex and fragile microbiologic ecosystem that is critical to the health, ability to produce food, and survival of the animal. Without a fully functional rumen, the animal will fail to produce milk and will eventually die. A dense population of highly motile protozoa is indicative of overall rumen health. The purpose of our project is to utilize image processing using a free online computer program, Physlet Tracker, to track the motion of the protozoa in order to help assess and evaluate the health of the rumen fluid and thus the cow.

J4 How Acne Medications Affect Bacterial Growth

Biology
Brenna Kennedy
Bishop Feehan High School

Because many teens, and even adults, struggle with acne, this experiment was chosen to examine what types of acne treatments are most effective at killing bacteria. The hypothesis that I investigated was, if acne medication is effective in killing bacteria, then the benzoyl peroxide will be the most effective at killing E. coli. I was also interested in seeing how the more natural acne products would compare to the more traditional acne medications in killing bacteria. In order to test if benzoyl peroxide is most effective, an experiment can be conducted to see which acne medications kill bacteria. E. coli bacteria (K-12 strain) is added to agar plates, and sterile disks treated with acne medications are then placed on the bacteria-treated plates. Zones of inhibition develop around the acne medications that are effective in killing bacteria, with the largest zones resulting from the most effective treatments. Results from the experiment showed that Tea Tree Oil was the most effective acne medication with an average zone of inhibition of 22.7mm, followed by the triple antibiotic gel (average inhibition 14.0 mm), and Burt's Bees Willow Bark (average inhibition 9.4mm). No zones of inhibition were seen for Benzoyl Peroxide, Adapalene Gel, and Alba Sulfur medications and for the water-treated bacteria, indicating that they were not effective in killing E. coli. The results also show that the natural treatments were more effective, because the Tea Tree Oil and the Willow Bark both displayed large zones of inhibition compared the more traditional acne medications.

J11 Charles River - Dangerous or Not: Identify and Characterize Bacteria

Biology
Alvin Chan
Community Charter School of Cambridge

The Charles River is a famous river in that flows 80 miles from Hopkinton to the Boston harbor where it meets the ocean. Its history went all the way back to the time of around 4000 BC when Native Americans used it to hunt and transport seafood. Europeans came to the New England area at around the mid 1600's and began utilizing the Charles River for their everyday needs. As new technology started to emerge and develop, the Charles River suffered the consequences and began to slowly become polluted and contaminated. It was once so polluted that the once flourishing river became unswimmable and dangerous. Over the past few decades, many organizations have contributed to cleaning the river. However, in the past few years, the Charles River's water quality grade has gone down significantly due to pollution and sewage. Now, many companies are trying to use more aspects of the Charles River and make it open to the public for swimming like the Swim Park Project despite the decreased water quality grade. Water quality is based on numerous aspects of water including the amount of certain metals, certain chemicals, certain bacteria, and much more. Another aspect of water quality is how it would affect humans in terms of drinking and everyday use. I will be focusing on the bacteria aspect of water quality and how the bacteria present in the Charles River and their quantity can affect the lives of humans. I will be conducting experiments as well as doing research that helps show how dangerous common bacteria are in the Charles River.

J13 The Effects of PH Level within a Designated Range on Hydra Populations

Biology
Katerina Krstanovic
Matignon High School

The initial purpose of the scientific experiment was to observe how environments with pH levels within an ideal pH range affect hydra populations. The experiment was intended to observe the exact correlation between pH ranges and organisms in general, with the hydras (hydra oligactis) being the experimental group.
The experiment was conducted using three separate jars with water of pH levels 6.5, 7.0, and 7.5, each of which contained five hydras. Each day, the hydras were given two daphnia pulex, and the experiment lasted for three days. Both trials were completed simultaneously within the same time period.
An overall stable number of living hydras in each jar suggested that pH levels that are within the specified pH range do not affect hydra populations in any observed way. In the first trial, there were only two living hydras in the jar with water of a pH of 7.0 in comparison to the four hydras in each of the other two jars. In the second trial, however, the number of hydras which remained alive was constant in each of the three jars (four hydras). These results suggest that pH levels within the recommended range are all equally suitable for hydra populations.

J20 The Effects of CO2 on Plant Growth

Biology
Kaylen Sanborn
Taunton High School

Levels of carbon dioxide are raising more and more as the years go on. Research shows that when plants get too much CO2, they'll be deprived of important nutrients. Most believe that it will improve the growth of plants, but that is not true. The purpose of this experiment is to investigate the effects of excess carbon dioxide on plants. Six plants were weighed and then split into two different miniature greenhouses; one greenhouse had carbon dioxide released every three days and the other was left in a regular environment. Over three trials of fifteen days, carbon dioxide was released to the plants and then the plants were weighed again. The experiment had not been long enough to impact the plants too much. The plants that received CO2 were lighter than the plants without the excess CO2 exposure. The hypothesis for this experiment was that if a plant gets too much CO2 then it will not grow as much as a plant in a regular environment. The evidence supported the hypothesis but only by a minuscule amount.

J21 A Comparison of Meat Freshness upon Different Thawing Methods

Biology
Daisy Wang
Boston Latin School

Objective: My goal is to systematically assess the effects of 5 different thawing methods on meat freshness, and specifically, bacteria growth and aldehyde formation due to the degradation of fatty acids.
Methods: Organic chicken meat was purchased and pieces around the same mass were placed in 5 different ziploc bags and each had a distinct way of thawing: microwave, fridge, room temperature, hot water, and cold water. The meat was frozen and thawed 3 times. At the end, all the meat was put into the fridge and 20 ml of disinfected water was added to each bag. This was left to rest for 2 days, and then the solution surrounding the chicken was swabbed then plated into petri dishes. The plates were kept in an incubator of around 37 degrees celsius for 5 days after plating. The solution was also collected for a chemical test (Tollen's Test) in order to assess whether or not there were formations of aldehydes, indicated by a silver mirror coating the sides of the test tube. 5 clean test tubes were coated with 0.8 M KOH, then I added 1 ml of 0.1 M $AgNO_3$, and drops of 0.1 M NH_4OH until the liquid became clear. 2 ml of each chicken solution were added to the different test tubes. It was then put in a water bath for 5 minutes.
Results: The bacteria growth on the plates showed that the hot water thawing had the most in terms of quantity, while the microwave thawing had the biggest colonies. In the Tollen's Test, the only thawing method with aldehyde formation was the microwave.
Conclusion: Overall, using the microwave for thawing purposes is the most harmful to meat and thus it is not recommended. The refrigerator is the least harmful, thus it is recommended for thawing purposes.

J22 The Tell-Tale Hearts

Biology
Peter Novick, Julian Portelli, Erick Silva
Somerville High School

Daphnia pulex is a very common species of the water flea, in fact the most common species of the water flea. Daphnia are very small crustaceans, ranging from 0.2-0.5 millimeters in length. Daphnia are, of course, organisms that live in a water environment. For our experiment, different sugar concentrations were tested to see how the daphnia would react to different concentrations of sugar, versus their normal habitat, pure water. For the experiment of different sugar concentrations, table sugar was used in different weights for different concentrations (3.5 grams of sugar per 100 milliliters of water, 1.75 grams, and 7 grams of sugar) were the separate solutions used for the daphnia. The purpose of using different concentrations was to compare and contrast the effects of sugar on the heart rate of the daphnia. The daphnia were first tested in filtered water, with no sugar (pure H_2O). Each solution had five daphnia tested, to present a variety of results. Table sugar packets ($C_{12}H_{22}O_{11}$) were added in the different weights to the 100 mL of water. The sugar concentrations were used to determine the heart rate in the minute, what happened, and why this happened. The main purpose was to find the main effect of the different sugar concentrations on the daphnia's heart rate, versus the pure water in their natural environment.

J23 Nutrition of Drosophila on Sex-Linked Inheritance of l(2)gl Mutation.

Biology
Jack Thalmann
St. Mark's School

The link between diet and inheritance of parent mutated alleles has not been fully studied for Vitamin A, Carbohydrate, Whey, Dextrose. This project seemed important to study, especially since experimental dieting has had such promising results in modern experimentation. I found a mutation, whose punnett square inheritance can be seen on step 8 of my procedure. Homozygous lethal inheritance, meaning that the inheritance of the gene from both mother and father fly were mutated. The Homozygous mutation in offspring was lethal, and affected 25% of the larvae. Lethal means that the offspring did not mature past the pupus stage of development. Heterozygous mutation was when only one half of the gene inherited, one allele, was mutated. The other was normal. This presented itself in a curly wing phenotype and affected 50% of the larvae. The other 25% of the larvae were what is know as Wild Type. Wild Type is a normally functioning fruit fly. With all Homozygous mutated offspring automatically eliminated, and Wild Type offspring identifiable by their straight wings, I can isolate Heterozygous mutated offspring to use in my experimentation. These would represent pregnant mothers with a cancerous mutation, who are able to pass it on to their children. I did this to test the effect of nutrients, whether positive or negative, on the diet of a pregnant woman. Would a higher or lower intake of these nutrients make it more or less likely for the child to inherit the cancerous gene.

J24 Deep Learning Approach for Classifying Motor Imagery EEG

Biology
Zekai Lin
St. John's Prep. School

Brain Computer Interface is a communication syatem that allows humans to control the external devices by their electric activity of the brains. Autoencoder could reduce the dimensionality of the data without lossing significant infomation. Meantime, EEG recored from the surface of the head are highly noisy, so Autoencoder could be applyed to build a more accurate algorithm and reduce the variance. In addition to the Autoencoder, Long Short Term Memory Cell in the Artificial Neural Net could be used for classifying time series and sequence data, including the EEG. LSTM aggregates all the feature along the time steps, so applying LSTM Cell could improve the accuracy as well. In this experiment, a deep learning architecture combining LSTM with autoencoder was made, and the result outperformed the classical machine learning algorithm, such as support vector machine, proving deep learning is effective in recognizing patterns of brain signal.

J27 The Effect of Household Products on Staphylococcus epidermidis

Biology
Rechelle Ballentos
Pioneer Charter School of Science II

Skin diseases are a common problem in society, and many treatments have been formulated to cure this problem both at home and in the laboratory setting. These skin diseases can be affected by a number of factors, a major one being bacteria residing and growing in great numbers on the skin. This project looks at the bacteria Staphylococcus epidermidis and a variety of household products with a scientific experiment being performed using the disk diffusion method to observe if the household products contain antibacterial properties. The different household products that were tested for were green tea, aloe vera, honey, lemon, rose water, apple cider vinegar, and water. The effectiveness of the products was tested by finding the diameter of the zone of inhibition after two days of incubation. The household products that presented a zone of inhibition were apple cider vinegar, lemon, and aloe vera. Honey was observed to have an increase in total colony growth as compared to the control group. At the conclusion of the experiment, since there was a large error in the experiment, the aloe vera could be a potential outlier to the data. Apple cider vinegar and lemon were found to have antibacterial activity against Staphylococcus epidermidis since both household products had a noticeable zone of inhibition. In contrast, honey was found to be beneficial towards the growth of the bacteria.

J28 Effect of Pesticides on Lotus Rhizome's Antibacterial Ability

Biology
Hyun Jun Heo
Lexington High School

Nelumbo Nucifera rhizome, commonly known as Lotus rhizome is one of the most important medicinal plants and phytochemical and therapeutic profiles indicate that Lotus rhizomes are known to improve blood circulation and have high contents of minerals and vitamins especially ascorbic acid. Previous research also showed that Nelumbo Nucifera rhizome performed antibacterial activities against gram-negative bacteria. This research was conducted in order to evaluate the effects of pesticides on lotus (Nelumbo nucifera) rhizome caused by the water pollution in lotus rhizomes' habitats, Southeastern Asia. In this study, the effects of pesticides on antibacterial activity of ethanol extracts from Nelumbo nucifera rhizome against Escherichia Coli was analyzed by paper disk agar method. Nelumbo nucifera rhizome extract was created using ethanol and different amount of Atrazine, Glyphosate were added to the separated groups. This paper also discusses in detail of the implementation of making the ethanol extract of the Nelumbo nucifera rhizome, because it has not been specifically optimized in existing literatures. The future applications based on this project are extensive as this project could be extended to evaluating the effects of pesticides on herbal medicine's ability.

K6 Effects of Agricultural Antibiotics on Bacterial Antibiotic Resistance

Biology
Arianna Schifman
Bishop Feehan High School

The purpose of this experiment was to determine whether or not the industrial treatment of livestock animals with antibiotics affected the likelihood that meat from this livestock will grow antibiotic-resistant bacteria. This experiment was chosen because of the increasing risk of antibiotic-resistant infections and legal debates regarding the use of antibiotics in agriculture. The hypothesis that this experiment was based upon states that if bacteria samples taken from both meats raised with and without antibiotics are both incubated while being treated with antibiotics samples, then the samples from the antibiotic-raised meat will be more resistant to the antibiotics and show greater bacterial growth. To test this, raw beef raised both with and without antibiotics was swabbed and grown using an incubator in agar plates along with a variety of common antibiotics used in agriculture. After a 24 hour period, the plates were removed and the counts of colonies and the area of inhibition for each plate was recorded. It was expected that the samples take from meat raised with antibiotic treatment would facilitate greater bacterial growth despite antibiotic treatment. The results of the experiment supported the hypothesis in accordance with the predicted outcomes. The result of the experiment indicated a majority of antibiotics were more effective against antibiotic-free meat in both number of colonies and area of inhibition.

K7 The Effects of Arbuscular Mycorrhizal Fungi and Rhizobacteria on Peas

Biology
James Goldbach
Falmouth Academy

The purpose of this experiment was to compare naturally occurring biofertilizers to artificial fertilizers to see which causes the plant to grow taller and faster and which makes the healthier plant. It was hypothesized that the group inoculated with arbuscular mycorrhizal fungi and rhizobacteria would surpass all other groups. 5 different methods of fertilization were used in this experiment on 5 groups of 20 plants each. Group A was given artificial fertilizer every day. Group R was inoculated with rhizobacteria. Group W was given just water. Group M was inoculated with mycorrhizal fungi. Group M+R was inoculated with both mycorrhizal fungi and rhizobacteria. After two weeks of measurement, while watering each pot each day, the strongest and tallest plants were M+R1 and M+R2 with an average height of 8.34 cm. The last week each group was divided into 4 parts. ¼ of each group was deprived of sunlight, ¼ was deprived of water and 2/4 were allowed to grow in the same way as the had been for the past 2 weeks. Each plant's height was measured and was measured in color and turgidity on a scale from 1 to 10. The final results showed that again the plants inoculated with arbuscular mycorrhizal fungi and rhizobacteria were the tallest at an average height of 12.8 cm. They also had the highest turgidity and color with averages respectively of 9.8/10 and 9.6/10 with sunlight and water, 9.8/10 and 6.2/10 deprived of sunlight and 6.8/10 and 10/10 deprived of water.

K10 Transgenesis in Drosophila Using Caffeine

Biology
MaiLee Daignault , Crystal Harrington
Berkshire Arts & Technology Charter Public School

During our project we experience a few difficulties and obstacles. The first and very inconvenient oen is that some of the cultures of flies kept dying, so we would have to refill vials with the exact same amount of caffeine and flies and start over. This backtracked us since it happened quite a few times and we had to even reorder a new culture of wild types to restart our project. Another difficulty we came across is having enough water in the incubator so they don't overheat and all die. In order to accomplish this we just needed to refill the water cups in the incubator every few days, but every few weeks we had a long weekend and came across vacations. This meant we wouldn't be able to check on the flies and change the water for days at a time and this caused many of the flies to die the first time this happened. Luckily I was able to get into the school over the vacations we had a few times and change the water to save the flies, but the times I did not get the chance to quite a few died. Looking through all the cultures under a microscope I have seen that caffeine has caused mutations in the flies that have consumed a great amount of caffeine in the past few weeks. I have seen different wing sizes, legs growing in the incorrect place, no wings, different colored eyes, no eyes, overgrown tongues (and even when they are put to sleep the tongues still move in and out of mouth), legs are missing or different sizes, no hair, abdomen very small and skinny, and the stages of growth have been seen to be different than in normal circumstances.

K12 Dietary Effects on Immunosuppressant Cytokines in Drosophila

Biology
William Allen
St. Mark's School

Type 1 Diabetes is a detrimental disease which is yet to be cured. The difficulty in curing Type 1 Diabetes is the fact that it is an autoimmune disease, meaning that the body's own immune system is killing cells within the body. Specifically in Type 1 Diabetes, autoreactive T cells destroy the pancreas' beta cells, the insulin producing cells, leaving the patient unable to produce insulin and unable to absorb glucose into their tissue. However, a protein called TNF, Tumor Necrosis Factor, has been shown to cause apoptosis or cell death in autoreactive T cells. Therefore by increasing TNF production in people with Type 1 Diabetes, one would expect the amount of autoreactive T cells to decrease. I attempted to model this relationship through the use a homolog gene, Eiger, in Drosophila, and used a low protein diet to increase Eiger production. While I was unable to measure the amount of Eiger produced, I was able to measure the apoptotic effect through the use a strain of Drosophila with a gene insertion that allows it to express Eiger apoptosis in the eye. Therefore, by measuring the ratio of eye area to bristle area of Drosophila fed a low protein diet and comparing it to Drosophila fed a control diet, I was able to find that a low protein diet did cause an increase in the apoptotic effect of Eiger. Hopefully this information could one day be used to increase the efficacy of an immunotherapy treatment for Type 1 Diabetes.

K14 Drugs & Genetics

Biology
Ysatti Bautista, Jacqueline Arroyave
Edward M. Kennedy Academy for Health Careers

For our study, we are interested in discovering why people that are diagnosed with the same illness and are taking the same prescribed drug/medication receive different doses and take the medication for different periods of time. The question we chose to base our study on is, Why Do Some People Respond To Drugs Differently Than Others Do? We believe each of the patients were taking different doses of the medication because each of them had a mutation in their genetic sequence that caused them to need higher doses and longer time taking the medication. As we approach the end of our study we will have figured out that people have different responses to drugs/medication because of the genetic mutations hidden in their genetic sequences. We concluded that when a patient has a mutation in his or her genetic information in his or her DNA sequence, it can effectively change the way he or she responds to the medication.

K15 The Effect of pH on Fluorescence

Biology
Grace Kelliher
North Quincy High School

An experiment was conducted to determine the effects of pH on the fluorescence output of samples containing fluorescein isothiocyanate (FITC) and phycoerythrin (PE) polystyrene beads. The beads were suspended in samples with acidic, neutral and basic pHs and analyzed on an Accuri C6 flow cytometer in conjunction with fluorescence activated cell sorting (FACS) to determine their fluorescence output.
Based on collected data, this study shows a direct correlation between the pH of the dilution buffer and the fluorescence output in samples containing FITC beads. There was an evident shift in fluorescence between the baseline samples and the samples with basic and acidic pHs and FITC samples. There was no significant shift from the baseline in samples containing PE.

K17 The Use of Essential Oils to Fight Fire Blight in Fruit Trees

Biology
Gonzalo Anyosa-Galvez
Cambridge Rindge & Latin High School

FireBlight is a worldwide plant disease in fruit trees. The bacteria Erwinia amylovora causes fireblight. The most effective treatment for FireBlight is to use antibiotics. However, there is evidence that Erwinia Amylovora is becoming resistant to antibiotics. Some essential oils are believed to have antibacterial properties. The disc diffusion method was used to measure anti-bacterial properties of the essential oils of Thyme, Oregano, and Orange with the following dilutions: 1:1, 1:10, 1:20, and 1:40. Kanamycin was used as a positive control and because Ethanol was used to dilute the essential oils, it was the negative control. The initial studies were conducted using Escherichia coli. The diameter of the inhibition zone varied between dilutions and essential oil. Although both Orange and Oregano had zones of inhibition, Thyme demonstrated antibacterial properties across most dilutions. Next, the most effective essential oil will be tested in the causative agent. Essential oils(e.g., Thyme, Orange, and Oregano) with antibacterial properties might be a natural alternative to antibiotics in the treatment of fire blight in fruit trees.

K21 GenEon Spray Solution Kill Bacteria?

Biology
Abby Genova, Lily Clardy
Hudson High School

The Hudson Public Schools made a decision to invest in the GenEon Spray Solution. This solution claims to kill up to 99% of bacteria found in classrooms with the ingredients of 99% water and less than 1% of hypochlorous acid. It claims you just need to spray the solution in the air and let it dwell, then wipe it off the hard surfaces.This project was designed to test the GenEon Spray Solution to see if it kills K12 E.coli. In this experiment, the materials used were sterile petri dishes, nutrient agar, sterile forceps, tetracycline antibiotic discs, filter paper discs, the GenEon Spray Solution, and the K12 E.coli. Our hypothesis was that if it is used according to the directions, then it does infact kill much of the bacteria found in classrooms. However, the custodians are not following these specific directions, so the solution may not be as effective. To start testing, we took one petri dish with nutrient agar and bacteria and sprayed it with the GenEon Spray Solution. Other plates had sterile filtered water, 10% bleach, and tetracycline to act as positive and negative controls. These plates were then placed in the incubator for five minutes to allow the sterile filter discs to dry. Once this happened, the plates were flipped upside down then placed in the incubator for 24 hours. Next, we took the plates out of the incubator to examine and record the zones of inhibition. The data was analyzed to see if the GenEon Spray Solution was different from the conventional disinfectants.

K24 What's in the Balance?

Biology
Rachel Ferrin
Taconic High School

The purpose of this experiment was to test the theory that diabetics have more acidic blood than non-diabetics due to the amount of ketones (an organic compound containing a carbonyl group =C=O bonded to two hydrocarbon groups, made by oxidizing secondary alcohols. The simplest such compound is acetone.) in the blood. I believe that diabetics are more likely to have more acidic blood than non-diabetics due to the ketones and other factors such as medications that would make the blood that way. To test this theory, ~10mL of blood was drawn from about 9 volunteers (4 diabetics and 5 non-diabetics) and three pH strips were dipped into each sample to gauge an approximate pH level. The result of this project was diabetics do have more acidic blood than non-diabetics. However, not every diabetic tested the same, as well as non-diabetics. Three participants had an approximate pH level of 5-6 and the fourth had a pH of 4 (this participant was also a dialysis patient). Five of the non-diabetics had a pH of approximately 7.5 (which is normal) but the fifth had a pH of around 6, believed to be caused by her pregnancy.

K28 NGS Analysis of Multiplex Programmable DNA Assemblies

Biology
Ansel Link
Lexington High School

This experiment analyzed the robustness of hybridization regions in programmable DNA assemblies when challenged with similar alternate sequences. In this research project the similar alternate sequences had differences only in the three bases closest to the end of the hybridization region.
For this experiment I utilized Next Generation Sequencing (NGS), to sequence short DNA fragments using the technique of Sequencing By Synthesis (SBS). I specifically used Illumina MiSeq sequencing, which uses a flow cell to amplify and sequence the DNA fragments. The sequencing information was then sent as a FASTQ file. In the experiment roughly two million clusters were generated, so I used Python to read the data set and match it against each of the 121 different assembly possibilities to create a tab delimited table.
From the tab delimited table, I was able to recognize that the location of base differences between two strands impacted the likelihood of misassembly. From the experiment I observed that a sequence is more likely to hybridize with the correct complement, then a sequence that has only one base pair difference. There is a less than one percent likelihood of a mismatch when there are two bases that are different, but when they do occur it is more likely to occur when the mismatch is farther away from the ligation site. Finally, it was least likely for a misassembly to occur between an experimental sequence and the control. However, the combinations with the control were more likely with barcodes that started with the base T because the control barcode also started with the base T.
This research is important for synthetic biology, where ligating short fragments of around 200 bases is necessary to create artificial genes longer than 100,000 bases.

N3 Occurence of Symbiosis in the Deep-Sea

Biology
Bridget Beaudoin
Falmouth High School

The depths of the Santa Barbara Basin, which is located off the coast of Southern California, oftentimes go anoxic or severely dysoxic due to the basin’s restricted water exchange in the Pacific Ocean. The lack of oxygen in the deepest parts of the Basin was presumed to make for an inhabitable environment for metazoans, which require oxygen to survive. However, researchers have discovered that meiofaunal sized worms such as the polychaete Xenonerilla bactericola and the gastrotrich Urodasys anorektoxys are in fact able to survive in said oxygen depleted conditions. Presumably, this is due to prokaryotic symbionts that these eukaryotes harbor. In an attempt to understand how these deep-sea worms function in anoxic environments, this project examines the relationship between metazoans and their surroundings.

N4 Accelerating Zika Virus Drug Discovery Using Chemogenomic Approaches

Biology
Akshaya Ravikumar
Sharon High School

The Zika virus (ZIKV) is a rapidly spreading mosquito-borne viral illness that is causing global concern due to severe complications such as congenital malformations (i.e. microcephaly) and neurological syndromes such as Guillain Barre Syndrome. Currently, there are no ZIKV-specific therapies or vaccines and there is a imminent need for rapid and cost-effective identification of anti-ZIKV drugs. Using computational methods, I tested the hypothesis: drugs that target host (human) proteins that directly interact with ZIKV can be potential anti-ZIKV drugs. A step-wise approach was used to test the hypothesis: (1) A list of human proteins that interact with ZIKV were compiled using “DeNovo”, a novel virus-host sequence based protein-protein interaction prediction software; (2) The FASTA sequence of each human interacting protein from Step 1 was examined in the Therapeutic Target Database to identify potential targets for each statistically significant protein based on the its E-value of <10-10. (3) Drugs acting on these significant targets were examined in the Therapeutic Target Database and Drugbank database which house currently available drugs that can be repurposed for novel indications. A total of 13 human proteins interacting with ZIKV emerged as potential therapeutic targets of which 8 proteins can be targeted by existing drugs. A significant enrichment for drugs targeting the reactome post chaperonin tubulin folding pathway was identified. The results show computational analysis of novel viral-host protein-protein interactions can yield putative anti-ZIKV drugs in a rapid and cost-effective manner. Cellular studies to establish the anti-ZIKV activity of these computationally prioritized drugs are required to prioritize these drug compounds for human ZIKV trials.

N8 How Do Changes in pH Affect Plants in an Aquatic Environment

Biology
Lily Traver
Bourne High School

The pH level in water is a vital part to a plant’s health. Without a safe pH level, the health of the plant is compromised. If/when the pH of water in an aquatic environment changes and goes above/below an aquatic plant's natural tolerance range, the plant's ability to intake nutrients is decreased. This can cause multiple problems, such as nutrient deficiency and stunted growth. The pH can inhibit the plant's ability of absorbing nutrients, therefore prohibiting the plant to function properly. If the level of pH in an aquatic environment affects the plants living within it, then a higher level of pH will be more harmful to the plants than a lower level of pH. The purpose of this experiment is to determine if the pH levels in freshwater can truly be harmful to hydrophytic plants. In this experiment, three tanks were set up and five plants were planted in each tank. In the first tank, the water was adjusted to a low pH. In the second tank, the water was adjusted to a neutral pH. In the third tank, the water was adjusted to a high pH. Over the course of two weeks, the condition of the plants was recorded. The independent variable of this experiment is the level of pH per tank. The dependent variable of this experiment is the condition of the plants in each tank. The control variable is the second tank, in which there consistently is a neutral, healthy pH. This experiment proved the hypothesis invalid. In the end, it was the first tank in which the plants were the most sickly-looking. In the acidic pH, the plants turned a pale yellow and showed some burn marks along the edges. The plants in the second tank, the neutral tank, remained healthy and green throughout the entire experiment. In tank three, the plants weren’t as green in the alkaline water.

N11 A Novel Approach to Transplantation without Immunosuppression

Biology
Jared Etienne
Foxborough Regional Charter School

This project plans to use phagocytic coelomocytes and yeast in order see whether antigen removal from an incompatible graft, would be a better option for transplantation then the current method, donor matching and immunosuppression. This project will use yeast (Saccharomyces cerevisiae) to represent the graft and will use coelomocytes extruded from Lumbricus terrestris to represent the immune system. The experiment will compare how the coelomocytes will react to the yeast without immunosuppressants, with immunosuppressants (cytochalasin D), and without antigens by removing them with an enzyme (PNGase-F). Rejection will be observed by periodically checking the solution for phagocytosis under a microscope with a dye. Each situation will also have another strain of yeast representing infection added to the solution. The results of the experiment most likely will show that the coelomocytes while under immunosuppression will not be able to respond to the graft or the infection, but when the antigens of the graft are removed, the coelomocytes will not respond to it, but still will be able to fight infection. This study will show that by removing the graft's antigens before transplantation, not only will immunosuppression be obsolete, but blood typing and organ matching will no longer be essential before transplantation.

N13 Inflammation and TWEAK

Biology
Zeus Mondol
Cambridge Rindge & Latin High School

TWEAK is an inflammatory cytokine produced by mast cells in the body. TWEAK is part of the TNF superfamily but binds to only the Fn14 receptor. TWEAK is part of the innate immune response and produces inflammation in areas recently infected by bacteria or in need of repair. TWEAK achieves this inflammation by releasing cytokines and chemokines which signal for cell growth. Cell proliferation increases the likelihood of a mutation occurring in the genetic code of the cell. Mutations in the cell replication portion of the gene often lead to uncontrollable division slowly resulting in a tumor. TWEAK is most effective when released in cells with high activation of the Fn14 receptor. Ovarian cancer B cells have been found to contain large amounts of Fn14 RNA-seq, indicating a strong possibility that TWEAK would cause inflammation if bound to those active receptors. Ovarian cancer may be linked to this cell pathway because of the immense increase of IL-8 production when treated with TWEAK.

N14 Nrf2b's Regulation of Oxidative Stress Response Genes in Zebrafish

Biology
Zhaohua Chunyu
Falmouth Academy

Oxidative stress can damage cells and cause cancers, cardiovascular diseases, neurodegenerative diseases, and diabetes. Nrf2, activated by oxidative chemicals, is a transcription factor that regulates antioxidant defense by binding sequences in enhancer regions of many antioxidant genes. The zebrafish fully conserves two paralogs of Nrf2a and Nrf2b in its genome, resulting from a fish-specific whole genome duplication, while humans and mammals possess only one Nrf2 gene.
The purpose of the experiment was to test whether the Nrf2b transcription factor regulates expression of oxidative response genes in zebrafish embryos. Hmox1 and keap1b gene expression was compared in Nrf2b knockouts and wild type zebrafish. Zebrafish embryos were exposed to DMSO or tBHQ to compare changes in basal expression and inducible expression. Treated and untreated embryos were homogenized, their RNAs isolated, cDNAs synthesized, and quantitative PCR was run. Relative quantification was used to show Nrf2b-dependent changes in gene expression. Hmox1 expression had a 10-fold increase over wild-type due to treatment with tBHQ. Basal expression had a 3.84-fold reduction due to knockout of Nrf2b. There was a 7.69-fold increase due to tBHQ in NRF-KO samples. Keap1b expression had a 2-fold increase due to treatment with tBHQ in wild types. Basal expression had a 2.78-fold decrease with Nrf2b knockouts. Fold change between Nrf2b KO-DMSO and Nrf2b KO-tBHQ was 1.35. Results show that tBHQ increases hmox1 and keap1b expression, and Nrf2b knockouts reduced both basal and inducible expression in zebrafish.

N15 Phytohormone Manipulation

Biology
Marsha Germain
Quincy High School

The global population is flourishing at an exponential rate and with it grows the desperate need for agricultural advances. Phytohormone stimulation can be the alternative for those struggling in means of food, and dangerous chemicals in commercial farming. Results of future experimentation will determine which ratio of Auxin to Cytokinin (a 1:1, 2:1 auxin to cytokinin, 2:1 cytokinin to auxin, and a controlled) will be the most succesful. Phytohormones are chemical messengers that regulate cellular activities, formation, development and coordinate the interaction of a plant's structures. Although only found in small doses, they are the foundation of plant growth. Auxins are a family of phythohormones involved in the develpment and elongation of plant cells. it also contributes to processes such as organogenesis, apical domincance. Cytokinin is significant for cytokinesis lateral root branching, fruit production and balancing the growth rate of the shoots and roots.
It was hypothesized that the lima beans tested with a 1:1 ratio of phytohormones would yield the best results due to there being a need for balance of hormones.
The overall engineering goal of this project was to promote the induction of phythormone stimulation in the cultivation of plants instead of chemicals and boost food production in struggling countries. The experiment was conducted over the course of one months through five stages including germination, potting, initial measurements, the addition of stimilants, and final measurements.
It was disvovered that the 2:1 ratio of Auxin to Cytokinin fared best while the 1:1 ratio was second best. It was concluded that Auxin's functions were more vital to the initial stages of plant life and therefore a greater concentration was necessary.

N18 Improving Efficacy of Ultrasonic Nutraceutical Liposomal Delivery

Biology
Sarah Abdulkerim, Mary Neguse
Medford High School

This research attempts to find the best method of encapsulating a-GPC in liposomes, to facilitate movement across the blood-brain barrier. The purpose of this research is to improve upon methods of penetrating the blood-brain barrier to slow the progression of Alzheimer's disease with drugs or compounds like a-GPC, which aids the neurotransmitter that supports memory and learning. To achieve this, a liposomal solution was created using sunflower lecithin powder, and mixed with a-GPC compound, then irradiated in an ultrasonic cleaner. The liposomes were then observed under a microscope to determine their size and frequency in each sample. The smallest liposomal size was 14.4 μm at 60 minutes. Encapsulation efficiency was determined using the equation ((Diameter of Liposomes * # of liposomes)/Diameter of Field of View)x100= Encapsulation percentage. It was found that the optimal amount of time for a-GPC to formulate is at 35 minutes, since it is also the time at which encapsulation efficiency is the highest (41.8% average) and the percentages for both trials are relatively consistent.

N20 Enzymatic Browning

Biology
Kenny Bui, Ashley Figueroa
East Boston High School

The objective of this experiment is to test for factors that could potentially prevent or slow down the oxidation process or enzymatic browning from occuring on the surface of a freshly cut apple slice. To indicate our answer, we decided to test with Vitamins A (Beta-Carotene), C (Ascorbic Acid), and E (Tocopherol) to compare which one had the correct compounds in order for the apple to stay fresh. Based on the data we collected over a 51 hour time frame, we discovered that Vitamin C, ascorbic acid, was the most effective anti-browning agent. In the beginning, it looked as if two vitamins both C and E, were at the same rate of effectiveness, but towards the end of the trial, vitamin C took the lead.

N23 Microbial Sensitivity and Resistance to Antibiotics between Subjects

Biology

Ianna Montilla, Katia Pinto, Maryan Mohamud

Jeremiah E. Burke H.S. - Dorchester

The goal of our project was to see to what types of antibiotics our oral bacteria are resistant or sensitive to, and how that varied between subjects. Each person has their own of set of diverse bacteria, but how those bacteria respond to different antibiotics is variable.

For this experiment, we took oral swabs of the subjects, and plated the bacteria on two agar plates for each subject. After plating, we added the 7 different antibiotics and the control, four on each plate, and left the plates at 37 degrees for 48 hours. At 48 hours, we took pictures of the plates and measurements of the area around the antibiotic to determine resistance or sensitivity.

Our experiment has shown us that there are some types of antibiotics that we are resistant to, and other that we are sensitive to. These results varied from each person in the group, showing that the bacteria that make up our microbiome vary from person to the next. All subjects were resistant to penicillin and ampicillin, and all no effect was seen with the control treatment. For the other five antibiotics, some bacteria from a subject responded by being resistant to antibiotics but some bacteria from another subject responded by being sensitive. This confirmed our hypothesis that our microbiomes vary from one subject to the next, and therefore antibiotic sensitivity varies greatly between subjects. In the future, we are interested in discovering if the bacteria of people living in healthier and cleaner locations versus polluted and dirtier locations have variability in their bacteria and bacteria antibiotic sensitivity.

P8 Does Feeding Animals GMO Foods Affect Their DNA?

Biology

Habso Salah, Maite Vinals

Edward M. Kennedy Academy for Health Careers

Some foods that humans and animals eat are GMO (Genetically Modified Organisms). There are some concerns that eating GMO food could affect humans and animals negatively. We were interested whether or not the DNA of animals is mutated because of GMO foods in their diet. We decided to test for the presence of GMO in meat samples from animals fed either GMO food or non-GMO food.

P9 Impact of Temperature on Coral Symbioses

Biology
Jillian Igoe
Falmouth Academy

Rising ocean temperatures are a concern for coral reef survival. In coral-algal symbioses, a coral host provides inorganic nutrients in exchange for photosynthetically fixed carbon and amino acids from zooxanthellae. While underlying the geologic success of coral reefs, this symbiosis can also pose a threat due to its sensitivity of the algal symbionts to temperature increases. Coral bleaching, the disruption of this fragile symbiosis by heat and light stress may ultimately result in mortality of the host. This experiment studied temperature acclimation on the process of coral bleaching and the breakdown of the microbiome in the northern coral, Astrangia poculata.
Three unbleached and three bleached colonies of Astrangia poculata were tested in five temperature circumstances. Before and after temperature exposures, Pulse Amplitude Modulated measurements, imaging and the coral polyp counts were performed. The results show that the bleached colonies were more affected by the temperature change. The loss of zooxanthellae likely impaired the nutritional health and immune system in the coral,due to lower algal density and photosynthetic yield.
Thus, the results show a clear significance of the symbiosis between Astrangia poculata and zooxanthellae - being both the coral's armor and its Achilles heel. The preservation of reef-building corals is dependent upon the scientific understanding of the volatile nature of the coral bleaching process.

P10 The Effect of Spices to Inhibit Bacterial Growth

Biology
Emily O'Gara
Taunton High School

Cinnamon and curry are both important spices that have been found to help inhibit the bacterial growth that is prominent in many illnesses. If cinnamon and curry are both found to inhibit the growth of the bacteria it will lead to a healthier alternative or treating destructive diseases, such as cancer. The presence of cinnamon and curry's major compounds are extremely toxic to a wide variety of diseases, and as a result harmful infectious microbial cells are shut down and stopped from taking over the human body. According to the hypothesis, if cinnamon and curry are used to prevent bacterial growth, then these spices will have a decreased presence on petri dish cultures and creating a ring of inhibition to the bacteria. Due to the results from experimentation, it is agreed upon that both cinnamon and curry create rings of inhibition and thus prevent bacterial growth. This project looks at the effect that curry and cinnamon have on bacterial growth, where they were put into separate Petri dishes and looked over two days. The experimental results supported the hypothesis, in which the cinnamon extract formed a clear ring from 1.3 cm (trial 1), 1.55 (trial 2), 2 (trial 3), 1.75 (trial 4), 1.1 (trial 5), and 1.4 (trial 6). Curry oil showed a ring of inhibition that ranged from no data (trial 1), 1.1 cm (trial 2), 1.55 cm (trial 3), 1.4 cm (trial 4), 1.9 cm (trial 5), and 1.2 (trial 6). This research will impact the lives of patients with harmful diseases.

P11 Do Different Dilutions of Disinfectants Affect Bacterial Resistance?

Biology
Nolan Tavares
Taunton High School

There are many antibacterial disinfectants that are used to kill bacteria, including Lysol and Clorox. Bacteria is a single-celled organism that is found on most Earth environments. There are many factors that affect bacterial growth, including energy levels, and minerals. During this experiment, four petri dishes, one of them being the control, were prepared to test the effects of disinfectants on E. coli. The disinfectants used were Lysol, Clorox, and a soap containing triclosan. To do the experiment, a coating of agar was placed on the bottom of each petri dish. Then each plate was divided in half, and E. coli was placed on both sides. Lastly, a sterile disk with the disinfectant was placed in the middle of both sections of the disk. All the disks were then placed into an incubator, where they stayed overnight for about three days. Measurements were then taken every day, for three days, for a total of two trials. At the end of the trials, the results were very similar; the triclosan dish effectively killed the most bacteria, which was far better than the other disinfectants. In the end, the hypothesis was proven to be correct. This was due to the triclosan's concentration; since a low concentration was used, the triclosan was successfully able to kill the most bacteria. This project did not go perfectly, however, and recommendations and changes to the project could be used if this was to be done again, as some questions were left because of this experiment.

P17 Effect of Cytokines on the Function of the Salivary Glands

Biology
Alicia Zou
Boston Latin School

Objective: We undertook this study to: 1) determine the role of IL- 22, a Th17 cytokine, on salivary gland function in a model of T cell cytokine-mediated exocrinopathy; 2) assess the direct effect of Th1 and Th17 cytokines on IL-7 and BAFF production using in vitro mouse salivary gland epithelial cell cultures.
Results: For Objective 1, after intraperitoneally injecting anti-CD3 antibody in C57BL/6 mice with anti-IL-22, the salivary flow rate showed a statistically significant increase compared to the control group. For Objective 2, after treatment of Th1 cytokines, TNFa and IFNg, and a combination of the two, the qPCR results show a statistically significant increase in the IL-7 mRNA levels of the IFNg treated and TNFa+IFNg treated groups. The BAFF mRNA levels showed no statistically significant increase nor decrease from the treatment groups. The treatment of Th17 cytokines, IL-17 and IL-22, showed no statistically significant increase nor decrease of IL-7 nor BAFF mRNA levels.
Conclusion: Endogenous IL-22 promotes salivary gland dysfunction in the anti-CD3-induced T cell cytokine-mediated exocrinopathy model. Th1 cytokines directly induce IL-7 expression in mouse salivary gland epithelial cells in vitro without affecting BAFF expression. In contrast, Th17 cytokines do not affect either IL-7 or BAFF expression in these cells.

P24 An Inquiry on the Evolution of Candidate Genes in the Origins of Span

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

The domestication process of rice began 10,000 years ago. Ever since cultivated rice (Oryza sativa) has been transmitted around the world, multiple populations of weedy rice have arisen. Weedy rice is a de-domesticated form of cultivated rice that has unfavorable traits causing significant reduction in crop yield for farmers. These weedy rice populations have undergone convergent evolution, as they share similar weedy traits such as red pericarps (seed coats) and the ability to disperse seed (shatter).This convergence makes them a very interesting topic for evolutionary biologists to explore. Specifically, our interest is in determining what are all of the origins of weedy rice and what genes are involved in the evolution of weediness.
Previous work in Caicedo lab has shown that weedy rice in Spain likely arose from japonica cultivated rice, which is the type of rice cultivated in Spain (see Figure 1). Like other weedy rice populations and unlike the crop, weedy rice in Spain has red pericarps and shatters its seed. Our interest was in determining whether alleles at the candidate genes (Rc, sh4 and qsh1) could explain the origin of these weedy traits and help us understand of when in the process of domestication Spanish weedy rice arose.

P25 Bubble-ology

Biology
Gislaine Dartois
Urban Science Academy

The reason I did my project was to see if I could make my own home-bubbles at home, that can compare or be better to the regular store bought bubbles. Which say that they last longer,and create more bubbles, and also create more bigger bubbles. When I finished my project and found out the end result. It was possible to make homemade bubbles that are stronger than store bought bubbles. All you do is just add a little bit of corn syrup.

Chemistry

Chemistry

A11 Effect of Mg(OH)2 and Al(OH)3 on Reducing the Flammability of Paint
A18 Addressing Global Water Scarcity Using Light Absorbing Nanomaterials
B1 Improving Water Desalination: Enhancing Shock Electrodialysis
B16 Constrained Chemical Descriptor Based QSAR
B17 The Effect of Household Substances on Biodegradable Plastic
D1 Experiments to Identify a Mystery Metal
F5 Measuring Calories
F20 Minimizing Bacteria in Thawing of Meat
G2 Strength of Magnetic Field in Acids and Bases
G11 Near IR Absorbing Gold Nanorods for Cancer Imaging and Therapy
G19 The Ascorbic Acid Concentration in Orange Juices
H22 Turning Milk into Plastic
H25 A Rainbow of Colors to Aid a Chemical Reaction
J1 Generation of Cost-Effective Nanoparticles for Fuel Cell Efficiency
J14 Effects of Milk Fat on Cheese Curd Yield
K5 The Absorbency Power of Fruit Peels
K18 Temperature on the Intensity and Length of Glow Stick Luminescence
K20 Saponification Sensation
K22 Can Temperature Affect How Long a Glow Stick Stays Lit
N1 Can Coffee Filters Be Used To Clean Oil Spills?
N12 Yeast: Brick to Bread
N21 Hot Pucks
N28 Plant Based Dye vs. Chemical Based Dye
P1 Solid Acid Catalysts: A Greener Alternative for Pharmaceutical Field
P18 How the pH of a Consumed Beverage Affects Drug Solubility

A11 Effect of Mg(OH)2 and Al(OH)3 on Reducing the Flammability of Paint

Chemistry

Aiman Najah
Pioneer Charter School of Science II

Flame retardants are compounds added to flammable materials to reduce their flammability and combine with flames to release CO2 and H2O to put out flames. Flame retardants can disrupt the combustion stage of the flame cycle, insulate the fuel source, or dilute the flammable gases and oxygen concentrations. Flame retardants are used in an array of items, such as electronics, refrigerators, washers and dryers, home's, electrical wires, paints, roofing, and composite panels.
The goal of this project is to reduce the flammability of wood, and other materials through coatings of paint. Wood would be coated by each of the flame retardants and no flame retardant for comparison and to determine the most effective one. I hypothesize that if the tongue depressor, or wooden stick is immersed in the Magnesium Hydroxide Nano paint solution, then the tongue depressor would have a lower combustion and burning time compared to the Ammonium Phosphate and the Sodium Carbonate.
Ultimately, the experiment accepted my hypothesis. The Mg(OH)2 nanoparticle mixture yielded a longer average ignition time as well as a longer ignition time for the 0.6% WT and 0.4% WT mixture for both Oil and Water based paints. Moreover, water based nano paint mixtures had a much higher ignition time, with the highest being 150.3 seconds and the lowest being 69.1 seconds. As a result of the experiment, the hypothesis was indeed accepted. Magnesium Hydroxide proved to be a much more effective and logistical flame retardant compared to Aluminum Hydroxide.

A18 Addressing Global Water Scarcity Using Light Absorbing Nanomaterials

Chemistry

Shriyaa Chittibabu
Shrewsbury High School

The focus of this project was to understand various commercial desalination technologies and develop inexpensive ways to produce clean, drinkable water from saline and brackish water sources. The objective of this experiment was to harvest freely available solar energy using highly light and infrared absorbing nanomaterials for converting dirty water (dirty and saline sources) to water vapor and condense it back to clean water. I have focused in discovering most suitable nanomaterials that could absorb light and heat from various light sources and transfer it back as heat energy. The experiments were conducted in two parts: indoor and outdoor testing. In general, this project tested the ability of efficiently converting light energy into heat energy by using different nanomaterials. I have used various light absorbing nanomaterials such as carbon black, microcrystalline graphite powder, nanocrystalline graphene platelets, nonwoven carbon nanotube (CNT) fabric along with black nickel flakes. I have used two light sources, a 1000 watts high pressure sodium lamp and a 1000 watts metal halide lamp, for testing the efficiency of various nanomaterials in heat generation under indoor conditions. I have also tested various nanomaterials on a sunny winter day in January for outdoor testing. I have measured average increase in temperature of suspended nanomaterials in water as a function of time under various lighting conditions. The amount of heat generated for various conditions was quantified from increase in temperature using the formula q=m*Cp*dT, where q is the heat generated in Joules, Cp is the specific heat capacity of water (4.18 J/g/°C), m is the mass of water in grams and dT is increase in temperature in °C. Based on this, I generated data,and collected data.

B1 Improving Water Desalination: Enhancing Shock Electrodialysis

Chemistry
Milo Chase
Bancroft School

A recently discovered method of water deionization called shock electrodialysis (SED) was investigated. Shock electrodialysis is a method of water desalination where a shock wave in the ion concentration profile of an electrolyte solution propagates out from a cathode and remains steady, effectively separating the solution into a distinct region of deionized solution and a region of solution concentrated with ions. In an effort to analyze the relative effectiveness of the two primary mechanisms for SED, the pore size of the frit used in the apparatus was varied and the resulting water deionization was measured using the absorbance readings of the samples taken. Even at faster flow rates, a size three frit with larger pores appeared to deionize more effectively than a size four frit. Thus, the results indicate that a larger average pore size facilitates enhanced water desalination over a corresponding frit of smaller average pore size.

B16 Constrained Chemical Descriptor Based QSAR

Chemistry
Ananthan Sadagopan
Westborough High School

Currently, there are two problems with quantitative structure-activity relationships (QSAR), the first being the structure-activity relationship (SAR) paradox, that can produce bad guesses for molecules, as the derivatives of the lead may lack the activity the lead possessed, the second being the lack of effectiveness when dealing with minor modifications (i.e. “which substituent on the phenyl ring will decrease IC50 the most”). The current models are better suited for giving general advice about the location of a lipophilic, hydrophilic, or bulky group. The challenges with the current computational models force the turn to the lab and analog-based drug design to further increase the potency of leads, which is an expensive endeavor. The tool developed is a chemical descriptor based QSAR that compensates for the flaws in the current methods, and can be used independently or in-tandem with current methods. It can assess the likelihood of a SAR paradox in the compound being studied, assess which small structural modifications will decrease IC50 the most, and can predict the relative IC50 of the compound and its analogs.

B17 The Effect of Household Substances on Biodegradable Plastic

Chemistry
Suvin Sundararajan
Westfield High School

This project analyzes the effects of varying the amounts of starch, glycerin, vinegar, and distilled water during the polymerization of a biodegradable polymer. The purpose was to assess whether changes to the proportions of polymer-forming materials to non-polymer-forming materials would increase the tensile strength.
Polymer samples were created by changing ingredient proportions, and dried for seven days. Each sample was examined to mark polymer orientation, and cut into squares parallel to striations. Tensile strength tests were conducted to measure the force as a function of time. During testing, samples were oriented along the polymer chain direction to test maximum tensile strength.
Using force probes to identify the breaking point, increases to proportions showed a linear decrease in tensile strength for the ingredients, with exceptions to cornstarch. Increasing cornstarch by 17% to 75% from a base recipe resulted in a 77% to 660 % increase in the tensile force. Anomalies in certain tensile strength tests suggested that the process of drying samples should be refined to consistently control the rate of evaporation and reduce sample variability.
Polymer-forming materials resulted in a greater tensile strength. Additional research is required to benchmark the tensile strength and other properties of this polymer with commonly used petroleum-based plastics to establish which products can be replaced with our biodegradable alternative. Theoretically this includes the majority of consumer goods produced with plastic, but also other lightweight materials.

D1 Experiments to Identify a Mystery Metal

Chemistry
Camila Muñeton, Shandira Soto
Boston Latin Academy

The reason behind this experiment was to discover the identity of a material found in an old classroom. In order to accomplish this goal, we observed the physical characteristics of the metal (this is how we refer to the material), tested how it reacted with other substances and finally, conducted a flame test, to try and get more definitive results. The series of tests allowed us to observe many characteristics of the metal. First, we learned that the material is silvery-white, almost lustrous, solid at its normal state, and can be bent easily. At first it appeared to be aluminium, but, using the density formula, we found that it was thicker than a standard piece of aluminum foil should be. Next, we tested for magnetism and found that it was not magnetic. Then, we submerged the metal foil in hydrochloric acid and Tin Chloride, to see if it would dissolve and observed the metal's reactivity trends. Finally, using the dissolved metal in HCl, we conducted a flame test, and compared the color of the flame to other known colors.
The number of tests conducted ruled out many metals that this material could not be, such as iron, lead, magnesium, cobalt among others. Some of the last metals it could have been were Tin and Nickel. The flame test and reaction with Tin chloride proved that there was at least a small amount of Tin in the material. We were then able to conclude that the metal must be Tin or a Tin alloy.

F5 Measuring Calories

Chemistry
Evelyn Ocegueda
East Boston High School

The main focus topic of this project consisted of calorimetry and calories. Kilocalories are a measure of energy, much like the Joule. Calorimetry is a form of measuring calories through the heat given off to water when burning a particular food item observing how the given off heat affects the water's temperature. Within this project, this concept was taken and based around different types of potato chips.
The research question for this experiment was as to what type of chip out of Pringles (original), Baked Lays (original), Cape Cod (original) , and UTZ (original) contained the most amount of calories per gram. This research question was tested using what is called a bomb calorimeter.
A bomb calorimeter was built using nested cans held up by ringstands. The inner can contained water which underwent a temperature change after a heat transfer giving off energy measured in calories from the burned food occured. The energy given off was measured using this temperature change in the unit of calories. After producing 3 trials for each type of food item and collecting the corresponding data, the overall conclusion that was reached was the Pringles contained the most calories when tested in the method used.
This data however could have been affected by factors including: a change in the original procedure, differences in chip mass, failure to allow cans to fully cool before proceeding to next trial, and the distance at which the flame was held from the water.

F20 Minimizing Bacteria in Thawing of Meat

Chemistry
Olivia Weber
Taunton High School

This experiment tested four common ways of thawing beef, a microwave, refrigerator, at room temperature and in a hot water bath. Bacteria begins to grow on meat as soon as the animal is butchered, and thawing is a crucial part of microbial growth, as if not thawed in a safe way, harmful bacteria could be in something consumed. To carry out this experiment, three pieces of beef were set out for each method of thawing, after they were thawed, the pieces were individually blended with water and made into a puree. With this puree, it was added to test tube full of 9 mL of water. Then, serial dilutions were carried out, each tube was diluted, then swabbed on petri dishes and finally placed in an incubator for 24 hours. It was hypothesized that if beef is thawed in a refrigerator then it will grow the least amount of bacteria and if it is thawed at room temperature, the beef will grow the most. This hypothesis turned out to be correct, this is because in the refrigerator the beef stayed at a constant temperature, and at room temperature the beef could have been exposed the harmful bacteria in the air, and it is also in the danger zone. In the experiment we used two different controls, which was the type of meat, beef, which was kept the same, and the beef puree that was not diluted.

G2 Strength of Magnetic Field in Acids and Bases

Chemistry
Aaron Huang
North Quincy High School

Four inch long with a diameter of one inch mild steel electromagnet was exposed to 650 mL of different pH levels to explore the ways acids and bases affect the strength of the electromagnet at 18.5V and 3.5A. The pH level was measured, and temperature was measured to determine that it is at a relative constant through all the trials. The strengths of the electromagnet were measured with distilled water, citric acid, milk of magnesia, soapy water, sea water, and milk all with varying pH levels, and the independent variable was pH level. The question being investigated was what is the effect of low and high pH levels on a magnetic field? The claim that was investigated was if an electromagnet is submerged in different pH levels, then it the strength of the magnetic field will increase in high pH levels, and decrease in low pH levels. The data demonstrated that there is no trend between pH levels and the strengths of the magnetic field as the pH level changes. The data collected is inconclusive and does not support the hypothesis.

G11 Near IR Absorbing Gold Nanorods for Cancer Imaging and Therapy

Chemistry
Salima Amiji
Bishop Feehan High School

Lung cancer remains a leading cause of mortality worldwide. Early detection and novel methods of therapy that do not cause unnecessary harm to normal cells are urgently needed.
In this study, I have synthesized and have examined the role of near-infrared (near-IR) radiation absorbing gold nanorods (Au-NR) as improved nano-materials for imaging and therapy of non-small cell lung cancer (NSCLC) cells. Two different methods – ascorbic acid/CTAB and hydroquinone methods – were used for synthesis of Au-NRs. Following synthesis, the Au-NR samples were imaged using transmission electron microscopy (TEM) and incubated with A549 NSCLC cells in culture and visualized by confocal microscopy.
The results of the study showed that the hydroquinone method was better in reproducibly preparing Au-NR with the aspect ratio of 3.5 to 4 for near-IR absorbance. The Au-NR were rapidly internalized by A549 cells and could be effectively seen in the cell endosomal compartments within 15 minutes of incubation by confocal microscopy.
Overall, this study led me to understand that there are better approaches for imaging and treatment of NSCLC, such as with Au-NR. In the future, I plan to use these nano-systems for thermal therapy of NSCLC.

G19 The Ascorbic Acid Concentration in Orange Juices

Chemistry
Shane Lerkvikarn
North Quincy High School

Ascorbic acid is very important to the growth and repair of all tissues within the body. A lack of daily vitamin C could scurvy and be harmful. Different types of orange juice were titrated using iodine to determine their ascorbic acid concentrations. The reaction between orange juice and iodine is an oxidation-reduction (redox) reaction. If ascorbic acid is present in the solution, iodine will react with it, and not with the starch, so the solution will not change color. However, once all of the ascorbic acid has been oxidized, added iodine will be free to react with the starch, producing a distinct color change. Starch was combined with the orange juice samples allowing the change to be seen. The purpose of this experiment was to determine which type of orange juice has the most ascorbic acid. The hypothesis was “if three different kinds of orange juice (homemade, premium, and concentrated) are titrated with iodine to determine ascorbic acid concentration, then homemade orange juice will require more iodine to be neutralized and will be calculated to have the most vitamin C out of the three types of juices. Homemade orange juice was calculated to have the most vitamin C. My results illustrate that the average amount of iodine used for homemade orange juice was greater than the premium orange juice and the frozen concentrated orange juice.

H22 Turning Milk into Plastic

Chemistry
Janaisha Delcompare, India Mallory
Edward M. Kennedy Academy for Health Careers

The purpose of this experiment is to see if milk can actually turn into plastic. Which milk will be more dense to form a better plastic? Since this experiment uses Soy milk, Almond milk, 1% and whole milk , the whole milk might make a better plastic because it's more dense than the others. There will be four cups filled with vinegar and hot milk poured into them. Once the milk reacts to the vinegar it will be poured over cloth and the liquid will drain while the solids stay on top of the cloth. The 1% milk formed the best and the Almond milk formed the worse ; stayed at a liquid state. The hypothesis was not supported.

H25 A Rainbow of Colors to Aid a Chemical Reaction

Chemistry
Zedah Alayon
Brockton High School

Turning iodine to iodide is a simple process, but is usually done with natural light, such as white light or sunlight. If light with wavelengths closest to ultraviolet light are applied to a chemical reaction then the reaction will take place in the shortest amount of time and the wavelengths on the opposite side of the spectrum will have the opposite outcome because ultraviolet light has very short wavelengths that contain more energy, exciting the electrons in the reaction and ultimately speeding it up, and infrared light has much longer wavelengths, which would take longer to prompt the reaction. The hypothesis was correct and fully supported by the data. The independent variable was the color of the light, measured in frequency (hz/nm) and the dependent variable was the time it took for the reaction to occur, measured in minutes to the nearest millisecond. The experiment would be conducted by mixing a solution of diluted oxalic acid and ammonia together with a solution of diluted iodine in an enclosed space under a lamp. The beaker will be placed in a box. Both substances will be fed through a funnel atop the covering. Immediately following the mixing of both substances, the funnel will be removed from the covering and the lamp will be bent to lay directly over the hole in the covering. Time will be recorded immediately following the lamp being turned on. A color change from dark orange or brown to clear will be the indication that the process has concluded. As the data for the experiment is analyzed, there are an abundance of observable stimuli that occurred during the experiment which can be noted. When different wavelengths of light are added to a chemical reaction, they change the speed of the chemical reaction drastically.

J1 Generation of Cost-Effective Nanoparticles for Fuel Cell Efficiency

Chemistry
Shidong Xu
Boston University Academy

Renewable energy technologies are critically dependent on the design of inexpensive, electrochemically stable, and highly active electro-catalysts. The most active and stable electro-catalysts rely on the use of precious metals such as platinum. Discovery of stable and highly active electro-catalysts with reduced precious metal loadings is therefore important for the widespread utilization of renewable energy devices. Efforts to replace platinum nanoparticles as the main electro-catalyst in fuel cells have been made. Many non-precious-metal materials are unsuitable due to their instability in oxidation-reduction reactions (ORR), which is the limiting step for fuel cells. However, titanium and tantalum are known to be stable in such environments. This makes them viable and inexpensive alternative options in our project.
The objectives of the project were to develop and optimize a synthetic procedure that can yield small, uniform titanium oxide and tantalum oxide nanoparticles (~5 nm in size), and to use the oxide nanoparticles as precursors for nitride materials to be tested for ORR. The project sought to test two synthesis methods for titanium/tantalum oxide nanoparticles. Of the 2 methods, the colloidal synthesis method was found simpler and produced more well-dispersed particles. Of all the parameters varied for optimization, decreasing the concentration of the isopropoxide precursor was the most effective in controlling the particle size distribution. The optimized colloidal synthesis method was very successful in obtaining small, uniform, and well-dispersed nanoparticles. In addition to inexpensively synthesizing high-quality nanoparticles, the colloidal synthesis method was also found to be capable of producing bimetallic (titanium-tantalum) nanoparticles.

J14 Effects of Milk Fat on Cheese Curd Yield

Chemistry
Nayely Gonzalez
Boston Latin Academy

The research question: “How does the percent fat in a quart of milk affect how much cheese curd is yielded?”. The method used to find the result was to coagulate three different milk, whole milk, reduced fat, and low-fat milk with a rennet pill at 33 C.
Milk is made up two proteins casein protein and whey protein. Casein proteins can form multi-molecular structures (casein michelle) when rennet (chymosin enzyme) is added to it. Casein contains kappa-casein that are negatively charged which keeps milk in its liquid form. Chymosin enzyme breaks the kappa-casein, cutting it and disposing of it along with the whey leaving behind para-kappa-casein. Para-kappa-casein then joins with two phosphates and later with one calcium to form casein micelles this forms a protein web. The protein web (curd) traps in fat and other minerals.
As an end result whole milk produced on average 161.5 g, reduced fat milk 129.3 g, and low fat 95.8 g. Reduced fat milk yielded 80% of what whole milk produced, and low fat yielded 60%. This indicated that the more fat a milk has the more cheese curd will yielded. These results could be used to help people find the right percent of fat that they need in milk to obtain the desired amount of cheese.

K5 The Absorbency Power of Fruit Peels

Chemistry
Jenny Zeng
North Quincy High School

Agricultural waste products were tested for their effectiveness in absorbency or removal of vinegar in a solution. The experiment was performed in order to determine: If the type of fruit peel used is related to the amount of vinegar that is absorbed in a solution, then banana peel will absorb the most amount of vinegar. Vinegar solution was prepared by incorporating 1.5 mL of vinegar into 50 mL of distilled water. Apple, banana, and orange peel was each measured in 10.0 gram portions. The peels were soaked in the vinegar solution for 1 hour. The titrant was prepared by diluting 10 mL of 1.0 M sodium hydroxide in 100 mL of distilled water to produce 0.1 M sodium hydroxide solution. After the allotted time passed, the peels were disposed and the solution titrated to determine the amount of vinegar remaining. Banana was invariably the most favorable fruit peel in every single set of data on average, as well as in every single trial. The greatest percent absorption was 58.7%. All other percentage adsorption was above 35.0%, with set two percent adsorption being 46.9%, and set four percent adsorption calculated to be 45.0%. Thus, banana peel was the most effective and favorable agricultural waste tested for removal of particles compared to orange or apple peel. Such agricultural wastes can be applied to contaminated wastewater in order to extract industrial effluents and heavy metals.

K18 Temperature on the Intensity and Length of Glow Stick Luminescence

Chemistry
Mya Le
North Quincy High School

Measurements of resistance of glow sticks in various temperature conditions (cold, room temperature, hot) using a homemade light measuring device were performed. The hypothesis was that if the intensity and length of luminescence of glow sticks were measured in a light measuring device with water at a cold temperature, room temperature, and hot temperature, then the intensity of luminescence would be highest at a hot temperature but length of luminescence would be longest at a cold temperature. A light measuring device was built to measure resistance using a photoresistor, a jar, aluminum foil, electrical tape, alligator clip leads, and a multimeter. Tap water was measured to correspond to the appropriate temperature of water, and the glow stick was activated and placed in the water. Resistance was measured using the multimeter on the 2000 kΩ setting and recorded in intervals until the multimeter could not detect resistance from the glow stick any longer. A higher resistance was interpreted to mean a lower intensity of luminescence and a lower resistance was interpreted to mean a higher intensity of luminescence. Generally, hot temperatures had a lower resistance and fluoresced for around 2 hours and glow sticks measured in cold temperatures had a higher resistance and fluoresced for around 6 hours. and cold temperatures had a higher resistance. The data acquired from this experiment supported the hypothesis, with glow sticks in hot temperature having an average highest intensity and glow sticks in cold temperature having a longer length of luminescence. For scientists that used similar chemicals to those that compose glow sticks, this experiment would be relevant for using temperature as a factor that would affect the chemiluminescence in their experiment.

K20 Saponification Sensation

Chemistry
Marie Carney
St. John Paul ll High School

Soap is a substance that is used everyday. From washing hands to cleaning dishes and pots, it allows for dirt and bacteria to be removed. The project was aimed at finding out how different concentrations of coconut oil affect the pH of soap. Some questions included How does the amount of coconut oil affect the pH of soap after each wash (crude soap, wash 1, wash 2, final product-dry)? and What is in soap that makes it good for cleaning? It is hypothesized that if three different concentrations of coconut oil are used during saponification then the highest concentrated soap with 30mL of coconut oil will have the lowest pH. This entailed going through the soap-making process three times each with a different amount of coconut oil. In the end, this was to create three bars of soap, showing that the pH's differed based on the amount of coconut oil. While the low pH of coconut oil and the high pH of sodium hydroxide could have effected the end result with a more neutral and lower pH, it was in fact due to the salt solution. The results showed that the soap with 30ml of coconut oil did have the lowest pH, but mainly because of the salt solution. In the end, the coconut oil made the soap softer and better for cleaning due to its many nutrients and minerals, but did not seem to effect the pH that much.

K22 Can Temperature Affect How Long a Glow Stick Stays Lit

Chemistry
Stefania Yee
Urban Science Academy

The goal of my science fair project was to keep one of the glow stick glowing for as long as possible. I used four identical glow sticks and placed them in four different temperatures of water. The temperatures of the water changed the glow sticks glow time. The glow stick placed in the boiling water burned the brightest but only glowed for 43 minutes while the glow of the glow stick placed in the coldest cup of water had a much dimmer glow but lasted over 5 hours. I had predicted the glow stick placed in the freezing water would take the longest amount of time to burn out because its chemical reaction to the cool water would be slow which would mean it would take its time burning out. My results show that my prediction of when the glow sticks would burn out was correct.

N1 Can Coffee Filters Be Used To Clean Oil Spills?

Chemistry
Twuyen Tran
North Quincy High School

The purpose of this experiment was to apply various quantities of paper coffee filters to a heterogenous mixture of peanut oil and salt water. It was predicted that the use of greater amounts of coffee filters would take in more of the oil, resulting in less peanut oil. A salt water solution was prepared and peanut oil was incorporated, mimicking the crude oil in oil spills. Paper coffee filters were added in order to absorb the oil from the mixture. A separatory funnel was utilized to extract the peanut oil from the mixture. It was then measured how much oil had been absorbed by the coffee filter. The final average for the control group, untouched peanut oil, was 50 milliliters. The final averages for the amount of leftover peanut oil after the application of 1, 2, 3, 4, and 5 coffee filters were 25.5, 31.85, 38.6, 42.45, and 46.3 milliliters. When additional coffee filters were used, less peanut oil was absorbed. A single coffee filter demonstrated to be the most effective in soaking up the oil. The hypothesis was not supported by the data collected. However, due to the relevance of this experiment, this method could be applied and altered by others in order to continue discovering an accessible and inexpensive fix for oil spills.

N12 Yeast: Brick to Bread

Chemistry
William Lyle
Foxborough Regional Charter School

In this experiment, the effects of yeast on the density of bread were tested. Following a recipe that came with the bread machine that was used, the amounts of yeast were varied based on the original amount. Alongside having some tests be made with the normal amount of yeast, and some with none, some loaves were made with half the amount the recipe calls for, and some were made with an extra half. Everything else in all of the tests stayed the same, with 343g of flour, 177.4 mL of water, 19.7cm3 of oil, 19.7cm3 of sugar, and 4.9cm3 of salt. All loaves were made in a bread machine, which was always put on the same setting. The ingredients always went into the machine in the same order: water, sugar, oil, salt, flour, and finally the yeast. The hypothesis was disproven, as the results showed the yeast to affect the bread in a limit function approaching 0, and not in a straight line as predicted.

N21 Hot Pucks

Chemistry
Paul Guerard
Boston Latin Academy

My experiment was about the effect of temperature of hockey pucks on the distance that they slide across the ice. In my experiment, I used twenty brand new hockey pucks and a laser thermometer gun to see what temperature they were at before putting them on the ramp and letting them slide down onto the ice. The ramp was three feet tall and four long which gave me an even five foot hypotenuse made of plexiglass that the pucks would slide onto the ice with. There were four different groups of hockey pucks with five hockey pucks in each group. Each group of hockey pucks were put into a zip-lock bag and placed into different environments for a total of eight hours. My control group was room temperature, another group was placed in the freezer, another was buried in snow, and another put into 2 wool socks and placed onto a radiator. Later that day my father and I went to the hockey rink and conducted the experiment and found that the colder the pucks are, the farther that they slide. That was my experiment.

N28 Plant Based Dye vs. Chemical Based Dye

Chemistry
Dixon Marroquin, Citlali Pena, Berlinda Zizi
Urban Science Academy

Our project was about testing out plant based dye and chemical based dye. A plant based dye is a dye that is 100% pure plant extracted juice which you can do so many things with such as coloring. The chemical based dye is obviously the normal dye that regular markers have that you buy from the store. We wanted to see which dye will work more efficiently than the other. The color we used for this experiment was red. My group and I had two main purposes for the experiment. Our first purpose was our concern for the environment. Due to many pollutants escaping into our waters, we are experiencing water pollution and many forms of sea life are paying the price for this,. We wanted to find a way to make the most basic thing that everyone has in their homes more environmentally friendly. Our second concern was for kids. Children love to put their mouths on everything and by knowing that we are alarmed how they can potentially put the markers in their mouths. The chemicals in these markers are not good so we thought about making markers that are child friendly by using plant dye so they won't get any toxicities in their systems.
The way we tested our experiment out was to take the beet juice marker and the chemical marker and literally color whole pages of graphing paper until the color ran out for all markers. We did three trials. I made three beet juice markers and I bought three store markers. When the markers died, we calculated how many squares in the graphing paper that was filled up and we compared how many squares the plant dye and chemical dye filled up to get the final answer. Our findings showed that the chemical based dye was unsurprisingly more efficient than the plant based dye.

P1 Solid Acid Catalysts: A Greener Alternative for Pharmaceutical Field

Chemistry
Kevin Wen
Somerville High School

The synthesis of aspirin was catalyzed by 0.25 g of a variety of solid acid catalysts that replaced the usual mineral acid—sulfuric acid (H2SO4). Solid acid catalysts have been known to yield cleaner and purer products than their less environmentally-suitable counterparts mineral acids. The normal procedure for synthesizing acetylsalicylic acid was carried out which included incorporating the catalyst with the reactants (salicylic acid, acetic anhydride), heating the mixture to the desired temperature (80°C - 90°C) in a water bath, crystallization, and vacuum filtration. Products were allowed to dry for 8 days until weighed for data analysis. Further testing was conducted on the purity of the products by running an H-NMR spectroscopy on each of the samples and using a melting point apparatus to identify the melting point range for each of the samples. Melting point and H-NMR testing revealed that the 6M aqueous solution of zinc chloride produced the purest aspirin samples while the samples catalyzed by sulfuric acid (H2SO4) were full of impurities. The advantages of employing solid acid catalysts in organic reactions are evident in the purities of their corresponding reaction products.

P18 How the pH of a Consumed Beverage Affects Drug Solubility

Chemistry
Alessandra Loffredo, Jessica Podesta
Stoughton High School

This experiment, titled “How the pH of a Consumed Beverage Affects Drug Solubility,” aims to discover a simple method of increasing the dissolution rate of pills meant for consumption, which leads to noticeable results sooner after ingestion. This method was later decided to be the pH of beverages that people drink when consuming a pill. Before the experiment was conducted, a hypothesis was formed predicting that if the pill is taken with an acidic beverage, the medication will have a faster rate of dissolution because the low pH will work in conjunction with that of the gastric acid, instead of a basic beverage that raises the stomach pH and therefore rendering the acid less effective. In order to prove or disprove the hypothesis, the amount of time it took for ibuprofen and acetaminophen pills to completely dissolve was tested. Three common beverages of varying pH levels were used: Coca-Cola with a pH of about 2.5, black Lipton tea with a pH of about 4.9, and tap water with a neutral pH of 7. Each beverage and pill combination was tested in a solution of gastric acid, the mixture of acid and chemical compounds found in a human stomach. Through experimentation, the hypothesis was able to be proven correct because there was a noticeable trend present in the data showing that lower pH lead to a faster dissolution time.

Biochemistry

Biochemistry

A23 How Bacteria Can Help Us Treat Diabetes
B2 Using siRNAs to Promote Homology-Directed DNA Repair
B15 Designing A Thyroid Hormone Detection System
D2 Effects of Phone Screens on the Eyes
D6 Effects of Inter-alpha-Trypsin Inhibitors on Erythrocyte Aggregation
D15 Organic Arch Support
F6 Difference in Energy Release of Lipids vs. Carbohydrates
H2 Exploring the Lower Oceanic Crust, One of the Last Frontiers on Earth
H10 Is Organic Really Organic?
H21 How to Break Down Superbug Bacteria
H24 Biomimetic Method Mediated by LRAP to Regenerate Enamel in 3D Spaces
J9 Correction of Mutations Underlying Tay Sachs Disease by RNA Editing
J12 The Effects of CO2 on the Growth of Crops in an Underwater Biosphere.
K26 Effects of Organic Solvents on Tetrahymena Phaygocytosis
K27 Isolation of High-Molecular-Weight Tau from Alzheimer’s Disease Brain
N16 What Type of Algae Produces the Most Biofuel?
N27 Modification of Tumor Environment by Secreted miRNA
P20 Functional Interactions of Metalloproteinases in Kidney Cystogenesis

A23 How Bacteria Can Help Us Treat Diabetes

Biochemistry
Marzuq Iqbal
Advanced Math and Science Academy

According to the American Diabetes Association 1.25 million people in the USA currently have type 1 diabetes. Another fact: In the U.S., there are $14 billion in T1D-associated healthcare expenditures and lost income annually. While a cure for diabetes is in the distant future, treatment is not. The treatment at hand isn't exactly cost or time effective. Through the use of bacterial transformation, better treatment is possible. Thus the question at hand: can diabetics control blood glucose with insulin produced by bacteria?
Bacterial transformation can be used for producing insulin such that diabetics may control their blood glucose levels with insulin produced by bacteria.
Methods/Procedure:
In this experiment, I will perform bacterial transformation. I will analyze the growth of bacteria and observe the roles of external and internal factors in gene regulation. The experiment will perform bacterial transformation through bacterial genes coding for the enzymes needed to metabolize arabinose. This would allow the genes to be activated due to the presence of arabinose. At this stage, the jellyfish gene encoding GFP (green fluorescent protein) would replace the genes breaking down the arabinose and thus emit a fluorescence of green. By observing this entire process, I would then illustrate and potentially implement a way to use bacterial transformation to such that the bacteria would produce more insulin and hence a treatment to type 1 diabetes.
Data & Results:
As expected no bacteria growth was observed in the Negative Control condition (bacteria without pGLO plasmid) since they did not express the ampicillin resistance gene. Bacteria transformed with 1x and 5x of pGLO plasmid showed growth (ampicillin resistance), as well as GFP.

B2 Using siRNAs to Promote Homology-Directed DNA Repair

Biochemistry
Karan Mehta
Bancroft School

This study extends the work of last year's investigation: Using siRNAs to Promote Homology-Directed DNA Repair. The purpose of this study was to determine whether or not a knockdown by small interfering RNAs (siRNAs) of certain repair genes may be used to increase the efficiency of CRISPR/Cas9, a gene-editing technology. In prior experimentation, the knockdown of the DNA-repair genes Ku70, XRCC4, and PRKDC was successfully studied and monitored for how each of these respective knockdowns impacted the percentage of homologous recombination (HR), a DNA-repair pathway in the cell (Shrivastav, M. et al., 2008).
This year, the study was extended by knocking down BRCA2, Rad51, and PARP1, and measuring how the knockdown of these genes influences DNA-repair pathway outcome. It was predicted that the knockdown of these genes would stimulate a different repair pathway: non-homologous end-joining (NHEJ).
Before performing new knockdown studies, significant improvements to the CRISPR/Cas9 protocol had to be made as part of phase 1 of experimentation. Thus far, the experimental procedure has been refined significantly. Due to persistent cell death, when determining the fluorescence intensity of each reporter, a new screening protocol has been chosen. In addition to using a more advanced cell-sorter, a new method for harvesting the cells has been adopted, greatly reducing cell-death and extraneous debris in the sample. Moreover, a Cas9/sgRNA titration experiment was conducted, and it was determined that a higher concentration of Cas9 enzyme delivered to the cells led to the largest number of cleavages. Further a yellow fluorescent protein reporter has been added to the cells, as a means of ensuring the events recorded are cells which have been successfully transfected.

B15 Designing A Thyroid Hormone Detection System

Biochemistry
Eshan Sane, Anoop Patta
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.

D2 Effects of Phone Screens on the Eyes

Biochemistry
Brigid Moriarty
Westfield High School

The purpose of this experiment was to see if the blue light from smartphones could be damaging to human eyesight. Overall, the hypothesis was proved by the experimentation. The question being answered was do phone screens hurt your eyes? The hypothesis was that if Night Shift is turned on, then it will have less of an effect on the eyes, because of the lack of blue light being emitted. Blue light has high energy, and research is beginning to show that it may damage human eyes.

To conduct the experiment, an iPhone was exposed to light sensitive paper at three time intervals; 2 minutes, 30 minutes, 60 minutes. The experiment was then repeated with night shift mode turned on. After the paper was developed, the area of the affected paper were measured in square centimeters. The higher the area, the more affected the paper was.

For the 30 and 60 minute intervals, the hypothesis was correct. The paper exposed to the night shift light had less of an affected area than the paper with the regular iPhone screen. For the 2 minute interval, the paper with the night shift mode was actually more affected than the regular iPhone light, calling for future experimentation.

This project can have a large impact on humans. As the world becomes more technologically advanced, the more important it becomes for humans to protect themselves from dangers that are still unknown. While it cannot yet be proved that phone screens damage eyesight, there is research that certainly supports it. It is vital that humans take precautions with their technology now, before it is too late.

D6 Effects of Inter-alpha-Trypsin Inhibitors on Erythrocyte Aggregation

Biochemistry
Lance Wong
Shrewsbury High School

Sepsis is a common and life-threatening inflammatory overreaction caused by an infection. It remains the primary cause of death from infection, despite advances in modern medicine. However, a new blood protein (Inter-alpha inhibitors, a serine protease inhibitor shortened as IAIP) has recently been found to lower mortality rates in animal testing when injected intravenously. Though its effect on mortality rates is known, it is not fully understood what parts of the inflammatory cascade IAIP targets. This project focused on investigating the effects of IAIP on erythrocyte aggregation, sedimentation, and rounding: a major part of the inflammatory cascade. Microscope analysis and ESR (Erythrocyte Sedimentation Rate) devices were utilized to inspect morphology and aggregation. The results show that IAIP has a significant effect in reversing the distortion caused by hydroperoxides ($p < 0.01$), and the aggregation caused by dextran ($p < 0.01$). Moreover, this is a clear indicator that the aggregation of blood and insufficient tissue perfusion during inflammation is associated with a drop in IAIP levels, meaning that IAIP would be an effective therapeutic aid for sepsis and other acute inflammatory diseases.

D15 Organic Arch Support

Biochemistry
Soukaina El Atifi, Lydia Gebru
Excel High

This project intent to determine the feasibility of making organic arch support out of plastics made from milk and vinegar mixture. The researchers hypothesized that if organic plastics be made from milk and vinegar mixture then it can be molded into arch support purposely to relieve pain in long walking or running. We made different ratio of milk and vinegar mixtures and molded it into foot arch support. We found out that it can be made into the arch support. Therefore, we recommend the use of these products as a safe alternative for foot arch support. However, we were not able to do the actual test in order to determine its efficiency and breaking point. Thereby, we recommend that actual test must be done in order to measure its efficiency and use.

F6 Difference in Energy Release of Lipids vs. Carbohydrates

Biochemistry
Mairead Baker
Boston Latin Academy

This project was put forward in an effort to distinguish how the chemical structures of lipids and carbohydrates affect the amounts of energy released when heat ruptures the bonds holding together the atoms comprising the macromolecules.
The amount of energy released by the macromolecules was determined by a calorimeter. The calorimeter contained 100 g of water, and the initial and final temperatures of the water were measured. Foods containing significant measures of lipids (walnuts, peanuts, cashews) and foods containing significant measures of carbohydrates (kidney beans, chickpeas, raisins) were measured for their initial mass using a gram scale. After being completely burnt out, their final mass was measured. Using the equation $Q = mc\Delta t$, the amount of calories absorbed (equal to the amount of energy released by the food) was calculated. Converting the calories released obtained by $Q = mc\Delta t$ to kilocalories and dividing by the change in mass of the food indicates the amount of energy stored per gram in each of the foods.
The equation $Q = mc\Delta t$ provided insight about the calories released by the foods. On average, the lipidous foods had a greater amount of energy released than did the foods with higher measures of carbohydrates.
Higher averages of energy stored per gram and energy released in the foods with higher measures of lipids indicated that lipids store more energy in covalent bonds between the atoms of the macromolecules than carbohydrates.

H2 Exploring the Lower Oceanic Crust, One of the Last Frontiers on Earth

Biochemistry
Sarah Lott, Rebecca Cox
Falmouth Academy

This experiment analyzed the microbial composition of communities in 7 of the 68 samples of deep subseafloor lower ocean crust collected during International Ocean Drilling Program (IODP) Expedition 360 from the Southwest Indian Ridge. It was hypothesized that DNA of bacteria, as opposed to archaea, would be most prevalent among the prokaryotic DNA signatures within the samples. This hypothesis was supported. DNA was extracted from crushed rock samples this then underwent WGA and the 16S gene region was PCR amplified. Carbonate and felsic veins were present in many of the rock core samples, which suggests that there was, at one time, water flow. ATP and the enzyme alkaline phosphatase were detected throughout the core, suggesting that the DNA reads found were from microbes that were alive in the rock. Pie charts of community composition were created using QIIME. Across all samples, more bacterial reads were found than archaeal reads, with an average ratio of bacterial to archaeal reads of 15.07 to 1, and a total of 949 different OTUs were found. Marine Group I, Marinimicrobia, and Proteobacteria, including Gammaproteobacteria, Alphaproteobacteria, and Deltaproteobacteria, were found in several samples throughout the core. A cluster dendrogram of all the sample was created. All samples with over 95% similarity were close to each other in depth. Within the biggest split, one of the two groups contained samples from 300mbsf and above and the other was more varied in its composition. This suggests that certain communities that cannot survive below 300mbsf.

H10 Is Organic Really Organic?

Biochemistry
Sokol Hoxha
Doherty Memorial H. S.

This project aimed to test for the presence of GMO markers in a variety of foods in organic-labeled and non-organic labeled versions. This was accomplished through a polymerase chain reaction (PCR). This process involved extracting DNA from samples and the gene tested for would be amplified. From there, the samples would have a gel electrophoresis run on them to visualize the bands of DNA. The expected result would be that there would be less or ideally no presence of GMO markers in the organic samples and a greater prevalence in the non-organic samples. Should this project be contained in the future, other aspects of organic foods would be tested for i.e., pesticide residue.

H21 How to Break Down Superbug Bacteria

Biochemistry
Shruti Srinivasan
North Attleboro High School

What if we could save 10 million lives a year? The CDC estimates that by 2050, approximately 10 million people will die every year of superbug bacterial infections. For my project, I wanted to find alternatives to antibiotics, as antibiotics are increasing the strength of superbugs. Gastronomy, or the study of food, was my main focus for looking at bacteria-inhibiting substances. I used the NCBI and CDC databases for researching various gram-negative and gram-positive bacteria and the compounds that make us their outer membranes. Afterward, I researched the different enzymes that break down each of these compounds. In my findings, I discovered that the enzymes necessary to break down the compounds were not located in sufficient quantity in foods. Many of the "superfoods" that I looked at had immune-boosting abilities, and the few that contained enzymes did not have enough to effectively fight bacteria. Later, I came across a method called fecal microbiota transplantation (FMT) that is currently used in treating chronic illnesses, such as ulcerative colitis. FMT is taking good bacteria from a healthy human's feces and giving it to a sick person to add good bacteria to their system. In my project, I found that the enzymes needed to break down the bacterias' membranes where all located in the human digestive system, making FMT a viable option for many superbugs located in the digestive system. Though I hoped to find an antibiotic alternative in food, I backed up the procedure of fecal microbiota transplantation for superbug bacteria.

H24 Biomimetic Method Mediated by LRAP to Regenerate Enamel in 3D Spaces

Biochemistry
Christopher Wang
Algonquin Regional H.S.

This project reports a biomimetic method to regenerate 3-dimensionally damaged enamel. Enamel is a mineralized tissue that consists of only 4% water, 1% organic material, and minerals making up the rest. Thus, fully developed enamel is unable to regenerate itself when damaged by factors such as caries, or acid in soda. Caries, which is a wide spread biofilm disease, causes demineralization of enamel. Although dental fillings serve as a current method to restore enamel, secondary caries can often form in the micro cracks between the filling and enamel. This study shows that this method can partially regenerate a 3D cavity in the enamel, which was formed through acid etching.

J9 Correction of Mutations Underlying Tay Sachs Disease by RNA Editing

Biochemistry
Hannah Stillman
Falmouth Academy

The purpose of this experiment was to explore RNA editing as a tool to correct mutations in mRNA that cause Tay Sachs disease. Tay Sachs is a fatal disease that primarily affects infants and is caused by a deficit of the enzyme beta-hexosaminidase A. Two mutations were corrected in this experiment: a Glycine to Serine substitution at amino acid 269, the most common cause of adult Tay Sachs, and a Glycine to Serine substitution at amino acid 454, a rare mutation that causes infantile Tay Sachs when heterozygous with another infantile Tay Sachs mutation. In replicates correcting only the G269S mutation, the correction rate was 630% and in corrections of only the G454S mutation, the correction rate was 78.52.1%. In corrections of both mutations simultaneously, the correction rate of G269S was 61.53.9% and the correction rate of G454 was 720.7%. There were 7 off target editing sites observed, 2 of which were silent. The average correction rate for off target editing sites was 26%. This editing system could be effective enough to treat anyone with these forms of Tay Sachs once a delivery system is invented. RNA editing could also potentially be harnessed to correct any disease-causing G to A substitution. It was hypothesized that using RNA editing, both mutations could be corrected in human embryonic kidney cells with a 70% success rate. This was well supported because the average correction rates of all mutations were within 10% of 70%.

J12 The Effects of CO2 on the Growth of Crops in an Underwater Biosphere.

Biochemistry
Kieran Gallison
Bishop Stang High School

The purpose of this project was threefold; first to build a biosphere that provided a suitable environment for plant growth underwater, then to test suitable substrates for optimal plant growth, and finally to test and monitor the amount of carbon dioxide in the biosphere. After engineering several biospheres, a strong and sturdy plexi-glass box tested successfully. The next several trials consisted of testing different plants in different substrates, most of which grew productively but eventually withered and died. Temperature, condensation, humidity, and biosphere integrity were monitored and controlled in order to remove them as factors that would affect plant growth for the purpose of the experiment. These variables were studied first in order to advance on to testing the air quality. Since the plants withered and died at about the same time within each trial, the theory was that a lack of carbon dioxide prevented the plants from reaching a harvestable level. To test this idea, carbon dioxide was injected into the biosphere manually every few days. Unfortunately, this led to the failure of the biosphere. After restarting the experiment, an electronic carbon dioxide monitor was placed inside the biosphere. This was done to get electronic measurements of carbon dioxide parts per million within the biosphere. This was done to prove or disprove the theory that the lack of carbon dioxide led to the plants declining growth levels.

K26 Effects of Organic Solvents on Tetrahymena Phaygocytosis

Biochemistry
Isaiah Mitte, Jennifer Cartagena
Edward M. Kennedy Academy for Health Careers

The purpose of this experiment is to find out and prove the damage organic solvents can cause Tetrahymena. Organic solvents compromise tetrahymena membrane integrity which decreases phagocytosis activity. The result of the experiment was successful. Organic solvents do compromise Tetrahymena ability to perform phagocytosis. We noticed that ethanol and triclosan did not have that many vacuoles to because many of the Tetrahymena lysised. In conclusion our hypothesis was supported by our experiment. This also proves that tetrahymena are affected by the organic solvents chosen for this experiment and in turn they might also be affected by other chemicals as well.
Purpose-The purpose of this experiment is to find out and possibly prove the damage these organic solvents are causing Tetrahymena.
Question-If organic solvents are added to Tetrahymena will phagocytosis ability be compromised?
Hypothesis or Goal-Organic solvents compromise tetrahymena membrane integrity which decreases phagocytosis activity.
Literature Review-Tetrahymena is a Protista. (Eukaryote) It can switch from benefiting from other organisms without harming them or affecting them (Commensalistic) to Pathogenic modes of survival. When hungry Tetrahymena eats bacteria. The celia near the oral cavity of the mouth help and it has become specialized for feeding.
METHODS
Variables or Testing Criteria
Manipulated: Organic Solvents
Responding: Number of vacuoles
Control: Tetrahymena
Materials: Tetrahymena, Compound Microscopes, Microscope Camera, India Ink, Ethanol (alcohol), Benzene (aromatic compound), Acetone (ketone), Formaldehyde, 7 Test Tubes, 7 Concave slides
Procedures
Example of stock solutions: (In 1 mL total volume is 1000 uL x 2%= 20 u

K27 Isolation of High-Molecular-Weight Tau from Alzheimer's Disease Brain

Biochemistry
Rohit Chopra
Community Charter School of Cambridge

The abnormal accumulation of tau protein as neurofibrillary tangles is the common pathological hallmark of a set of neurodegenerative diseases, including Alzheimer's disease (AD). The deposition of neurofibrillary tangles strongly correlates with cognitive decline in AD, suggesting that tau plays a critical role in neurodegeneration. Tau pathology in AD spreads in a hierarchical pattern, whereby it first appears in the entorhinal cortex, then spreads to the hippocampus and later to the surrounding areas. Emerging evidence indicates that the propagation of tau pathology may be due to the transmission of an aberrant species of tau protein – perhaps a misfolded or aggregated protein complex. Precisely characterizing the AD-associated tau species that can be transferred between neurons is essential for understanding mechanisms by which it propagates in AD, and blocking the propagation of tau pathology might represent a promising therapeutic strategy for AD. Previous studies have shown that a rare species of soluble phosphorylated high molecular weight (HMW) tau is the form of tau involved in neuronal uptake and propagation. In this study we followed up by isolating this "magic tau" from AD postmortem brain tissues using a combination of size exclusion chromatography and affinity chromatography followed by biochemical characterization of the isolate.

N16 What Type of Algae Produces the Most Biofuel?

Biochemistry
Silvia Toncelli
Bishop Feehan High School

The purpose of this experiment and research was to find a new efficient type of fuel that was good for the environment. This research was based on the experiments of Martin Axelsson and Francesco Gentili, who posted their research on a science forum and found that chlorella (a type of green algae) produced a significant amount of biofuel when subjected to a chloroform methanol solution. The chloroform methanol solution reacted with the membranes of the algae cells and a significant amount of lipids left the cell. Therefore, the hypothesis that lead to this experiment was that chlorella, a single celled green algae, would produce a greater amount of oil in comparison to other forms of green algae (in the case if this experiment, filamentous and colonial algae). To perform this experiment, three species of algae; chlorella, spirogyra, and volvox aureus; were exposed to white light for two weeks as a growing period. The algae were then subjected to 25 ml of a 2:1 chloroform methanol solution. When the lipids left the algae, they were measured and the measurements of the oil were recorded. The expected outcome of the experiment was that only the chlorella cells would react with the chloroform methanol solution and the amount of oil the chlorella would produce would be very low. The algae in fact all reacted with the chloroform methanol solution and produced a solid amount of oil. In the end of the experiment, the hypothesis was supported by the results when the chlorella algae cultures produced amounts of 14 and 15 ml of oil, whereas the spirogyra produced 10 and 11 ml and the volvox aureus produced 7 and 5 ml.

N27 Modification of Tumor Environment by Secreted miRNA

Biochemistry
Emma Kelly
Newton Country Day Sch/Sacred Heart

Ovarian cancer is the leading cause of death from gynecologic cancer in the United States. Epithelial to mesenchymal transition is essential for ovarian cancer metastasis. This process is dependent in part on the transcription factor SLUG. SLUG expression in sixteen OVCAR3 ovarian cancer murine xenografts was compared to normal tissues from three non-tumor bearing mice using immunohistochemical staining. Stain intensity and percentage of cells stained were scored on a scale from 0 to 3 and then multiplied together to create an H-score for each section. Ovarian follicles were used as internal positive controls, while sections incubated without primary antibody were used as negative controls. Interobserver agreement was assessed by calculating a weighted Cohen's Kappa statistic. The median H-scores between normal fallopian tube epithelia and ovarian cancers were compared using a Mann-Whitney U test. The weighted Kappa statistic for the H-scores was 0.67 (95% CI 0.53 – 0.81), which falls within the "good" range of concordance. Staining was strong and uniform in normal fallopian tube cells, with a median H-score of 7.7±1.3, compared to mostly negative in ovarian cancer tumor cells, with a median H-score of 0.42±0.21. RNA-seq analysis of ovarian cancer cell lines using data from the Cancer Line Encyclopedia database revealed loss of SLUG as a common but not universal event. In an annotated patient dataset of more than 1600 ovarian cancer patients, low SLUG expression was associated with improved overall survival. SLUG loss is a characteristic feature in ovarian cancer pathogenesis and may be a favorable prognostic biomarker.

P20 Functional Interactions of Metalloproteinases in Kidney Cystogenesis

Biochemistry
Frank Xu
Brookline High School

Both ADAM10 and MMP14 belong to a subfamily of metzincin metalloproteases. They function in cell adhesion and proteolytic cleavage of ectodomains of diverse cell surface receptors and signaling molecules. They have similar structures and cleave similar cell surface proteins. Dysregulation of ADAM10 and MMP14 contributes to several major pathological processes such as inflammation, neurodegenerative diseases and cancer metastasis. We have found that ADAM10 and MMP14 form a tight complex on the cell surface. It remains unknown how the ADAM10-MMP14 complex affects cell proliferation and cystic growth of kidney epithelial cells. In a 3-dimensional collagen gel system, ectopic expression of MMP14 abolishes the integrity and polarity of kidney epithelial cells. These cells also lose cell-cell contact inhibition and grow in cystic pattern, which is an important feature of renal cystogenesis and cancer. However, ectopic expression of an enzyme-dead E/A mutant of MMP14 restores cell-cell contact inhibition. These cells grow in a tubular pattern. In addition, blockage of ADAM10 activity causes significantly activation of pro-MMP2 by MMP14, which degrades surrounding collagen matrix before cell migration and cancer metastasis. Our finding demonstrates the importance and complexity of the ADAM10-MMP14 complex. The modification of both enzyme activities in this complex is critical to screening and designing an effective therapeutic regimen for neurodegeneration and cancer.

Physics & Electronics

Physics & Electronics

A26 Laternfish: A Low-Cost Industrial Gripper to Optimize Gripping Force
B3 Optical Monitoring of Muscle Hemodynamics in Humans after Exercise
C15 Comparing the Cost, Longevity and Voltage of 3 Different Battery Types
C26 Effects of Aerodynamics and Buoyancy on Pendulum Motion
D4 Conductivity and Weight, Copper, Aluminum, Maybe Both.
D13 High Energy Quantum Nanosuperconducting Portable Nuclear “ARC” Reactor
D27 The Magnus Effect
F9 Optimization of AC Heating in Ferrofluid and Diamagnetic Bismuth
F23 The Effect of Different Liquids on the Faraday Effect
G6 The Effect of Different Alcohols on Cloud Chamber Reactivity
G8 How Far Away from a Tesla Coil Can a Light Bulb Be Illuminated?
G9 Acoustic Topological Waveguide in a Hexagonal Pillar Array
H5 Passive Blood Spatter Pattern Analysis on Different Substrates
H14 Wave Hello to Renewable Energy
H18 Water Drying
J7 The Investigation of Pepper’s Ghost
J17 How To Build an X-ray Machine
K3 Cleaning Up The Trash
K4 Are We Becoming More Alone in Space?
K16 Magnetized Water
N6 Using Light to Measure Water Quality in Streams and Rivers
N7 Geomagnetic Field Strength Measurement
N19 The Durability of Pens
N22 3-2-1 Blood
N26 How Golf Ball Core Affects Distance
P21 Piezoelectric Shoes
P22 Photovoltaichroma

A26 Laternfish: A Low-Cost Industrial Gripper to Optimize Gripping Force

Physics & Electronics
RuiPei Huang
Bancroft School

While most of the industrial end effectors are set with a fixed gripping force value, it can either damage or deform delicate objects by becoming excessive or fail to pick up the heavy objects by being insufficient. For growing industries like e-commerce and nuclear power, objects of various masses, shapes, and textures need to be handled by the end effectors; therefore, a versatile gripper which can intelligent grasp, or use the minimum gripping force to pick up objects of different shapes and masses, has become necissitated (Banerji). The research done before in this area focused on using high-cost equipment such as the 3-axis loadcell. The purpose of this research was to develop a novel low cost friction two-finger robotic gripper that can pick up different objects using the minimum gripping force needed. It was hypothesized that the developed robotic end effector can autonomously exert minimum gripping force when lifting objects with arbitrary mass, shapes, and textures.
The mechanical parts of the end effector were designed in the AutoCAD software and laser cut and assembled. Arduino UNO was then selected as the embedded control for the system. An FSR resistance sensor was placed on the inner side of one of the robotic fingers to detect their contact with the target objects, while an ultrasonic sensor was mounted above the fingers to monitor the slipping tendency of the objects. An electric servo was used to power the end effector, and a stepper motor was used to perform the lifting action. For programming, a PI—proportional and integral—controller was employed to adjust the speed of the end effector when approaching the objects. Experiements are being designed to collect data to testify the intelligent grasping ability of the end effector.

B3 Optical Monitoring of Muscle Hemodynamics in Humans after Exercise

Physics & Electronics
Shubhecchha Dhaurali
Medford High School

This project used near-infrared spectroscopy, a non-invasive method of measuring oxy-hemoglobin, deoxyhemoglobin, and myoglobin within tissue, and diffuse correlation spectroscopy, another non-invasive technology that measures regional blood flow, to quantify blood flow and oxygen consumption changes for 6 healthy humans during rest and after exercise. This was in order to determine any method of peripheral arterial disease, PAD, detection using NIRS. The protocol for this project was first a baseline measurement with a 2 minute rest, 1 min occlusion at 60 mmHg, 1 min baseline, 2 min oscillations at 60 mmHg at 0.1 Hz, 1 min baseline, then an arterial occlusion with a 2 min baseline, 1 min occlusion at 200 mmHg, 1 min baseline, 2 min oscillations at 200 mmHg 0.1 Hz, and 1 min baseline. Then the equipment was unhooked and then the exercises were completed twice followed by the individual venous and arterial measurements. I hypothesized that there will be a clearer arterial consumption rate and blood flow pattern, the pattern detected will allow for PAD detection, and the different intensities would have similar oscillation and occultation patterns. I hypothesized correctly on the results, but the measurements needed for the quantification were actually the occlusions for linear regression on venous and arterial measurements. This project has developed blood flow and oxygen consumption presets to define what normal levels are for healthy patients therefore making it possible to compare hemodynamic quantifications to a PAD patient for detection purposes with the average blood flow to be 0.5484 mL of blood per 100 mL of tissue per minute and 1.7667\muM /100 ml blood/min.

C15 Comparing the Cost, Longevity and Voltage of 3 Different Battery Types

Physics & Electronics
Renee Suhocki
Westfield High School

The overall purpose of this project was to test and prove my theory that although a common standard drug store battery, such as the brand “Duracell”, may have a longer lifespan compared to its other competitors on the market, it will be eco-friendlier and economically advantageous for the average consumer to purchase rechargeable batteries, even though they have a shorter lifespan compared to a Duracell battery, or any other well-known battery brand. To test my hypothesis I attempted to fully drain the batteries to see which type had the longest life span. Proceeding my initial trials, I hooked up a voltage probe to each battery to measure their differences in electrical potential energy. After running and testing the batteries for about three weeks, the Duracell battery outlasted the solar and electric rechargeable batteries every trial. The Solar battery took about 3 days to drain, the electric rechargeable battery took about 3 and a half days to drain, and the Duracell battery took 4 full days to fully drain. My experiment proved my hypothesis correct. The average rate at which voltage decreases was greater for the solar battery compared to the alkaline AA battery. However, 5 Duracell batteries were used over the course of this experiment compared to the use of only 1 solar rechargeable battery and 1 electric rechargeable battery the entire time. Therefore, it is more economically and ecofriendly to purchase the rechargeable electric/solar batteries. They can get up to 300-500 charges in their lifespan and only cost $14.99 for a 4 pack on amazon.com. That is equivalent to 2,000 uses. This is compared to a 10pk of Duracell AA batteries that cost $10-$20 depending on where you buy them from and only provide a one-time use.

C26 Effects of Aerodynamics and Buoyancy on Pendulum Motion

Physics & Electronics
Barut Ural
Southeastern Reg. Voc-Tech. H S

This project is an experimental and theoretical examination of my hypotheses that, contrary to conventional wisdom, pendulum motion is affected by amplitude, bob mass, bob diameter, drag, buoyancy, and the properties of the ambient medium. I created and used a screening test protocol to design my test matrix. I designed and performed a comprehensive set of experiments to produced good quality high-speed video records of motion for a wide range of bobs. I analyzed the video files using AutoTracker software, and produced data tables bob trajectories.
For my theoretical work, I formulated the equations of motion by adding the drag and buoyancy forces to the force diagram. I used an accurate nonlinear drag coefficient correlation to calculate the magnitude of the drag force. I solved the equations of motion numerically, and created an Excel based computer tool. The pendulum periods predicted by my Excel tool are in excellent agreement with the actual periods observed in my experiments. Ideal periods, on the other hand, often differ substantially from the experimental periods. My tool also predicts the amplitude decay.
This experimental and theoretical research proved all of my hypotheses. Another interesting conclusion of this project, revealed by my data, is the paradoxical role of bob mass. Bob inertia is governed by absolute bob mass plus the virtual mass, while the restoring gravity force is governed by absolute bob weight minus the buoyant force. I discovered this behavior while I was trying to consolidate my theoretical predictions with my test data.
Remarkably, I also found out that the drag force can actually shorten the pendulum period in some cases. This is because of the rapid amplitude decay caused by the drag (i.e. bob travels a smaller distance).

D4 Conductivity and Weight, Copper, Aluminum, Maybe Both.

Physics & Electronics
Kyle McCaffery
Westfield High School

This idea arose when the power company replaced the older copper power line that led from the main pole to my house with an aluminum line. I questioned this and wondered if aluminum was really the best choice of these two materials to be used in power lines. I understood that copper was much more expensive, weighed more and had a smaller volume by weight compared to aluminum.
My experiment began with the collection of raw metal that was one hundred percent pure or as close as I could get to pure. I would then weigh out the amounts that were needed to produce alloys for the experiment. Once the metals were melted in my foundry, I poured these metals into angle iron molds that were made to create a six inch wire out of the metal alloy. Once the wires were cooled, I used an ohmmeter to test the resistance of each piece. The results were recorded then averaged between the three samples I had for each wire.
The results were that the copper was the most efficient at conducting but was very heavy and very expensive compared to the aluminum. The copper however was not as dramatically different in the conductivity in comparison to the aluminum that I was expecting. The difference between the two one hundred percent samples was only about two hundredths of an ohm.
This data can be used to determine the next metal alloy to be used in future electrical wiring job. This data could save communities and private businesses huge sums of money considering that copper is three times the price of aluminum. These results can save possibly millions if not billions of dollars by just changing the alloys in out electrical lines. Think about the possibilities.

D13 High Energy Quantum Nanosuperconducting Portable Nuclear “ARC” Reactor

Physics & Electronics
Aakash Sunkari
North Attleboro High School

Atoms hold tremendous amounts of binding energy within their nucleons- and this energy is released via nuclear reactions. Current nuclear reactors harness this power via fission, and more recently fusion. Current states of reactors are rather scientifically primitive. Their size, cost, and relative complexity supersedes their function. This project aims to design a portable nuclear reactor which can produce equivalent or more energy as current reactors, yet with reduced cost, size, and complexity. New high energy nuclear and quantum physics discoveries will be used to achieve this goal. To achieve a higher energy output at a smaller scale, the main idea is to increase efficiency by directly using high energy electrons. The design of the reactor uses the weak force functions beta decay, electron capture, and gamma ray production in conjunction with nanosuperconductivity to increase the energy density of a nucleon. Quantum Mechanical Neutrinoless Double Beta Decay will be used to increase the efficiency of the reactor. In addition, the auger effect of electron capture will be used to induce the catalyzation of double beta decay. To confine the nuclear reaction, a room temperature superconductor will be constructed using carbon nanotubes to achieve a goal of a 16-fold increase of power by confining the reaction by a factor of 2. The measured output of the reactor is approximately 632MW, comparatively to a traditional reactor’s output of 500MW. This reactor design could, in future, be a viable alternative not only to nuclear energy, but perhaps to all energy sources as well.

D27 The Magnus Effect

Physics & Electronics
Hunter Brassard, Alex Colleoni-Pimenta
Hudson High School

In our experiment, we were trying to find out why the path of a cylindrical or spherical object was curved when a rotation was applied. We thought that If the surface of a rotating cylindrical or spherical object is comprised of matter and there is a constant air flow towards it, then a change of force will be measured because of the airflow over the surface of the cylinder and the pressures it applies. These different pressures measured later proved and showed us why a spherical or cylindrical object's path curves. A dowel was used as the cylindrical object that an airflow from a fan was applied to. A wind tunnel was also utilized in order to direct the wind to the dowel, making the pressure sensor readings unequivocal, proving the effect. The wind tunnel consisted of thin sheet wood with two cut out areas made of plastic in order for easy viewing and accessibility to the inside. A light source was above the top window of the tunnel to illuminate the experiment. An anemometer was then used to calculate the air speeds of the fan. The pressure sensors that detected pressures on the dowel was connected to a pressure reader which measured the readings received from the sensors. Also, the dowel spun using a motor to rotate it at different designated speeds. We extrapolated where the dowel would travel using the readings of pressure and with the knowledge of the Bernoulli's principle. There were three trials, all of which proved our hypothesis. The motor spun the dowel at three chosen speeds, both forwards and backward. The data gathered showed that the speed of the motor affects how much of a change in force there is, while also showing how a rotation affects the trajectory of a round object. The result of our experiment showed what the Magnus effect is and how it works.

F9 Optimization of AC Heating in Ferrofluid and Diamagnetic Bismuth

Physics & Electronics
Asiya Karim
Lexington High School

Magnetic tumor nanotherapy uses an alternating field to heat ferrofluids injected into tumors to kill tumor cells. One of the challenges in this process is to determine the temperature that the fluid and the tumor has reached in order to kill the tumor successfully. However, it is impractical to plant a temperature sensor inside the body due to several reasons such as invasive process, exact location, heating up of metallic sensor itself in ac field and others In this project, I am trying to determine the temperature of the ferrofluid fluid deep inside the body non-invasively. I hypothesized I can relate the change of current in the oscillator circuit to the temperature of the tumor. In this project I tested out my hypothesis using Ferrofluid and bismuth. One of the most interesting aspects of the data indicates that the heating of Ferrofluid tracks the change in viscosity of the oil used in making the Ferrofluid. In fact there is a kink in the data, exactly where the viscosity versus temperature has a kink. While there are several theoretical explanations of the heating effect of the magnetic nanofluids, this experiment identifies the most important contributions. This is very useful to researchers in the field since they can use this information to program and track how high a temperature they want to achieve for the particular tumor as well as in how much time this is to be achieved.

F23 The Effect of Different Liquids on the Faraday Effect

Physics & Electronics
Owen Bloch-Jones, Ezra Taub
Boston Latin Academy

In this experiment, we are examining the relationship between different densities of mediums the Faraday Effect. The Faraday Effect is a change in the angle of polarization of light due to a magnetic wave. The background research that we did indicated that a higher verdet constant would result in a greater change due to the Faraday Effect. We hypothesized that a higher density medium would have a higher verdet constant, and thus show a greater change. We measured the change by putting two polarizers at perpendicular angles to each other and measuring light intensity at the end. When we did the experiment the first time there was no change when the setup was active and when it was not. Our background research also showed that there should have been some change, so we concluded that our experimental setup was not accurate or precise enough to properly measure the effect and therefore more testing was required in order to answer our question. After that, we made changes to our procedure so that that the experiment was more controlled and precise.

G6 The Effect of Different Alcohols on Cloud Chamber Reactivity

Physics & Electronics
Gedeon Pil
Falmouth Academy

The purpose of this study was to determine how different alcohols affect the number of alpha particles detected by a diffusion cloud chamber. Cloud chambers are devices that use supersaturated alcohol vapor to trace the paths of charged particles. Though no longer considered cutting-edge technology, they still play an important role in modern science, particularly in the testing of climate models. Scientists at the European Organization for Nuclear Research (CERN) often use diffusion cloud chambers to study the role cosmic radiation plays in cloud formation. In this study two cloud chambers, one containing 22.7 mL of ethyl alcohol and one containing 22.7 mL of isopropyl alcohol, were observed for a period of 30 minutes. It was hypothesized prior to experimentation that if the volumes of the alcohols used were kept the same or similar, the chamber containing ethyl alcohol would detect more alpha particles than the chamber containing isopropyl alcohol. The data gathered did not support the hypothesis. On average, the isopropyl alcohol chamber detected about 0.5 more alpha particles each minute than the ethyl alcohol chamber. However, the standard deviations of the averages significantly overlap. This suggests that the difference between the two alcohols was not statistically significant and that neither alcohol was more sensitive. The results of this project provide valuable information for those currently doing research involving cloud chambers. They suggest that the experimenters can use either ethyl alcohol or isopropyl alcohol in their cloud chambers without affecting the outcome of their studies.

G8 How Far Away from a Tesla Coil Can a Light Bulb Be Illuminated?

Physics & Electronics
Logan Martelly, Zachary Brown
Joseph Case High School

This experiment is based around the idea of wireless energy. This idea was first developed by Nikola Tesla through his experiments with the tesla coil. The tesla coil is supplied by a high voltage transformer which then charges a bank of capacitors. This bank of capacitors then jumps the spark gap and a surge of high voltage is sent through the primary coil where a magnetic field is created inside of the primary coil. The secondary coil is placed in the center of the primary coil so that this magnetic field produced by the primary induces a current onto the secondary coil and this current then travels to the top of the secondary coil where it is then released through the toroid at the top sending high frequency voltage into the air powering nearby things such as a fluorescent bulb. The magnetic field then collapses and the process starts over again. We will be using this idea of wireless energy from a tesla coil in order to test a variety of light bulbs with a variety of wattages to see if their wattages affect the distance to where they are affected by the tesla coil. We are also testing the different effects that the tesla coil has on these objects. The results were that the incandescents and the LEDs only lit up because of the arcs that were inside of them but the fluorescence however did actually light up and had that results that went along with our hypothesis.

G9 Acoustic Topological Waveguide in a Hexagonal Pillar Array

Physics & Electronics
Shuvom Sadhuka
Cambridge Rindge & Latin High School

Topological insulators are materials that conduct electricity along the surface but not through the interior, a result of band inversion about the chemical potential. Recently, analogous topological behavior was found in acoustic systems, where band inversions can produce topologically protected sound wave transport. However, the parameters controlling acoustic topology remain largely unexplored [1-2]. Here we numerically calculate a set of band inversions that occur in a phononic honeycomb lattice in 2 dimensions, defined by 3 parameters: 2 speeds of sound and a geometric filling fraction. We find that the parametric boundary of topological transitions forms a simple surface, similar to a curved sheet of paper. Our Newtonian analog provides physical intuition towards topological quantum materials, as well as practical steps towards acoustic waveguide applications.

H5 Passive Blood Spatter Pattern Analysis on Different Substrates

Physics & Electronics
Leah Littlefield
Falmouth Academy

The purpose of this experiment was to study the effects of different surfaces on passive blood spatter. This is a technique used in Bloodstain Pattern Analysis, a subset of forensic science that focuses on bloodstains and spatter patterns to infer the possible causes of the bloodletting event. The type of stain formed is determined to a great extent by the surface on which it lands or to which it is transferred. Permeability, porosity, roughness, and hardness are the four main characteristics of a surface that impact the stain formed. It was hypothesized that the smoother and less porous the surface, the more regularly shaped the final bloodstains on that surface. The greatest number of satellite drops would be found on irregular/rough nonporous surfaces. Finally, the spread would be greatest on smooth and porous surfaces. To test this, Synthetic Training Blood was dropped from a height of 6 inches onto pieces of drywall, slate, ceramic tile, linen fabric, ¼" pile carpet, pine, glass and maple. The area, number of satellite drops, and regularity were then recorded and analyzed. The results only partially supported this hypothesis. While generally, the harder surfaces had greater surface, the fabric was one of the highest rated in terms of regularity. This is understandable, because the blood wicked along the threads in the fabric. The results for satellite drops did not support my hypothesis, because the results did not seem to follow the trend that had been anticipated.

H14 Wave Hello to Renewable Energy

Physics & Electronics
Emma Olson
Bishop Feehan High School

Energy is essential to everyday life and as technology progresses, the human race uses more much energy resources to perform daily tasks. Energy resources can be broken into two categories, renewable and nonrenewable. Renewable energy sources cannot be easily depleted and are often thought of as limitless. In contrast, nonrenewable energy sources are not limitless and in the near future could be completely depleted. Renewable energy sources ensure that human beings cannot run out of energy, therefore using renewable resources can allow humans to use energy without depleting it. As an abundant natural resource, the ocean is a powerful source of energy that is limitless. Ocean waves will continue to exist as long as the sun shines based on the fact that solar power causes wind energy and wind blowing over the surface of the ocean creates surface waves. Ocean energy sources have been studied, but currently advances are behind other renewable energy sources. Research into wave energy is beneficial to society as it could turn an available natural resource into a productive green energy source. The experiment "Wave Hello to Wave Energy" will evaluate whether the fluctuations of water height as created by waves will push air up through a tube in order to create energy which can be captured and stored. The hypothesis is "If the scientist attempts to generate energy from both stagnant water and waves, then the power of the waves will generate more energy to be stored by the scientist." The scientist expected that more energy would be generated by waves than stagnant water, which would be evident in the graphs and charts. The results were expected to be drastically different, as the graphs which recorded the constant (stagnant water) would have barely any energy produced.

H18 Water Drying

Physics & Electronics
Kayli Wu
North Quincy High School

Three different shirts, 100% cotton fabric material, 100% polyester fabric material, 100% Dri-Fit fabric material were compared to see which shirt dried more water. The hypothesis is if 100% polyester, 100% Dri-Fit and 100% cotton adult small long sleeves shirts are compared against each other, then 100% Dri-Fit shirt will dry off more water in three hours. The engineering goal was to determine which type of fabric material shirt are better fit to wear for athletes. It modeled which fabric shirt will dry best for the sweat an athlete produces. The three shirts were wetted by water and hung to dry for three hours. Hourly, the amount of water dried were measured to determine which type of fabric will dry off the most water. It demonstrated that the 100% polyester shirt dried more water than 100% Dri-Fit shirt and 100% cotton shirt. The overall average water dried in three hours was 154.8 grams for 100% cotton shirt, 182 grams for 100% polyester shirt and 171.6 grams for 100% Dri-Fit shirt. It showed that 100% polyester shirt had a better drying water ability after three hours. Wearing 100% polyester fabric shirt will be more comfortable for athletes because it has a faster drying ability than 100% cotton fabric shirt and 100% Dri-Fit shirt.

J7 The Investigation of Pepper’s Ghost

Physics & Electronics
Hung-Wei Lu
Northfield-Mt.Hermon School

The purpose of this investigation is to provide a non-conventional explanation and scientific model for Pepper's Ghost, an optical illusion effect that has been conventionally explained with refraction. Through a few preliminary experiments involving a miniature of Pepper's Ghost, I discovered that reflection seems to be the primary cause of Pepper's Ghost rather than refraction. In a preliminary experiment, I set up a transparent slice of plastic sheet to touch the bottom of a phone screen. The plastic sheet helps create a 3D-looking virtual image that seems to levitate above the phone screen. There is one requirement, however: the intersection of the plastic sheet and the phone screen has to remain at an angle less than 90 degrees in order for the "Ghost" to appear. Once the angle reaches 90 degrees or more, the image disappears. This certainly implies a huge factor of Pepper's Ghost is determined by reflection of a plane lens instead of refraction.
The goal of the investigation and its experiments is to discover exactly how the phenomenon depends on reflection, how we can control this phenomenon using different types of reflections, and how we can optimize the effect of Pepper's Ghost after obtaining these results.

J17 How To Build an X-ray Machine

Physics & Electronics
Alexa Mendez
Calvary Chapel Academy

The objective of this project was to construct and use a homemade X-ray machine safely. The problem that was to be addressed was to investigate how to make and use the homemade X-ray machine safely to conduct experiments and answer scientific questions. An X-ray tube was connected to a high voltage power supply. Then a Geiger counter measured the amount of radiation that was being produced. The results of the testing showed that the device was capable of generating radiation and being constructed safely.

K3 Cleaning Up The Trash

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

I chose this project because space trash surrounding Earth is a huge problem and when I researched it and saw that there is only one logical idea to help solve this problem, and that the idea didn’t even come from this country. I felt like I needed to start brainstorming better ways to solve this problem. My hypothesis was that a smaller mass would have a more successful launch and would also attract more space trash once it entered Earth’s orbit. To test this, I used a simulator to test the success of the different masses. The simulator allows me to change different components that are all essential to a successful launch. I set the components that were not being tested to an appropriate medium and I changed the desirable components in proportional amounts. My data showed that the smallest mass had the highest successful launch, proving my hypothesis correct. The next stage of this test would be building a magnetic set of objects to test the collection of magnetic space trash.

K4 Are We Becoming More Alone in Space?

Physics & Electronics
Kyle Brooks
Berkshire Arts & Technology Charter Public School

The topic of this science fair experiment is about how using red shift and blue shift we are able to see how fast objects are moving toward us and away from us. I predicted, based on my background research and the accepted value, that the universe was expanding at a rate of one million kilometers per second and that there are systems approaching us even though the universe is expanding. What I did to see if this was true was I measured the redshifts and blueshifts of graphs of light waves emitting from galaxies, quasars, and stars and plugged it into the equation v = cz to find how fast they are moving closer or farther away from us. My data shows that out of the systems that I measured quasars on average went the fastest and the fastest one that I measured, was going at a rate of 910,800 kilometers per second away from. Using the data that I collected I found that the more redshift that there is the faster the objects is moving away from us and that if you can find a system that has a larger redshift you might see it moving away from us very close to the rate that the universe is expanding.

K16 Magnetized Water

Physics & Electronics
Nuo Lin
North Quincy High School

Research was to find the effect that a magnetic field has on the flow of water through a burette. A magnetic field can be created by any magnet and each magnetic field has a north and south pole. These poles are attracted by the opposite pole and is repelled by the same pole. Since water is a highly polar molecule, it has a negative section and a positive section, which are the oxygen and hydrogens respectively. In theory, the flow of water would be affected by the pull of the magnetic field on the positive and negative parts of the water. The time it took for 100 mL of tap water to flow through a burette with various magnetic orientations were recorded. There were 10 trials and 3 different trials in each set and 10 sets of data making 300 pieces of data. The flow of water with a magnetic field when compared to the flow of water without a magnetic field was decreased by at most 179.10%, which disproved my hypothesis of “if the flow of water is affected by the presence of a magnetic field, then the flow of water would be 10% slower in the presence of a magnetic field when the field is created by two magnets that are attracted by each other and it would be 10% faster in the presence of a magnetic field when the field is created by two magnets that are repelling each other.”The knowledge of the effect of a magnetic field on the flow of water could be used to create pipes that do not conduct a magnetic field ot make the most efficient sewer system.

N6 Using Light to Measure Water Quality in Streams and Rivers

Physics & Electronics
Francesca DiMare
Brockton High School

This project sought to establish an inexpensive method of water quality measurement available to the citizen scientist. This was accomplished by exploring whether a low-cost apparatus could be used to find a correlation between a water sample's refractive index and its quality, which was tested in terms of salinity, turbidity, and percent transmission. A laser was pointed at each sample at 70°, then the refracted ray was marked and measured. Finally, Snell's law was used to calculate each sample's refractive index. Initially, various concentrations of salt were used to test the apparatus's success at measuring salinity contamination, producing a 0.85% deviation from theoretical values. Next, soil collected from the bottom of a creek was added in increments of .2g to create an artificial representation of various turbidity levels. Finally, the refractive indexes of water samples collected from local streams and rivers were measured and compared to results from a spectrophotometer. Measured data for the refractive index of the various amounts of soil and the collected samples did not show any conclusive correlation with the sample's respective contaminant level. Differences in refractive index between samples varied by values in the thousandths place, suggesting any measured correlation or lack thereof was likely a result of the 0.85% error. This demonstrates that while this method could be used to measure salinity contamination, it is not effective at measuring turbidity and other pollutants, as most changes in water quality impacted refractive index to a degree too small for conclusive measurements to be taken.

N7 Geomagnetic Field Strength Measurement

Physics & Electronics
Amrita Thirumalai
Worcester Academy

GOAL: To measure the earth's magnetic field strength using home-made apparatus.
METHOD: I constructed a coil to generate a magnetic field that is perpendicular to the earth's magnetic field. This was done by orienting the axis of the coil perpendicular to magnetic North, that is indicated by the magnetic needle of a compass. By varying the current in the coil, I can vary the magnetic field strength generated by the coils. The compass reacts to the net magnetic field which results from vector summation of the earth's and coil's magnetic fields. The magnetic needle will deflect by 45 degrees only when the field strength generated by the coils is identical to the earth's field. Note that this was done keeping the compass needle and the coil axis in the same horizontal plane.
Rather than limiting the experiment to a single measurement, I took multiple measurements corresponding to different positive and negative angles of deviation from magnetic North, which is the vector sum of the field strengths of the earth's and coil's magnetic fields, and plotted these on a graph whose slope gives the geomagnetic field strength.
FUTURE RESEARCH: In stead of using a battery connected in series with a potentiometer/rheostat, ammeter and two coils to vary the current, I would like replace it with a constant current source circuit to vary the current. This will reduce any stray magnetic fields created by the rheostat. I would also like to make use of the compass feature of an iPhone to see if it changes my results.

N19 The Durability of Pens

Physics & Electronics
Patrick Quinn
Boston Latin Academy

Mainly everyone uses a pen, and so do I. In this report I tested four different brands of pens: Bic, Papermate, G2, and Pentel. Before setting out, I emailed all four companies, and did research on the assembly of pens, the chemistry of ink, and other topics surrounding pens. The experiment was testing for durability. Each pen was attached to a mixer with a scotch tape and drew circles on thick paper, which was placed on a platform. A stopwatch tracked how long each pen lasted, and the results were recorded. The main reason for this experiment was to find out the best pen for classes. In this paper you will find all my research, materials, experimental procedures, all of my data, and my analysis.

N22 3-2-1 Blood

Physics & Electronics
Zeina Okar
Mary Lyon Pilot High School

Every criminal leaves behind some form of evidence at the crime scene. We now live in a world where DNA evidence can be recovered from virtually any form of biological material; saliva, mucous, hair, skin cells or even sweat. A few drops of blood left at the crime scene has the dual nature of not only providing the “who” but also the “what” regarding the circumstances of a crime. Blood stain analysis can provide details in a case for which there is no suspect. Which leads me to question whether blood stain analysis can provide information about the height of the person committing the crime? To answer this question, we examined how the diameter of blood splatter changes as distance increases. My hypothesis states that, the greater the distance blood has to travel the larger the splatter, hence taller people should produce more blood splatter. My purpose for doing this experiment is to highlight the importance of the blood splatter method in an age when people are becoming increasingly reliant on DNA which has been known to create false promises when not reliably used. Also to demonstrate how pertinent blood spatter analysis is to analyzing a crime scene.

N26 How Golf Ball Core Affects Distance

Physics & Electronics
John Daly
Hanover High School

The purpose of this experiment was to figure out if the core of the golf ball would have an affect on how far the ball would travel. The hypothesis of the experiment was if a similar/equal force was applied to all four golf balls, the golf balls would not all travel the same distance. The independent variable of the experiment was the core of the golf ball. The dependent variable would be how far the ball traveled/ where the ball landed. The experimental constants would be the amount of force applied to the ball, the club which was used, the temperature of the golf balls, the quality of grass the ball was on, and the cleanness of the ball.

P21 Piezoelectric Shoes

Physics & Electronics
Mary Pyrdol, Christopher Tran
Brockton High School

In this project, the scientists constructed a prototype piezoelectric shoe with the potential of being an alternative system of generating electricity. Following the scientific method, the scientists starting with identifying a specific problem, in this case, dealing with was the global recognition of the energy crisis. The project included an experimentation to see if the weight of an object affects its ability to generate electricity through mechanical pressure. The next step was formulating a hypothesis, explaining how the scientists believed that the weight of an object affect its ability to generate electricity through mechanical pressure because they assumed that the heavier the object, the more pressure applied and thus the more electricity generated. Then the scientists constructed blueprints for the piezoelectric shoe, a shoe that when worn and mobilized will generate electricity. The testing stage tested different weights wearing the shoes and recording the amounts of electricity generated by the different weights. The scientists compared the results to figure out that increasing weight did not increase the amount of generated electricity through mechanical pressure because of a negative and more precise trend in the amount of voltage created as weight increased. The scientists successfully engineered a device that has the potential to solve the energy crisis.

P22 Photovoltaichroma

Physics & Electronics
Eileen Xu
Wachusett Regional High School

The purpose of this project was to determine whether there was a difference in voltage depending on the natural dye used in a dye-sensitized solar cell(DSSC), and if there was, which dye produced the most voltage. To deal with the world's increasing energy usage, new ways of harnessing renewable resources are being developed. Solar energy and solar cells are one of these processes.
The independent variable(the dye used) had 10 variants including the control, tested 10 times for a total of 100 data points. To form a DSSC, two parts were created and joined. First, the plants for the dye were mashed up/blended. Raspberry (control), blackberry, blueberry, black cherry, pomegranate, plum, cranberry, red cabbage, red onion, purple potato were used. Then the dye was set aside, and a paste of TiO2, colorless vinegar, and a drop of dish soap was made. The paste was then applied to the conductive side of a tin-oxide glass slide (the electrode), and baked. The sintered paste was then let cool, and set to permeate in the plant matter. Another glass electrode had its conductive side coated with graphite. An iodine solution was dripped over the dyed paste, then the two slides were overlapped and clipped together. Finally, the cells had their voltage tested by a voltage probe under a 300-watt tungsten lightbulb.
The results showed that there were differences in the voltages produced according to their source, as predicted. The averages taken rank the voltage in volts, V created by the dyes (greatest to least) as red cabbage → blackberry → raspberry → black cherry → pomegranate → red onion → blueberry → cranberry → plum → purple potato. The highest average voltage was produced by the red cabbage, showing that it was the best among these samples to use when extracting dye for a DSSC.

Environmental Science

Environmental Science

A27 Vitamin C
B27 Benthic Macroinvertebrates as Bioindicators
B28 A Modular Platform for Node-Based Environmental Sensor Networks
C14 Urban Turbines
C17 Light Sensitive Turntable: Effects on Brassica rapa
C18 Reaction of SO2 with Cement and Impact on Chloride Induced Degradation
C24 The Decomposition of Plant Matter in Salt Marshes
D19 Ceasing Coral Bleaching
D21 Illuminating the Problem: Bioluminescence
D25 Saving the Environment with Wave Energy
F1 What's In Your Water?
F4 Decomposition of Plastic
F17 Bioluminescence with Fireflies
G4 Mosquito Madness Massacre
G14 Affordable Desalination Of Ocean Water
G20 The Quality of Drinking Water
G21 D.O. Disaster
G26 PH Effects on Freshwater Snails
H4 Food For Thought
H8 Circumvention of Barriers by Lower Troposphere Aerosolized Pollutants
H11 The Effect of Lowered Oxygen Levels on Hermit Crab Behavior
H15 Designing a P-Band Radar System to Measure Soil Moisture Content
J6 Finding Biodegradable Alternatives to Synthetic Plastics
J8 Deicing Alternatives - Better for Surfaces and the Environment
J15 The Effect of Noise Pollution on Grass Shrimp
J16 Nutrient Leaching From Arctic Permafrost Thaw
J19 Improving the Energy Produced by a Flexible Solar Cell
K2 Curing Ailments but Poisoning the Environment?
K8 Habitat Modeling of Northern Sand Lance in the Stellwagen Bank Region
K13 Examining the Effects of Land Use on Water Quality
K25 One Pebble, One Life: Reducing Water Pollution by Natural Filtration
N5 De-Icers: Are We A-Salting Our Environment? The Effects of Road Salt.

N25 Freshwater Organism: The Effect of Water Pollutants
P3 Eggshells vs. Coffee Ground
P4 Effect of Ammonium Sulfate on the Thoracic Movement of Daphnia Magna
P13 Living Light
P14 The Effect of Heat and Light on Water Bottles' Fluid Purity
P26 Microplastics in Shrimp: Farmed vs. Wild

A27 Vitamin C

Environmental Science
Luis Pires
Excel High

The question this experiment was trying to answer was how does vitamin C(orange juice) affect the cellular respiration rate of a genetically modified and non-genetically modified organism? The hypothesis for this experiment was that if you have an all natural non-genetically modified plant (in this case lettuce) with 25 mL of orange juice (Vitamin C), then the all natural non-genetically modified plant (lettuce) will have a higher rate of cellular respiration. This was tested by putting each lettuce into a dark chamber than using a Co2 probe to test the cellular respiration rate. For the control I tested the experiment with water(15 ml) and the other three I used different amounts of vitamin C (25ml, 50ml, 100ml). This was all conducted with a 3 week timespan. The results showed that the 25 ml of orange juice(vitamin C) had a very static cellular respiration rate with both types of plants. In conclusion my hypothesis was incorrect. Only 100 ml of orange juice(vitamin C) will make the plants have a higher rate of cellular respiration.

B27 Benthic Macroinvertebrates as Bioindicators

Environmental Science
Bridgette Bowyer
Southeastern Reg. Voc-Tech. H S

This project consist of going out into the field and catching macroinvertebrates from Black Brook in Easton MA to show water quality in a variety of areas along this brook. The brook is split up into three research areas, all with different levels of man-made industrialization. At each site, teams were spread out to collect data. Data was collected over a time of about 45 minutes to an hour. Macroinvertebrates were brought back to the lab for evaluation and results were rounded up from the different groups and an average was determined to find the water quality of Black Brook.

B28 A Modular Platform for Node-Based Environmental Sensor Networks

Environmental Science
Curtis Fisher
Martha's Vineyard Regional H. S.

Information is central to our understanding of everything we observe. At a fundamental level, data form the basic unit of information. Environmental scientists use data in accordance with observation of the environment to evaluate their research. Data collection is tedious and often yields insufficient data for significant analysis. This research focuses on utilizing pre-established paradigms in data collection and transmission to create a new system capable of autonomously recording data and facilitating real-time access to it through the internet. It serves to reduce time spent manually collecting data and fulfills the need for greater access to data. The system’s modularity is essential in making it practical to deploy; both sensors and radios can be configured to fulfill data requirements without the additional expense of under-utilized equipment and resources. This research provides the means to acquire data in a low-cost, power-efficient, and user-friendly way.

C14 Urban Turbines

Environmental Science
Owen Favreau
Martha's Vineyard Regional H. S.

Vertical axis wind turbines are machines that can transfer wind energy into usable electricity. While lesser known in the United States, their more compact and durable design allows for more versatile use. This experiment was designed to build and test a smaller vertical axis wind turbine (VAWT) to see if electricity could be produced. This was done by constructing a small turbine and subjecting it to various simulated wind speeds. Throughout the experiment, blade positioning was altered to obtain a wider range of data through a multimeter. Even though different blade positions produced different amounts of electricity, the results demonstrated that a turbine of this size and weight, could only achieve a maximum watt output of only 17 mW (milliwatts). It was concluded that no substantial wattage could be produced with a turbine of this size.

C17 Light Sensitive Turntable: Effects on Brassica rapa

Environmental Science
Cheaheon Lim
Northfield-Mt.Hermon School

Auxin polarization induced by PIN3 genes is critical in effectuating plant phototropism. Upon activation by phototropins that detect light and inhibit the activity of the PINOID kinase (PID), PIN auxin efflux carriers act as auxin transporters, stimulating the elongation of cells on the plant quartile opposite to the light source.
To survey the effects of potential energy loss from auxin-induced asymmetrical development in Brassica rapa, the present study examined the yield and growth of test subjects under a unidirectional lightsource in two treatment groups. B. rapa in the control group were cultivated on a stationary surface, and bioassays and macroscopic analyses yielded substantive evidence of phototropism in the plant canopies of samples under observation. Phototropism was inhibited in the other treatment group by cultivating B. rapa on a photosensitive turntable engineered by the researcher.
Quantitative analysis revealed that B. rapa in the turntable treatment group demonstrated superior physiological health indicators compared to that of samples cultivated on the control surface, producing approximately 58.171% to 90.492% greater yields. Multivariable regression planes constructed to further examine the energy efficiency of phototrophic growth indicated that heightened leaf stalk development had a greater stake in diminishing B. rapa yields than the asymmetrical elongation of sample stem cells. Such results demonstrate the promising impact the genetic inhibition of specific manifestations of phototropism in staple crops can have on maximizing crop yields in agricultural ventures that are limited by intercrop shading.

C18 Reaction of SO2 with Cement and Impact on Chloride Induced Degradation

Environmental Science
Lazi Danga
Bancroft School

In previous studies, the adsorptive properties of hydrated cement has been explored, particularly as it relates to NO2 and SO2. It has also been noticed that chloride ions have a negative impact on the structure of hydrated cement, leading to its degradation. Thus, in order to help sustain concrete in the face of chloride-ion induced degradation, the powdered cement will be exposed to sulfuric acid (it has been observed that adsorption of SO2 into hydrated cement particles is a two step reaction during which sulfur dioxide reacts with water to form sulfuric acid, which itself will react with the calcium hydroxide in the concrete) in an aqueous solution. In order to test the above reaction, a known concentration of H2SO4 was react with powdered hydrated cement particles. In order to determine the amount of H2SO4 adsorbed into the concrete, an acid-base titration was performed between H2SO4 and NaOH. Then, the powdered cement was incorporated as part of the fine aggregate in the production of more cement, which will be exposed to an aqueous solution of sodium chloride, and then placed under a hydraulic press, where the pressure at which the concrete begins to crack will be recorded. If the pressure at which the concrete cracks is higher in the concrete containing H2SO4 exposed concrete than in the control group of concrete not containing H2SO4 exposed concrete, then it will support the idea that SO2 can be used to help concrete resist chloride-ion induced degradation.

C24 The Decomposition of Plant Matter in Salt Marshes

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

The purpose of this experiment was inspired to measure how decomposition ranges in Cape Cod salt marshes and how this decomposition may have been affected by climate change. Climate change is affecting many things, and salt marshes are no different. Decomposition is vital in ecosystems if this delicate system is interrupted; major effects to the surrounding environment will occur. Measuring the difference in salt marshes may help scientist restore these areas, or use them as comparisons for future marshes under investigation. The hypothesis created states decomposition varies depending on salt marsh location. After digging deep into research, it was predicted that decomposition will vary marsh to mash; as each marsh is different. The data gathered from this experiment will help scientists and homeowners alike. Scientist who work in marshes can use the data, and homeowners can better understand the salt marshes they live near. In order to test the hypothesis, an experiment was formed.
The experiment was conducted over a series of ninety days, in which thirty tea bags were dug in ten marshes, three tea bags per marsh. Three tea bags were also left on the surface of a marsh to act as a control site. Once every week each marsh was visited to record parameters of water quality and ensure the sites were not disturbed. After the trials were completed, the biomass of the retrievable tea bags was measured. This allowed the results of the averages of the recovered tea bags for each marsh to be compared to the two controls. During the experiment, the water quality of the marshes was also thirteen over the course of the entire experiment as a way to try and understand the decomposition of tea bags in each marsh.

D19 Ceasing Coral Bleaching

Environmental Science
Julia Danko
Wachusett Regional High School

Many scientists estimate that by 2040 the world's coral reefs will be completely gone. Reefs are fundamental to most aquatic ecosystems since they contain such diverse and unique life forms. Coral bleaching is one of the main reasons for mass coral mortality. Numerous environmental stressors cause bleaching, but increasing ocean temperatures and increased exposure to ultraviolet light are the major causes.
Nutrient recycling in the form of symbiotic relationships is key to the survival of reef organisms. The most important of these symbioses is between the coral animal and the algae, known as zooxanthellae. When the coral is stressed, it expels its zooxanthellae and becomes white, appearing "bleached." UV light is known to invoke this response within coral. A specific group of compounds known as mycosporine-like amino acids (MAAs) are known to protect against UV light. Thus the purpose of this project was to determine if adding MAAs to the zooxanthellae can help the algae resist UV stress.
In order to test the defining question, increasing concentrations of MAAs which had been extracted from the cyanobacteria Lyngbya were added to zooxanthellae. The hypothesis stated that as the amount of MAAs increased the chlorophyll and number of cells would also increase. It was found that MAAs do seem to provide some aid to the zooxanthellae under stressful light conditions as the chlorophyll and cell count data rose slightly over the control.

D21 Illuminating the Problem: Bioluminescence

Environmental Science
Chase Beausoleil
Bishop Feehan High School

Testing bioluminescent dinoflagellates to detect pollution was chosen as the experiment because bioluminescent dinoflagellates were recently an interest. After researching and finding a limited account for the use of bioluminescence, the question of what the dinoflagellates could be used for arose. More research ensued, and a source was found claiming that the health of the dinoflagellates may be connected to the brightness of their luminescence. From this information, the idea to test the brightness of bioluminescent dinoflagellates in varying levels of oil arose. The hypothesis for the experiment is if an increasing amount of crude oil is placed into three different groups, each containing three containers of dinoflagellates, then the amount of light given off by the dinoflagellates will decrease for every increase in crude oil. To perform the experiment, all materials were gathered and the custom shake table was built. Then, after being poured into the Erlenmeyer flasks with the growth medium, the dinoflagellates were placed into a room under a 24-hour light cycle. Varying levels of crude oil were poured into the Erlenmeyer flasks and the light from the dinoflagellates on the shake table was tested for four nights. The expected result of the experiment was that after four days, the light from the dinoflagellates with the greatest amount of crude oil would decrease the most. The results of the experiment were that the dinoflagellates in no oil continued to thrive, while the health of the dinoflagellates in oil decreased. The conclusion was that the results agreed with the hypothesis, and that the health of the dinoflagellates decreased more rapidly for those in more oil.

D25 Saving the Environment with Wave Energy

Environmental Science
NaShanti Moore-Ellis
Cardinal Spellman High

I made a machine that will take in the wave energy from the ocean and turn it into electrical energy. To test whether my experiment would work I used a nine-foot PVC pipe and a fan, from a dock on Scituate Harbor and measured the open circuit voltage, short circuit milliamps, volts across a light bulb, and milliamps through a light bulb to see if the wave energy was turning into electrical energy. The open circuit voltage was 1.25, which proves the set up can generate electricity. The short circuit milliamps was 57; that proves the project can make electric current flow. The third and fourth tests show I can light up a light bulb using the wave energy. I measured 0.87 volts across the lamp and the light bulb passed about 43 milliamps of current. When doing the math, I found the light bulb used 37 milliwatts of power, proving that it is possible to light a light bulb using ocean wave energy. Even though my experiment didn't have the results I wanted, I believe I would have gotten better results with better equipment; but the experiment still created electric power through wave action. This proves that my hypothesis was right. It is possible to make a machine to generate electricity through ocean waves energy. I plan to redesign my project and test it using a wave tank which I'll build using a 20-gallon fish tank.

F1 What's In Your Water?

Environmental Science
Elise Mizerak
Wachusett Regional High School

Traces of plastic microfibers, small pieces of plastic that are less than 5 mm in length, have been found in tap water around the world and many are thought to originate from synthetic fabrics. When synthetic fabrics are washed, they release plastic microfibers that conventional water purification systems are not always able to effectively filter out. Thus, these microfibers have a propensity to end up in drinking water and even ocean wildlife.
This project made use of five synthetic fabrics in a multifaceted examination of the relationship between water temperature, fabric type, and number of microfibers produced. The five fabrics were cut into small rectangles and stirred in a circular motion thirty times. At this point, 0.5 mL samples of the polluted water were examined under the microscope and the plastic microfibers in each sample were counted.
After simulating washing machine activity in water of five temperatures, it was determined that although the effect of variable water temperature on microfiber production is not consistent, each fabric stands to creates different amounts of microfibers. While nylon produced the fewest microfibers per 0.5 mL sample, polar fleece produced the most - nearly twofold as many as nylon. In polyester and polar fleece, T-tests yielded significant differences between microfiber production in the hottest and coldest temperatures. Further analysis will investigate microfiber production following multiple washes.

F4 Decomposition of Plastic

Environmental Science
Mahika Gupta
North Attleboro High School

In the United States mass production of plastics, which began just six decades ago, has accelerated so rapidly. If the present trend continues 2050 there will be 12 billion metric tons of plastic in landfills. That amount is 35,000 times as heavy as the Empire State Building. This is an imminent problem that needs a solution. Bioplastics are plastics in which the carbon present is derived from renewable feedstock and not fossil fuels. Not all bioplastics are biodegradable because some biobased plastics contain both renewable and fossil-fuel-based carbon. The percentage of biobased ingredients and the conditions under which the biobased product may biodegrade, vary widely. Biodegradable plastics are plastics that can be completely mineralized by microorganisms. Finding the perfect plastic that decomposes without harming the environment and is beneficial for consumers is essential. In the experiment, the decomposition rate of four different types of plastic: corn starch, potato starch, carbon oil (polyethylene), and biodegradable plant plastic are observed. After conducting the experiment, it was concluded the potato plastic was the best. The next step of testing the experiment in an environment similar to the ocean. Testing with extra bacterias such as the Pseudomonas putida will also help to increase the understandings of the degradation of plastic. The purpose of this experiment is to find an important and effective way to decompose plastic so it does not harm the planet and the humans living on it. Finding a solution to keep the globe clean and healthy will only help all generations.

F17 Bioluminescence with Fireflies

Environmental Science
Brandon Fossile, Julya Esteves-Ruiz
Assabet Valley Voc. H. S.

Sea fireflies bioluminescence are affected by the outbreak of pollutants such as sunscreen and tanning oil in the ocean. The objective of this paper is to determine whether pollutants from everyday life will affect the natural bioluminescence of Sea Fireflies in their natural habitat. Not much research has been done on Sea Fireflies because they are rare. For this experiment, Sea Fireflies were tested in three different conditions namely, a control salt water, sunscreen diluted in saltwater and tanning oil diluted in saltwater; the amount of light that was projected was tested for in the various conditions. The experiments were run by 3 day trials, testing was conducted on Monday, Wednesday and Friday. The Sea Fireflies were captured on a camera and the amount of bioluminesce they gave off in the polluted conditions and the regulated environment was measured. Others should take into consideration the lives of the marine animals in the ocean by funding further research so there is a cleaner safer living habitat for these animals. In the future, makeup, perfumes, lotions and deodorants will be added to the conditions being tested to find out their adverse effects on the environment.

G4 Mosquito Madness Massacre

Environmental Science
Emily Coelho, Melissa Gonzalez, Daniela Bonilla
Pioneer Charter School of Science

Mosquito bites are shown to be one of the leading causes of the spread of mosquito borne diseases such as malaria. The diseases are often fatal, but with proper care can be treated or avoided all together. The aim of this project was to find which substance between bleach, apple cider vinegar and oil was the most effective way to kill mosquito larvae. Groups of mosquito larvae were treated with oil, apple cider vinegar and bleach. The apple cider vinegar and the bleach worked the best as they successfully killed all the larvae. The results of this experiment could be used to help with research on the elimination of mosquito larvae in third world countries , where mosquito borne diseases are prevalent.

G14 Affordable Desalination Of Ocean Water

Environmental Science
Carter Paul, Harrison Paul, Ian Minier
Marlborough High School

The purpose of our project "Affordable Desalination of Ocean Water" was to provide a clean and cost efficient way of supplying drinkable water to people without access to potable water sources. Existing methods of reverse osmosis are typically very expensive, and we set out to find a middle ground between cost and efficiency. To solve this, we created a modified design of a solar distillery. The prototype was built with a wood frame and polycarbonate cover. Undesirable water was placed in the bottom of the distillery, and the distillery was set up in a location exposed to the sun. The water is then evaporated, and any pollutants are left behind. The distilled water retrieved from our prototype was tested for conductivity, temperature, turbidity, and pH. We distilled and then tested salt water, pond water, and pond water with salt. Pure distilled water was tested as a control for the gathered data taken before and after the samples were processed in the distillery. After testing our water samples we found that the distillation made possible with the prototype provided drinkable water (notably a safe level of acidity). The conductivity, turbidity, and acidity were all reduced significantly. The group concluded that the prototype was able to produce water samples that provided anticipated data results, yet bacteria and more extensive conductivity testing would be needed to prove the water was actually drinkable in large quantities. In terms of prototype construction, the design was successful and represents an effective method of distilling undesirable water at a low expense to the user. This device, even with some alternative materials, could be built at a larger scale to feed families living in impoverished countries with limited sources of clean and/or drinkable water.

G20 The Quality of Drinking Water

Environmental Science
Yi Lin
North Quincy High School

Water is essential to all living things, such as a human. Every day, a human consumes certain quantities of water depends on their age and gender. However, not everyone knows what is in the water. Therefore, this experiment was conducted with the purpose testing the water quality in the city of Quincy. Chemical components in the water can cause serious of health issues. Water treatment facilities added chlorine as a disinfectant, but it produces byproducts such as Trihalomethanes and bladder cancers that linked to miscarriages. An excessive concentration in the drinking water can cause methemoglobinemia in infants and in the stomach in adults.
In this experiment, the tap water of Quincy, the Polar Spring water, and the technical-graded distilled water were tested. In order to find the quantities of chlorine and the quantities of nitrate, the testing strips were used. The testing strip provided a color coding that shows a range of quantities of each chemical components. Then, the data was recorded in the science fair notebook.
In conclusion, the data from each source of water concluded the sources of water that were tested were considered as safe. The quantities of nitrate and the quantities of chlorine did not exceed the safety guideline of World Health Organization. In the future, this experiment can be used as a guide on which type of water human should drink.

G21 D.O. Disaster

Environmental Science
Catherine Quinn, Taylor Perez
Oliver Ames High School

A healthy water ecosystem requires oxygen just like any other living ecosystem. Fish prefer a comfortable dissolved oxygen level of at least 5 ppm, but the lower the number is, the more distress the environment is under. The oxygen requirement of marine life causes an issue with human activities negatively impacting these oxygen levels. Runoff from nitrogen-based fertilizers and sewage systems causes eutrophication, increasing the levels of nitrogen in water ecosystems and promoting the overgrowth of algae. The abundance of algae quickly depletes the water of its oxygen, leaving other species to struggle and causing a decrease in biodiversity. With a lack of public acknowledgement for the health and beauty of our local ponds, we decided to test water sources from different parts of our town to see if they are suitable for a diverse environment. The data we collected and the connections we made between the D.O. levels and the location of the water can help determine what we can do to preserve the biodiversity of our ponds and prevent further degradation.

G26 PH Effects on Freshwater Snails

Environmental Science
Fiona Dunn
The Winsor School

Species across the globe are experiencing drastic changes in environmental conditions as a result of human activities and pollution. Animals and plants acclimate to shifting environmental conditions via phenotypic plasticity, developing and expressing traits in response to local environmental conditions. This phenotypic plasticity is be associated with genetic alterations which allow for adaptation to a continually changing environment. This experiment aims to examine phenotypic and genotypic effects of pH in freshwater Physa acuta snails. I hypothesized that exposure to more acidic water would be associated with effects on antipredator behavior, shell damage, and expression of genes associated with stress and cytoskeleton formation. Juvenile snails were exposed to water of 4 different pH levels (5.5, 6, 6.7, 7) for 44 days. Antipredator response for snails from each pH group was assessed by measuring the time it took for snails to crawl out of water containing crayfish kairomones. Shell matrix damage from each pH group was quantified using a scanning electron microscope. qPCR was used to examine changes in expression of genes associated with cell stress (heat shock proteins 70 and 90) and cytoskeleton formation (tubulin) in snails from each pH group. For antipredator testing, snails exposed to lower pH exhibited faster crawl-out time. Snails exposed to lower pH had greater shell damage. qPCR analysis is underway to determine potential association between pH exposure and alterations in gene expression. Future research could investigate underlying mechanisms that mediate antipredator response and shell damage, as well as examining expression of additional genes associated with physical consequences of exposure to lower pH and other environmental toxins.

H4 Food For Thought

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

Black Soldier Flies are beneficial to the Earth. They are about 42% protein during the larval stage, which other organisms can benefit from. By consuming BSFL, the organisms gain protein and other nutrients they could be lacking. BSFL have no mouth parts, no stingers, are unable to transmit disease, and they do not create a “buzz” sound. The Black Soldier Flies are raised in the greenhouse. There, they are used as research, viewing, and a protein source for the Tilapia.

Due to the fact that BSFL prefer food with protein, clam waste and cod should be consumed in large quantities. The hypothesis of this experiment states, “The food sources the Black Soldier Fly Larvae prefer are the foods with high amounts of proteins, such as the clam waste and cod.” It is important to investigate this topic because BSFL have the potential to replace fish food and benefit other organisms. The experiment was conducted by having 18 bins, 6 mixtures and 3 trials per mixture. There were 50 BSFL placed into each of the bins. The control group were 10 BSFL taken out for each of the 6 mixtures before they consumed any food sources. The bins were checked daily for 4 days, then 10 BSFL were taken from each bins. The bins were left over the weekend, and checked on that Tuesday for 10 more BSFL taken from each of the bins.

Once the results were concluded, the trends the graphs showed were that the BSFL preferred clam waste for Treatments 1, 2, 3, and 6, corn for Treatment 4, and cod for Treatment 6.

The data collected supports the hypothesis. The hypothesis states that, “The food sources the Black Soldier Fly Larvae prefer are the foods with high amounts of proteins, such as the clam waste and cod.” During the experiment, the black soldier fly larvae consumed the foods containing protein.

H8 Circumvention of Barriers by Lower Troposphere Aerosolized Pollutants

Environmental Science
Mitchell Green
Foxborough Regional Charter School

In this experiment the ability of nitrites to pass barriers designed to limit their movement was tested. The hypothesis , “If nitrites are present in stormwater runnoff, then the nitrites will be able to circumvent man made ground barriers.,” was tested.
Over five years, three vernal pools were studied for qualitative and quantitative signs of ecosystem health. Nitrites from road and home runoff have been demonstrated and are consistent with lawn and garden fertilizers. The path and volume to the pools and distribution in these pools have been documented. Stormwater runoff barriers were engineered to absorb these nitrites. While effective in limiting nitrite pollutant migration, nitrites are circumventing the barriers.
To examine the possibility that nitrites are aerosolized and travel over barriers, filter paper was hung from trees within the vernal pool area protected by storm water barriers. The paper was collected weekly or after precipitation and tested for nitrites. Control samples were placed in containers which allowed airflow, but no exposure to precipitation or splatter.
Initial data documents low level (0.25 ppm) nitrites in the filter paper samples with slightly higher levels in samples after the first post summer rain (0.25-0.5 ppm). Controls had no detectable nitrite (<0.25 ppm). Ground level road, field, and vernal pool water samples demonstrated nitrites (0.25-0.5 ppm).
This initial data shows an ability of lower troposphere aerosolized nitrite pollutants to transverse stormwater runoff barriers.

H11 The Effect of Lowered Oxygen Levels on Hermit Crab Behavior

Environmental Science
Grace Russell
Falmouth Academy

The purpose of this experiment was to demonstrate the effects of eutrophication on hermit crabs behavior by producing an algal bloom to see how quickly the dissolved oxygen levels would decrease. It was hypothesized that once the bloom began to decompose, oxygen levels would drop at twice the rate of water without algae. It was hypothesized that hermit crab behavior would slow down with oxygen deprivation: crab lateral movement and leg movement would decrease, crabs would begin to clump together, and crabs would eventually die due to lack of oxygen. It was hypothesized that these behavioral changes would happen over the course of one week and that mortality would occur around 25% decreased oxygen. Twenty three hermit crabs were observed in a 14 gallon tank and dissolved oxygen levels were measured every three hours along with behavioral changes. Crab activity and behavior did slow down significantly with decreased oxygen. Crab movement decreased 50% within 24 hours and went down to almost zero movement within 48 hours. Crab leg movement followed a similar pattern and stopped completely after 75 hours. Clumping began at 12 hours but heightened between hour 24 and 48. Six total deaths were recorded by the seventh day (168th hour). The remainder of crabs died within the next 24 hours. With increasing human pollution, such as fertilizer runoff, organisms are being put at greater risk for oxygen depletion. The results of this experiment show that nitrogen pollution, can destroy hermit crab populations within a matter of days.

H15 Designing a P-Band Radar System to Measure Soil Moisture Content

Environmental Science
Joseph Rotondo
Upper Cape Cod Voc-Tec. H. S.

The project that has been completed was inspired by the need for an accurate soil moisture radar that can effectively measure the water content found in soil. The hypothesis that was created states that using an ARENA product by Remote Sensing Solutions Incorporated, a cost-effective radar solution for soil moisture can be created. The materials will be relatively inexpensive, and the product will be available on a massive scale. The ending result will be similar or better than what was expected, and the radar will correctly measure soil moisture. Being interested in radar technology, research was gathered on possible methods to measure and record soil moisture content. This project was created to help industries understand the amount of water in soil so they can use this calculation to improve crop yield and reduce possible erosion. The data gathered reveals the construction and testing of new radar technology to benefit industries and society as a whole.
The hypothesis was mostly supported, a radar system was built to measure soil moisture. The cost-effectiveness of the radar however must be improved through further prototypes. Connectors were used in the creation of this radar, however further construction may use board soldered parts to lower costs. The radar system does measure soil moisture and can benefit the upcoming project designs. The agricultural, hydrological, and climatological fields may utilize the findings and prototype of this project to benefit their industries. This in turn helps the society with new research, reduced costs for produce, and guarantees less water usage for fields.

J6 Finding Biodegradable Alternatives to Synthetic Plastics

Environmental Science
Eva Kuruvilla, Alexa Benack, Sara Cahill
Hopkinton High School

Because plastic is such a widely used product, the world is producing the plastic at a much faster rate than we are able to get rid of it. Due to this, plastic is building up in landfills, as well as throughout our land and waterways. The plastics are harming marine life and the surrounding ecosystems due to its presence and the chemicals being released. It is our job as the next generation to come up with a solution to the plastic crisis. Last year, we focused our project on finding plastic alternatives that would be more environmentally friendly and we continued with the same problem by finding a way to degrade the already existing plastic. Galleria mellonella, or commonly known as wax worms, live in beehives eating the wax. Because plastic has a similar structure with the carbon backbones to the wax, the worms are able to eat the wax, they are also able to eat the plastic found in our environment. In the project, we looked at how the wax worms ate different types of plastic. The final results showed us that the worms were unable to eat harder plastics, but ate all different types of bags. They consumed the high density polyethylene the most, followed by corn and then potato starch plastics. This is very exciting for the future as we are hoping to find a way to isolate the enzyme or bacteria that is breaking down the plastic. Eventually, it would be great to use this substance independently from the worms as a more efficient way to break down the plastics found polluting the world today.

J8 Deicing Alternatives - Better for Surfaces and the Environment

Environmental Science
Kevin Zhou
Lexington High School

This experiment involved testing the deicing capabilities of a deicing alternative, beet juice (with 20% salt) solution against deicing sodium chloride and a control group, water, as well as their effects on vegetation. To test for the deicing capabilities, I froze 2 cups of water in 3 trays and then applied 2 oz of each deicer. I then measured how much ice was remaining after 30 minutes for each tray, as well as the total time it took for all the ice to melt. This gave data on each deicer's deicing capabilities, as the faster the ice melts, the more potent it is. For vegetation, I planted bean seeds with three different soil trays, with each tray having a total of 72 seeds. I then doused each tray with 2 cups of water to start to give a necessary wetenning of the soil, and compounded this with ⅕ of each deicing solution with the water in the trays after all the ice has melted. In other words, I took ⅕ of the liquid in the trays after the melting process and applied this to a soil tray, with each soil tray getting one deicer. I sprayed each tray with ⅕ total cups of water twice a day for the next two weeks, and I recorded the number of germinations after one week, the number of germinations after two weeks, and the number of plants that grew two leaves after two weeks for each tray.

J15 The Effect of Noise Pollution on Grass Shrimp

Environmental Science
Saniya Rajagopal
Falmouth Academy

The purpose of this experiment was to determine grass shrimp's tolerance of noise pollution at varying frequencies. Marsh grass shrimp are important dietary components for fish in New England waters. Noise in the ocean affects behaviors critical to the survival of marine life. As for grass shrimp, little research has been developed on their tolerance of noise pollution. It was hypothesized that the grass shrimp will leave their habitat at 5,000 hertz. A fish tank had one side turned into a marsh environment and the other into an open ocean environment, with 20 shrimp placed on either side. The next day, 25 were in the marsh side and 15 in the ocean. With speakers on the marsh side, frequencies of 100, 500, 1,000, 5,000, 10,000, and 25,000 hertz were each played for a minute long. This was then tested with the noise on the ocean side, then both trials were repeated. The average shrimp on the marsh side when the speakers were on that side had a 2.5 shrimp increase with 17% of the shrimp joining that side. The average shrimp on the ocean side when the speakers were on that side had a 2 shrimp increase with 8% of the shrimp joining that side. Each trial, the shrimp were attracted to the noise which determined their location, even though they preferred the marsh to the ocean. Noise pollution determines the location of grass shrimp and could drive them out of their preferred environment.

J16 Nutrient Leaching From Arctic Permafrost Thaw

Environmental Science
Charles Xu
Falmouth High School

A vast layer of permanently frozen ground called permafrost covers the artic, sequestering thousand-year-old carbon and nutrients. Recent warming trends have begun to thaw permafrost, and if current rates are maintained, vast quantities of permafrost will quickly thaw and yield a new source of readily available carbon. The carbon is quickly metabolized, emitting methane and carbon dioxide, resulting in a feedback loop of accelerated warming. Nutrient release from permafrost samples in conjunction with higher temperatures could increase primary productivity, alter Arctic ecology, and sequester carbon. In this study, a permafrost core from the Mackenzie River watershed was quickly mixed with water three times to simulate precipitation events. Simulating precipitation by quickly mixing replicates the natural mechanism of nutrient leach from thawing permafrost, as precipitation would leach the soils and then run off due to the impermeable permafrost layer below. All samples leached NOx, ammonia, phosphorus and silica in each precipitation event, and up to 30% of bulk soil nitrogen leached out after three mixtures with water. Each later mix with water did not decrease the rate at which nutrients leached, suggesting the possibility for the continued release of nutrients from thawing permafrost. Permafrost thaw rate and total permafrost watershed area was utilized to calculate nutrient fluxes from thawing permafrost. Permafrost fluxes are on the same magnitude as current annual fluxes. The rapid release of nutrients from permafrost represents an ecologically significant increase, which has the potential to stimulate primary productivity and alter Arctic ecosystems.

J19 Improving the Energy Produced by a Flexible Solar Cell

Environmental Science
Michele Schremp
Bishop Feehan High School

It was hypothesized that the solar cells would produce more energy when directly facing the sun even as it moved across the sky. An Arduino computer could be used to make a solar tracking device that would ensure that the solar cells would always be facing the sun, and be able to produce the most energy possible at all times. It was also hypothesized that the flexible solar cells were bent in such a way that some part of the surface was always oriented directly towards the sun, then the power output could be improved.
To test this hypothesis, flat, concave, and convex solar cells were tested. Using a tripod, the amount of voltage and current produced at angles from -30 to 90 degrees relative to the sun. Using an Arduino computer, a servo motor, and a lux meter, a solar tracking device was constructed to place the solar cell at 0 degrees relative to the sun.
The flat solar cells produced the most energy at 0 degrees, or when oriented directly towards the sun. The convex solar cells were the greatest improvement over the plain solar cell, as they were bent in such a way that more parts of the cell are directly facing the sun as it moves across the sky. The active, pan and tilt solar tracking system was able to use the lux meter to track the sun and could be used to orient the solar panel towards the sun as it moves across the sky. Overall, these two approaches, a convex deflected solar cell or the active solar tracker both resulted in an overall improvement in energy output compared to the flat solar cell.

K2 Curing Ailments but Poisoning the Environment?

Environmental Science
Leeyia Hoose, Ariana Lysonski-Phillips
Taconic High School

The topic chosen to investigate was the effects of antibiotics on Daphnia magna and ryegrass. This topic was chosen in order to conduct first hand research to see how antibiotics in the water supply affect living organisms. Daphnia magna and ryegrass were used because both organisms rely on water to survive and proliferate. The hypothesis investigated was whether both organisms would be negatively affected by the exposure to the antibiotics Oxytetracycline, Penicillin, and Cephalexin. This experiment began with making serial solutions to determine the concentration to expose the organisms. The concentrations determined for the Penicillin and Cephalexin solutions were lower than the concentration of Oxytetracycline; Oxytetracycline has a greater prevalence in the environment due to being prescribed more often and thus was justifiably high in concentration. The experiment planned mimicked real life exposure by analyzing heart rates and population growth of Daphnia magna and the growth of ryegrass overtime was observed. The results of this experiment concluded that the lifespan of Daphnia magna was negatively affected when antibiotics were present, and as a consequence of antibiotics being present the grass grew faster, taller and seemingly more healthy.

K8 Habitat Modeling of Northern Sand Lance in the Stellwagen Bank Region

Environmental Science
Ben Schwenk
Falmouth Academy

Northern sand lance (Ammodytes dubius) are small forage fish that play a crucial role in the ecology of the Gulf of Maine and are an essential food item of some of the most commercially, culturally, and ecologically critical species in the northeast, including bluefin tuna, cod, and humpback whales. The purpose of this project is to use generalized additive models (GAMs) to provide a better understanding of the relationship between physiochemical parameters and sand lance presence in Stellwagen Bank. GAMs were created using data collected from 367 stations from 2014-2017. The best-fit GAMs were determined using an Akaike weight analysis, resulting in the use of two GAMs: one with an included spatial parameter, one without. The accuracy of GAMs was determined via a receiver operating characteristic curve. The most influential factors were found to be depth, bottom temperature, bottom salinity, and sand concentration. These factors suggest that sand lance prefer shallower depths, bottom temperatures of ~9°C, bottom salinities ≥ 32.25 PSU, and sand concentrations of ~87.5%. Probability heatmaps extrapolated from the spatially-explicit GAM showed a concentration of sand lance distribution along the southern and northern ends of Stellwagen. However, these findings should be used with caution, as the GAMs lacked a high accuracy score. This study is the first of many that attempts to model the specific relationships between northern sand lance and physiochemical parameters and will hopefully be useful in future mappings of sand lance distribution, constructions of sand lance habitats, and our general understanding of the species.

K13 Examining the Effects of Land Use on Water Quality

Environmental Science
Heily Chavez, Britney Rivera, Sabrina Ruiz
East Boston High School

The goal of this experiment is to determine whether the body of water near an urban location will have a higher amount of total suspended solids than the body of water in a suburban area. First, we chose a stream in an urban location called Aberjona River and a stream in a suburban location called Spot Pond Brook. Then, we collected three samples of water in each stream and recorded observations for that day. We repeated this twice a month for four months. The samples were sent to Vermont EPSCoR due to our involvement in the Basin Resilience to Extreme Events (BREE) research program. The data we received led us to conclude that the stream located in the urban location, Aberjona River, contains much more TSS than the suburban stream. The average TSS found in Spot Pond Brook was about 6.85 mg/L whereas the average TSS found in Aberjona River was more than double at 17.47 mg/L. This clearly demonstrates that due to the streams location it was more exposed to harmful substances added to the environment by humans either directly or indirectly.

K25 One Pebble, One Life: Reducing Water Pollution by Natural Filtration

Environmental Science
Wiener Douyon
Prospect Hill Academy Charter School

This report analyzes if natural, abundant resources can make improvements to the water quality of both the Mystic and Charles Rivers. The water quality in Mystic River, Charles River, and Cambridge tap water was observed by comparing the levels of phosphorous, nitrogen, and iron. With these records, a model was made to reduce contaminants and to increase the water quality. The model was constructed based on a natural aquifer, with proportional layers that mimic the significant components. The major takeaway was that there was a slight decrease in iron and nitrate levels, indicating the potential efficacy of the created models. With these conclusions, further improvements were made so that the model could be a template of an affordable and sustainable filter that is both simple in design and efficient in improving water quality in all regions of the world.

N5 De-Icers: Are We A-Salting Our Environment? The Effects of Road Salt.

Environmental Science
Divya Raghunathan
Shrewsbury High School

For years, road salt has been used to de-ice roads to ensure safe travel. However, the extended use of these de-icers has brought on many problems. Prolonged utilization of this material can cause stunted growth to wildlife and damage to cars. This experiment was meant to test alternatives to this traditional method. Beet juice, pickle brine, coffee grounds, and alfalfa meal were tested against road salt on three criteria: ice melting efficiency, effect on car paint and steel, and effect on the growth of plants. By studying potential alternatives for this material that meets all of these criteria, one would have a way to deice their roads, driveways, and sidewalks without causing harm to their surroundings. The hypothesis stated that alfalfa meal would be the best alternative to traditional methods. After conducting the experiment and average out the results from each test, the data did somewhat support the hypothesis.

N25 Freshwater Organism: The Effect of Water Pollutants

Environmental Science
Cianna Pinto, Adamaris Agosto
Edward M. Kennedy Academy for Health Careers

The purpose of this experiment was to see the way an organism is affected by pollutants in their habitat. If samples from the Courthouse are polluted as compared to the Control and the Vertex Balcony samples, then our model organism Tetrahymena will exhibit behavioral changes, such as mobility and morphology, due to the contaminants present. Courthouse, Control, and Vertex Balcony samples were viewed under a microscope to observe any different properties the samples had as well as the changes in behavior of the Tetrahymena in the environments. Our results proved our hypothesis correct. In the Courthouse sample, the Tetrahymena ended up moving very slowly and ultimately dying. In the Vertex Balcony sample Tetrahymena moved more slowly and there were less than in Control.

P3 Eggshells vs. Coffee Ground

Environmental Science
Gamael Chalvire
Excel High

The purpose of this project is to see if eggshells or coffee grounds make plants grow faster. My hypothesis is: if eggshells contains calcium then the plants with eggshells will grow faster. I put eggshells in cups with soil and did the same thing for the eggshells. I recorded the amount of seeds that germinated in each cup for both of eggshells and coffee grounds and also counted the number of leafs. My hypothesis was correct in that the seeds in the eggshells grew faster.

P4 Effect of Ammonium Sulfate on the Thoracic Movement of Daphnia Magna

Environmental Science
Luca Duclos-Orsello, Gabriel Torres
Somerville High School

Ammonium Sulfate is an ionic salt that is water soluble and known in industry as ALS. The Secondary Maximum Contaminant Levels set recommendation for sulfates in water 250 mg/L. These standards are in place to protect people from the consumption of contaminants that put human health at risk. Daphnia Magna are filter feeding crustaceans found in freshwater sources all across North America and have been found in South Africa. Their Thoracic appendages are essentially both the lungs and the small intestine of these “water fleas”. Daphnia magna are an extremely important part of the food chain. A lack of Daphnia magna can lead to major algal blooms which can kill entire ecosystems in lakes and ponds. Therefore, the effect of solutions on them can have a major correlation with the effect on an entire ecosystem. The results of this experiment showed that at low levels of Ammonium Sulfate, the Daphnia magna thrived, yet as the concentration grew, they became less healthy, and even died. One question these results pose is if there is a way one can counteract the effects of Ammonium Sulfate. This experiment adds to the knowledge of the negative effects this, and other Sulfates, can have not only on the environment, but also the ecosystem. This illustrates that laws must be enforced against the dumping of such chemicals into water sources, or the runoff created by the use of Sulfates as fertilizers. The government only creates these laws for substances they deem extremely toxic, yet many other substances, including Sulfates, can also cause damage and must be held in check. If not, many bodies of water will reach dangerous levels of concentration. In conclusion, this experiment not only informs people of the effect these substances can have on Daphnia magna, but the entire world.

P13 Living Light

Environmental Science
Kelly Gallagher
Bishop Feehan High School

This experiment was chosen for the purpose of finding an alternative for already in use outdoor light sources. These common supplies of artificial brightness, contribute to the damaging phenomen; light pollution. Light pollution is detrimental to our environment and atmosphere. The luminescent properties that bioluminescent algae possess, show potential for a valuable use. The predicted outcome of this project, is that when bioluminescent algae are put in particular conditions to mimic the actions of an artificial outdoor light source, then they will prove to be a viable option. To perform this experiment, in brief, the algae is grown. Then the algae is stirred to aggravate the dinoflagellates and active the luminescence. Then, the algae is tested several ways. The first being a measurement and comparison of luminous intensity of the algae. Followed by a testing of the luminous intensity every two hours, to discern a change as time progresses. A comparison of pollution emission. Lastly, a comparison of optimal temperature range of all of the variables. Repetition of these steps is necessary to ensure that the bioluminescent algae will prove to be an effective alternative to common outdoor night light sources. However, the algae proved to be incapable of providing an efficient light source, in comparison to standard bulbs. They lacked efficiency in their ability to continually output a sufficient amount of luminous intensity, and in their tolerance for harsher temperature conditions.

P14 The Effect of Heat and Light on Water Bottles' Fluid Purity

Environmental Science
Emily Childs, Luke Goodnow-Russell
Somerville High School

Water is vital to life, and thus, water bottles constantly surround us as we forge a path to health via proper hydration. The question is do they do more harm than good? In our experiment we set out to find which water bottles retained the least amount of changes in water after being exposed to heat and light for 3 days, or 72 hours. In order to do so, we purchased 5 water bottles and placed them under a strong LED light to monitor any possible changes. The water bottles were sealed in an environment with no moisture, no light other than the LED, and no other things that might compromise the study. After the 72 hours was up, the water inside was tested to see if there were any changes in the quality of the water. The largest outlier (or biggest surprise) in the data was the pH level of the water in the blender bottle. The amount of pH in the water of the blender bottle was two levels higher than the second most affected water (Umbro), and four levels above the baseline pre-test. The only bottle that remained identical was the small Poland Springs, which is most likely because all water came from a larger Poland Springs Bottle. Thus, water can be affected by LED light and resulting heat, particularly when on display in stores or when left out in the sun.

P26 Microplastics in Shrimp: Farmed vs. Wild

Environmental Science
Roman Louw
Berkshire Waldorf High School

Microplastics are fragments of plastic less than 5mm in size and include microbeads used in consumer and commercial products, fibers from clothing and other items, and plastics which have photodegraded or otherwise fractured into tiny bits. They are prevalent in marine environments. Due to their small size, they can be ingested by a variety of organisms. My study investigates the presence of microplastics in the faunal tissue of farmed shrimp and wild shrimp.

Earth & Space Science

Earth & Space Science

D5 A Novel Algorithm to Increase Exoplanetary Detection Accuracy
F8 Algorithmic New England Leaves

D5 A Novel Algorithm to Increase Exoplanetary Detection Accuracy

Earth & Space Science
Garima Prabhakar
Shrewsbury High School

Radial velocity, although an efficient method of detecting exoplanets is also plagued by many downsides, including the problem of dealing with noise from stellar activity in the data. This study attempts to look at this problem in a new perspective and differentiate between signals in the data caused by exoplanets and signals caused by noise from stellar activity. A minimum period required for the star in the data is first calculated, and then the data is run through and analyzed. The overall average algorithm accuracy was 98%. The results indicate that this method may be used for preliminary elimination of noise, but caution has to be taken with stars with radii less than 0.5 or greater than 1.5. The new methods for taking the experiment further are suggested, and steps towards them are currently underway.

F8 Algorithmic New England Leaves

Earth & Space Science
Kiran Dsouza, Rohit Dsouza
Concord-Carlisle Regional H. S.

Lindenmayer systems (L-systems) have been widely used to create realistic models of plants and to model actual plants. However, there are relatively few examples of actual real-world plants that have been modeled using L-systems and even these examples lack a systematic measure of how accurate the model is. We hypothesize that if we abstract leaves to 2-dimensions, we can use L-systems to recreate actual New England leaves collected during a high school Leaf Project. We will match our 2-dimensional models against the actual leaves and score them based on how much they deviate.

Mathematics

Mathematics

G17 Continuum Modelling of Traffic Systems with Autonomous Vehicles

G17 Continuum Modelling of Traffic Systems with Autonomous Vehicles

Mathematics
Kaiying Hou, Brian Rhee
Phillips Academy

Describing the behavior of automobile traffic via mathematical modeling and computer simulation has been a field of study conducted by mathematicians throughout the last century. One of the oldest models in traffic flow theory casts the problem in terms of densities and fluxes in partial differential conservation laws. In the past few years, the rise of autonomous vehicles (driven by software without human intervention) presents a new problem for classical traffic modeling. Autonomous vehicles react very differently from the traditional human-driven vehicles, resulting in modifications to the underlying partial differential equation constitutive laws. In this paper, we aim to provide insight into some new proposed constitutive laws by using continuum modeling to study traffic flows with a mix of human and autonomous vehicles. We also introduce various existing traffic flow models and present a new model for traffic flow that is based on an interaction between human drivers and autonomous vehicles where each vehicle can only measure the total density of surrounding cars, regardless of human or autonomous status. By implementing the Lax-Friedrichs scheme in Octave, we test how these different constitutive laws perform in our model and analyze the density curves that form over time steps. We also analytically derive and implement a Roe solver for a class of coupled conservation equations in which the velocities of cars are polynomial functions of the total density of surrounding cars regardless of type. We hope that our results could help civil engineers bring forth real progress in implementing efficient road systems that integrate both human-operated and unmanned vehicles.

Section 6 - Page 162 of 162

NOTES

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

2018 Board of Directors

Executive Committee

Chair
Barnas G. Monteith
Tumblehome Learning, Inc

Vice Chair
Rishi Shukla
Dock Square Equity

Treasurer
Samuel L. Batchelder, Esq.
Goodwin, Proctor LLC (ret)

Assistant Treasurer
Jane A. Bell
Corporate Secretary
Cabot Corporation

Co-Chair, MSSEF High School Committee
William F. Rigney
STEM Education Consultant

Co-Chair, MSSEF Middle School Committee & Secretary of the Corporation
Sandra H. Mayrand
UMASS Medical School (ret)

Directors-At-Large

Rachel Connolly
Director, STEM Education
WGBH & PBS Learning Media

Jay Kugler DeYoung, Esq.
Principal
Fish & Richardson

Timothy A. French, Esq.
Principal
Fish & Richardson

Howard Harrison
Massachusetts Institute of Technology

Christopher L. Lawson
NEC Energy Solutions, Inc.

Dr. Megan E. Rokop
Honors Biology Director
UMASS Boston

MSSEF Honorary Directors
Marvin C. Grossman
Management Consultant

Mary Ellen Stephen (ret)
Plymouth North High School

Staff Officers of the Corporation

President & Chief Executive Officer
Cora Beth Abel
MSSEF, Inc.

Vice President of Corporate Development
Eleanor A. Tishler
MSSEF, Inc.

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

2018 HIGH SCHOOL COMMITTEE

Dedicated science teachers, professors, industry scientists, engineers, alumni and parents provide their expertise and personal to establish and administer the statewide senior high and middle school science fairs. This corps of volunteers is a key strength of our organization.

William F. Rigney, Co-Chair
STEM Education Consultant

Kristen Bellavance
Taunton High School

Nancy Cianchetta
Everett High School

Nancy G. Degon
MSSEF Scientific Review Committee Chair
Auburn High School (ret.)

Kaylee DeGrace
Brockton High School

MaryAnn DeMaria
Millbury Jr/Sr High School

Stephanie Gill
Marlborough High School

Nicholas Guerin
Region II High School Fair Chair,
Wachusett Regional High School, Holden

Howard Harrison
Massachusetts Institute of Technology

Alex Hatzberger
North Attleboro High School

Kathleen M. Jones
TTT Mentor Program
Cambridge

Kimberly Kamborian
GEMS Director

Karin LeBeau, Director
MSSEF Middle School State Science Fair
MSSEF Event Manager

Alison Riordan
Plymouth Public Schools

Dr. Megan Rokop
UMASS Boston

Rishi Shukla
MSSEF Alumnus
Consultant

Jon Tyler
Westfield High School

Shannon Zayac
STEM Program Manager
MA College of Liberal Arts

2018 ACKNOWLEDGMENTS

MSSEF Science Fair Coordination Team

The Massachusetts State Science & Engineering Fair, Inc. (MSSEF) wishes to thank Elizabeth Kronberg, Nancy Langevin, Karin Lebeau, Pat Monteith and Susan Brennan for their dedicated services in coordinating the 2018 Science Fair. Our appreciation and thanks are also extended to the MSSEF Board of Directors, High School Committee, staff, volunteers and alumni for the hundreds of hours of service they have given on behalf of the MSSEF Science Fair. Their professional experience, enthusiasm and team spirit are making the 69th Annual State Science & Engineering Fair one of the finest ever.

Science Fair Venue
Massachusetts Institute of Technology
Paul Parravano, Co-Director
MIT Office of the President
Government & Community Relations

Liaison Services
MIT Campus Activities (CAC)
Michael W. Foley
CAC Director & Dept. Head

MIT Athletics Dept.
Dan Martin
Asst. Dept. Head & Director
Facilities & Operations

MIT Security Division

MIT Audio-Visual Dept.
Paul Shay

Parking
Hyatt Regency Hotel
Technology Square Garage

Event Services
Christian Party Rental
Rita's Catering

Computer & Website Services
Barnas G. Monteith
Tumblehome Learning

Acquia
Constant Contact
JotForm
Rackspace
WordPress

Info Desk & Boutique
Gary Tishler
Jack Tishler

MasterMind Challenge
Symantec Corp.
Kelly Burns

Parents Finance Seminar
Oliver Souyayong, UMB
Stephanie Wells, MEFA
Emily Decatur, NEBHE

Campus Tours
MIT Students

Design Services
Capers Design
Bridgewater, MA

Signage
Gnomon Copy
Cambridge, MA

Photographers
Tony Rinaldo
Concord, MA

Ed Malitsky
Boston

Print Services
RICOH USA
Paul Donahue

Harding Ounanian
Production

Professional Services
David Asadoorian, CPA
Concord, MA

Randstad USA/Cambridge

Books in Balance
Tewksbury, MA

Meeting/Seminar Hosts
Fish & Richardson, Boston
Meditech, Framingham
MIT
Framingham State University
Education Development Center (EDC)
Lowell & Worcester Public Schools
Worcester Polytechnic Institute

CABOT

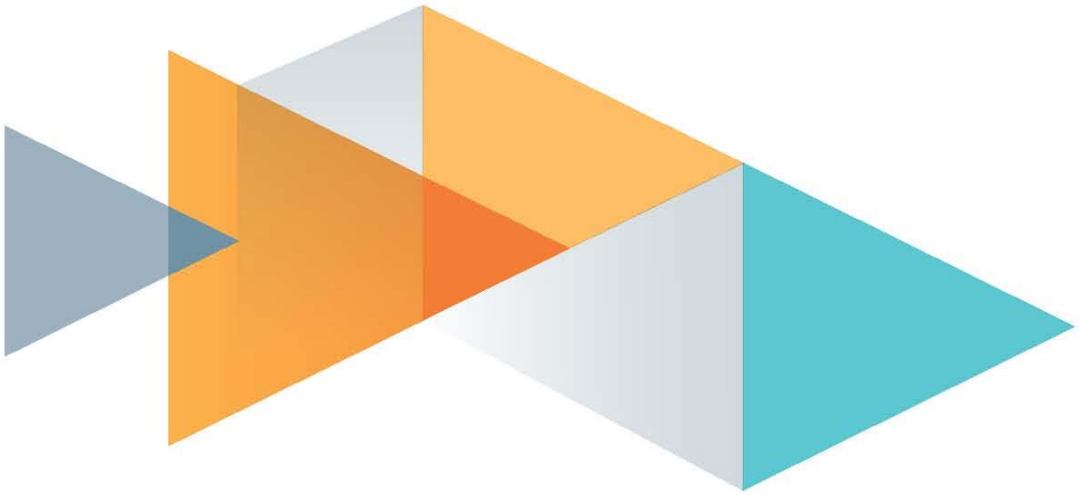
CABOT CORPORATION

Proud sponsor of the
Massachusetts State Science & Engineering Fair.

Congratulations and thank you to all who have made this event possible and to students who have begun their participation in the future of science, research & development, technology and engineering.

Sean D. Keohane
President and CEO, Cabot Corporation

cabotcorp.com



Developing future thought leaders through experiences in science and engineering practices using well-proven programs and novel approaches that empower students and educators to learn, in and beyond the classroom.

MSSEF
Massachusetts State Science & Engineering Fair

Massachusetts State Science & Engineering Fair, Inc.

955 Massachusetts Avenue, #350 • Cambridge, MA 02139 • 617.491.1500 • **scifair.com**