



BULLETIN
of the
**South Carolina Academy of
Science**
Volume XCII
2021

Including the 93rd Annual Meeting Program*

* 2020 Annual Meeting was cancelled due to the global Covid19 pandemic



THE CITADEL
THE MILITARY COLLEGE
OF SOUTH CAROLINA

TOPICAL SESSIONS SCAS

Saturday, April 17th 2021

SESSION 1: CELL & MOLECULAR BIOLOGY

Meeting ID: 973 4450 3366

All Zoom session links (in [blue](#)) open in a new window and require you to enter the meeting ID and password for access

10:00 AM – 12:15 PM

Moderator: Breeanne Swart

10:00 AM REGULATORY ROLE OF MICRORNA-34A ON HUMAN MAST CELL INFLAMMATORY GENE EXPRESSION

Madison Ryan and Carole Oskeritzian, USC School of Medicine

10:15 AM EFFECTS OF *ORIGANUM MAJORANA* ON MCF-7 & MCF-12A CELL LINES

Zoe Sanders, Madeleine Treaster, Chrissy Anderson, and Diana Ivankovic, Anderson University

10:30 AM EGG DEVELOPMENT IN THE INSECT VECTOR *STOMOXYS CALCITRANS*

Brittni Hall, and Mary-Katherine Mills, USC Aiken

10:45 AM CLONING AND TESTING THE EFFECTS OF SHORT HAIRPIN RNAS ON EXPRESSION OF THE HIV-1 TRANS-ACTIVATOR OF TRANSCRIPTION

Q'May Qourters and William Jackson, USC Aiken

11:00 AM BREAK

11:15 AM CREATING AND TESTING A HIV-DEPENDENT TBID EXPRESSION PLASMID

Nina Adams and William Jackson, USC Aiken

11:30 AM DETECTION OF TOMATO MOSAIC VIRUS USING A NOVEL AT HOME RT-PCR APPROACH

Kaylee Petraccione, Molly Tancini, Emma Lehmann, and Michelle Barthet, Coastal Carolina University

11:45 AM DESIGN, CLONING, AND TESTING OF AN ANTI-HIV-I REV SMALL INTERFERING RNA

Kylie Tager and William Jackson, USC Aiken

12:00 PM ANALYZING THE FUNCTION OF A HIV-BASED EXPRESSION SYSTEM

Madison Carelock and William Jackson, USC Aiken

SESSION 2: ENGINEERING

Meeting ID: 982 3062 8307

All Zoom session links (in [blue](#)) open in a new window and require you to enter the meeting ID and password for access

10:00 AM – 12:00 AM

Moderator: Dave Trautman

10:00 AM THE EFFECT OF WATER CONTENT ON THERMOPHYSICAL PROPERTIES OF IONIC LIQUIDS FOR SOLAR THERMAL APPLICATIONS

Melanie Howe and Titan C. Paul, USC Aiken

10:15 AM NANOPARTICLES SHAPE EFFECT ON STABILITY OF AL₂O₃-WATER NANOFLUIDS

Caroline Dempsey and Titan C. Paul, USC Aiken

10:30 AM CREATION OF A CIP METHOD FOR THE HEAT EXCHANGERS AT ROLLS-ROYCE

Austin Locklear, Carly Dempsey, Melanie Howe, and Bethany Fralick, USC Aiken

10:45 AM RELIABILITY CENTERED MAINTENANCE

Matthew Beeler, Adam Harley, Cameron Bedenbaugh, and Bethany Fralick, USC Aiken

11:00 AM BREAK

11:15 AM SRNL TOOL DESIGN PROCESS

Daniel Nwachukwu, **Aaron George**, Christopher Seigler, and Bethany Fralick, USC Aiken

11:30 AM METAL-ORGANIC FRAMEWORKS IN NUCLEAR PACKAGING: A DESIGN SUPPORTING THE PRACTICAL USE OF EXPERIMENTAL MATERIALS IN NUCLEAR PACKAGING

Mallorie Prandy, Quin-Tasia Utsey, Alexander Hart, and Bethany Fralick, USC Aiken

11:45 AM MONITORING AND CONTROL SYSTEM DCS UPGRADE (SRNL)

John Bunch, Christopher Mills, Daniel Stevens, and Bethany Fralick, USC Aiken

Continued on next page

**SESSION 3: FIELD BIOLOGY, CLIMATOLOGY,
PHARMACOLOGY, & PHYSIOLOGY**

Meeting ID: 926 7072 3398

All Zoom session links (in [blue](#)) open in a new window and require you to enter the meeting ID
and password for access

10:00 AM – 12:00 AM

Moderator: Scott Curtis

- 10:00 AM DOES EXPOSURE TO SUBLETHAL CONCENTRATIONS OF GLYPHOSATE, 2,4-D AND THEIR COMBINED FORMULATION INDUCE OXIDATIVE STRESS IN *EISENIA FETIDA*?
Mary Davidson, Phylcia Allen, and Edna Steele, Converse College
- 10:15 AM THE GULF STREAM: CONNECTIONS BETWEEN TIDE HEIGHT AND SEA TEMPERATURES ALONG THE EAST COAST
Kaeley Johnston and Scott Curtis, The Citadel
- 10:30 AM THE EFFECTS OF CBD OIL ON THE MITIGATION OF STRESS IN RATS
Vienna Oswald and Michelle Vieyra, USC Aiken
- 10:45 AM EFFECT OF EXERCISE ON HEART RATE AND BLOOD PRESSURE IN STUDENT ATHLETES AT USC SUMTER
Samara Castleberry, John Freeman, Pearl Fernandes, and Daniel Kiernan
USC Sumter
- 11:00 AM BREAK
- 11:15 AM CHARACTERISTICS OF COMPETITIVE BATON TWIRLERS
Alexis Dicks, Miranda Proctor, Amanda Trujillo, and Andrew Hatchett, USC Aiken
- 11:30 AM PERCEIVED STRESS LEVELS AND BACTERIOPHAGE PRESENCE ON THE CAMPUS OF COASTAL CAROLINA UNIVERSITY
Korinne Swanson, Madaline Plank, Owen Smith, and Paul Richardson, Coastal Carolina University
- 11:45 AM THE COVID-19 SENTINEL PROJECT: MONITORING THE INCIDENT RATE OF COVID-19 ON CAMPUS
Madison Gentilo and Paul Richardson, Coastal Carolina University

SESSION 4: ASTRONOMY, CHEMISTRY, COMPUTER SCIENCE, & MATHEMATICS

Meeting ID: 990 7280 5028

All Zoom session links (in [blue](#)) open in a new window and require you to enter the meeting ID and password for access

10:00 AM – 12:15 PM

Moderator: Antara Mukherjee

- 10:00 AM ANALYZING PERIODOGRAMS OF ASTRONOMICAL DATA USING THE LOMB-SCARGLE METHOD
Troy Ray and Todd Wittman, The Citadel
- 10:15 AM IMPACTS OF TIME AND WEATHER ON THE FLORAL SCENT EMISSION OF *GELSEMIUM SEMPERVIRENS*
Kyla Bonikowski, Haley Williams, Steven Weaver, Annette Golonka, and Bettie Obi-Johnson
- 10:30 AM STUDYING THE STRUCTURE-ACTIVITY RELATIONSHIPS OF 2,4'-DIHYDROXYACETOPHENONE IN THE 2,4- H^{TM} -DIHYDROXYACETOPHENONE DIOXYGENASE REACTION
Faith Oladejo and Kenneth Roberts, USC Aiken
- 10:45 AM PREPARING FUNCTIONAL POLYMER SURFACES BY SURFACE-INITIATED ALKENE METATHESIS
Colette Sullivan and Nicholas Marshall, USC Aiken
- 11:00 AM BREAK
- 11:15 AM DEVELOP AN AI-ASSISTED SMART SURVEY SYSTEM TO REDUCE SURVEY-TAKING FATIGUE
Andrew Hunt and Yilian Zhang, USC Aiken
- 11:30 AM EXAMINING THE PERFORMANCE OF A HIGH PERFORMANCE COMPUTER AND A MULTI-CORE WORKSTATION
Christopher Brunswick, Keith McBride, and Bethany Fralick, USC Aiken
- 11:45 AM PRIME PROGRESSIONS
Aaron Fannin and Breeanne Swart, The Citadel
- 12:00 PM MATHEMATICAL CHARACTERIZATIONS OF THE GENERALIZED LOMAX DISTRIBUTION
Denzyl Lastimoso and Sher Chhetri, USC Sumter

SESSION 5: PHYSICS 1

Meeting ID: 994 8731 8716

All Zoom session links (in [blue](#)) open in a new window and require you to enter the meeting ID and password for access

10:00 AM – 12:15 PM

Moderator: Scott Yost

10:00 AM THE PUZZLE OF ACCRETION DISKS AND THERMAL STABILITY

Jessica Anderson and P. Chris Fragile, College of Charleston

10:15 AM BIPLANE AERODYNAMICS

Samuel Poulin and Pat Briggs, The Citadel

10:30 AM INVESTIGATING CRITICAL OXYGEN USING MAGNETIC LEVITATION

Seth Zoppelt and Ana Oprisan, College of Charleston

10:45 AM THE EFFECT OF A MAGNETIC FIELD ON A COMPUTER

Ben Walker and Pat Briggs, The Citadel

11:00 AM BREAK

11:15 AM FLOW VELOCITY OF TIDES ON THE ASHLEY RIVER

Erin Garber and Kaelyn Leake, The Citadel

11:30 AM USING MUSR WITH CDO TO DETECT HYDROGEN LIKE DEFECTS IN SEMICONDUCTORS

Samuel Cathcart, and Brittany Baker, Francis Marion University

11:45 AM IMPACT DEPTH OF 5.56X45MM NATO

Ryan Salter and Patrick Briggs, The Citadel

12:00 PM EMPIRICAL MODE DECOMPOSITION OF NONSTATIONARY OPTOGENETIC DATA

Xandre Clementsmith and Sorinel Oprisan, College of Charleston

Continued on next page

SESSION 6: PHYSICS 2

Meeting ID: 910 7214 4757

All Zoom session links (in [blue](#)) open in a new window and require you to enter the meeting ID and password for access

2:00 PM – 3:00 PM

Moderator: Kaelyn Leake

- 2:00 PM CAUSALITY MEASURES AMONG HYPOTHALAMIC MCH NEURONS DURING REM SLEEP
Xandre Clementsmith and Sorinel Oprisan, College of Charleston
- 2:15 PM COMPARISON OF METHODS OF GENERATING PHOTON RADIATION IN HADRON
SCATTERING WITH VARYING QUARK MASS
Matthew Dittrich and Scott Yost, The Citadel
- 2:30 PM A DEEP LEARNING NEURAL NETWORK FOR SUBVOCALIZED SOUNDS IDENTIFICATION
FROM ELECTROENCEPHALOGRAMS
Maximus London-Kolb and Sorinel Oprisan, College of Charleston
- 2:45 PM VECTOR MAPPING THE COEFFICIENT OF PRESSURE PROFILE OF A NACA-4 AIRFOIL
Brandon Shively and Patrick Briggs, The Citadel

SCJAS 2021 PRESENTER TIME & SESSION

By last name of first author

<i>Acateca, Angela</i>	2:00PM: Physiology and Health 2
<i>Ackerman, Evan</i>	10:00AM: Computer Science
<i>Ariyo, Toluwanimi</i>	10:15AM: Bio/Bot/Zoo/Cell & Mol
<i>Aycock, Brantley</i>	10:00AM: Psychology 1
<i>Aycock, Carson</i>	10:15AM: Psychology 1
<i>Ayers, Isabella</i>	10:30AM: Psychology 1
<i>Babinec, Stephanie</i>	2:00PM: Sociology
<i>Bagnal, Ashlynn</i>	10:45AM: Psychology 1
<i>Bali, Raeva</i>	2:45PM: Env Sci/Micro/Phys & Health
<i>Barfield, Kathleen</i>	10:45AM: Environmental Science 1
<i>Beeraka, Karthik</i>	11:30AM: Bio/Bot/Zoo/Cell & Mol
<i>Benjamin, Bethany</i>	11:00AM: Environmental Science 1
<i>Best, Aubrey</i>	2:15PM: Psychology, Sociology, and Consumer Science
<i>Blackmon, Anselle</i>	11:00AM: Psychology 1
<i>Blackmon, Hope</i>	3:30PM: Consumer Science
<i>Blalock, Ella</i>	11:30AM: Environmental Science 1
<i>Boinapalli, Rithika</i>	2:00PM: Botany and Zoology
<i>Bonds, Jada</i>	10:00AM: Chemistry
<i>Bowie, Alec</i>	11:30AM: Psychology 1
<i>Boysia, Andrew</i>	11:45AM: Psychology 1
<i>Bracey, Porshay</i>	2:00PM: Engineering 2
<i>Bravo, Brandon</i>	2:15PM: Sociology
<i>Brewer, Isaac</i>	2:00PM: Biochemistry and Chemistry
<i>Brown, Camryn</i>	3:45PM: Psychology, Sociology, and Consumer Science
<i>Brown, Lucia</i>	11:45AM: Physics, Engineering, and Mathematics
<i>Brownfield, Georgia</i>	10:15AM: Physiology and Health 1
<i>Bryant, Samuel</i>	10:30AM: Physiology and Health 1
<i>Caddell, Anna</i>	4:00PM: Psychology, Sociology, and Consumer Science
<i>Caldwell, Asia</i>	2:45PM: Engineering 3
<i>Camlin, Eva</i>	12:00PM: Psychology 1
<i>Campanella, Silas</i>	11:45AM: Environmental Science 1
<i>Carter, Emma</i>	12:15PM: Psychology 1
<i>Castellanos, Isabella</i>	4:30PM: Engineering 2
<i>Cecil, Blake</i>	2:15PM: Engineering 1
<i>Cervantes, Josue</i>	10:15AM: Chemistry
<i>Chattha, Aleena</i>	2:30PM: Sociology
<i>Chau, Dylan</i>	2:15PM: Env Sci/Micro/Phys & Health
<i>Cheek, Zachary</i>	2:15PM: Biochemistry and Chemistry
<i>Chen, Eileen</i>	2:30PM: Biochemistry and Chemistry
<i>Chu, Catherine</i>	2:45PM: Sociology
<i>Chung, Katie</i>	2:30PM: Env Sci/Micro/Phys & Health
<i>Coats, Lillian</i>	10:30AM: Chemistry

Cohen, Hallie	2:15PM: Physiology and Health 2
Collazo, Italia	2:00PM: Environmental Science 2
Comose, PJ	2:30PM: Engineering 1
Conrad, Joseph	2:45PM: Engineering 1
Corbin, Kennedy	10:00AM: Psychology 2
Coutsos, Dawson	10:15AM: Psychology 2
Coyle Vega, Xavious	10:00AM: Microbiology
Cruz, Pierceton	3:00PM: Engineering 1
Curran, Elise	10:45AM: Chemistry
Desai, Parth	3:30PM: Engineering 1
Dillon, Scott	12:00PM: Environmental Science 1
Dotson, Kathleen	11:00AM: Physiology and Health 1
Eichhorn, Nika	2:30PM: Psychology, Sociology, and Consumer Science
Elsahli, Ismail	2:15PM: Consumer Science
Evans, Jesma	10:45AM: Psychology 2
Evans, Jesma	11:00AM: Psychology 2
Evans, Mary	12:15PM: Environmental Science 1
Evans, Tanner	10:30AM: Psychology 2
Fan, Kevin	2:00PM: Env Sci/Micro/Phys & Health
Felder, Cierra	11:30AM: Physiology and Health 1
Felix, Tiffany	10:00AM: Bio/Bot/Zoo/Cell & Mol
Ferguson, Christopher	12:30PM: Environmental Science 1
Fernandez, Javier	2:45PM: Biochemistry and Chemistry
Fettig, Isabella	2:15PM: Botany and Zoology
Findley, Edward-Jaydon	3:45PM: Engineering 1
Fitzmaurice, Georgina	2:45PM: Psychology, Sociology, and Consumer Science
Fletcher, Wesley	2:30PM: Consumer Science
Folding, Savannah	4:00PM: Engineering 1
Frattaroli, Nikki	10:00AM: Computer Science and Physics
Freeman, Delaney	12:30PM: Psychology 1
Funk, Sullivan	4:15PM: Engineering 1
Funk, Sullivan	12:45PM: Environmental Science 1
Furgala, Justin	11:00AM: Chemistry
Gambaloza, Geraldo	2:15PM: Engineering 2
Ganesh babu, Shyam	4:30PM: Engineering 1
Ganis, Griffin	2:45PM: Consumer Science
Garcia, Samuel	10:15AM: Computer Science
Gartner, Haleigh	11:45AM: Bio/Bot/Zoo/ Cell & Mol
Gentry, Joseph	2:30PM: Engineering 2
Geraghty, Emily	11:30AM: Chemistry
Gilbert, Kylie	11:30AM: Psychology 2
Gorospe, Mary Abigail	3:30PM: Env Sci/Micro/Phys & Health
Gottipaty, Vijay	10:00AM: Environmental Science 1
Green, Kameron	2:45PM: Engineering 2
Green, Luci	3:00PM: Sociology

Guntupalli, Nidhi	2:30PM: Botany and Zoology
Gupta, Nitin	10:30AM: Computer Science
Guruvelli, Raviteja	10:45AM: Computer Science
Gutshall, Emma	11:45AM: Psychology 2
Ham, James	12:15PM: Bio/Bot/Zoo/Cell & Mol
Han, Madison	10:15AM: Microbiology
Haque, Ishraq	1:00PM: Environmental Science 1
Harris, Emily Anne	4:15PM: Psychology, Sociology, and Consumer Science
Heaps, Christopher	3:00PM: Engineering 2
Hilbourn, Maura	12:00PM: Bio/Bot/Zoo/Cell & Mol
Hill, Joseph	10:00AM: Psychology 3
Hill-Liles, Sona	2:15PM: Environmental Science 2
Hoover, Zachary	11:45AM: Chemistry
Houghton, Aiden	3:30PM: Engineering 2
Huang, Angel	10:30AM: Microbiology
Huang, Zachary	11:30AM: Computer Science and Physics
Ihekweazu, Christian	11:00AM: Computer Science
Jackson, Steven	2:30PM: Environmental Science 2
Johnson, Amaya	10:30AM: Environmental Science 1
Jowers, Aislyn	3:30PM: Sociology
Ju, Cindy	10:15AM: Psychology 3
Kanthamneni, Anish	11:30AM: Computer Science
Kapoor, Shriya	10:45AM: Computer Science and Physics
Keiser, Emma	11:00AM: Bio/Bot/Zoo/Cell & Mol
Kerai, Heiyaani	2:45PM: Botany and Zoology
Kneece, Vikram	3:45PM: Sociology
Kong, Justin	4:00PM: Sociology
Koon, Kyle	11:45AM: Computer Science
Koverman, Charles	3:45PM: Engineering 2
Krompecher, John	3:00PM: Environmental Science 2
Kulkarni, Anish	4:00PM: Engineering 2
Kunkle, Daniel	4:15PM: Engineering 2
Leadbitter, Ryan	10:45AM: Microbiology
LeBarron, Christopher	3:45PM: Env Sci/Micro/Phys & Health
Lewis, Delaney	12:00PM: Psychology 2
Lewis, Kinsley	2:00PM: Engineering 1
Li, Christopher	11:45AM: Computer Science and Physics
Liu, Ziwei	12:00PM: Chemistry
Locker, Jay	11:45AM: Physiology and Health 1
Lott, Nathaniel	10:30AM: Physics, Engineering, and Mathematics
Maddipati, Sreya	3:30PM: Environmental Science 2
Majewski, Ashley	10:00AM: Physiology and Health 1
Massalon, Jackson	3:00PM: Consumer Science
McCallum, Elizabeth	12:15PM: Psychology 2
McConnell, Kat	3:00PM: Psychology, Sociology, and Consumer Science

McLaurin, Gavin	2:15PM: Engineering 3
McNeal, Ari	2:00PM: Consumer Science
Mensch, Anna Grace	10:45AM: Physiology and Health 1
Miller, Matthew	12:30PM: Psychology 2
Mills, Alexander	10:30AM: Psychology 3
Mills, Ethan	12:15PM: Chemistry
Mitta, Apurva	2:30PM: Engineering 3
Montés, José	12:30PM: Chemistry
Moore, Zachary	3:45PM: Engineering 3
Morgan, Elena	10:45AM: Physics, Engineering, and Mathematics
Morrison, Sophia	4:00PM: Env Sci/Micro/Phys & Health
Mueller, Natalie	11:00AM: Physics, Engineering, and Mathematics
Murphy, Mackenzie	10:45AM: Psychology 3
Nealey, Madeline	3:45PM: Environmental Science 2
Nguyen, Tim	11:00AM: Psychology 3
Orr, Anders	12:00PM: Physics, Engineering, and Mathematics
Pacific, Samuel	3:00PM: Engineering 3
Parise, Sanjana	12:00PM: Physiology and Health 1
Park, Christopher	11:30AM: Psychology 3
Parmar, Aryan	2:30PM: Physiology and Health 2
Pasala, Meghan	4:00PM: Environmental Science 2
Patel, Jay	4:15PM: Environmental Science 2
Perea, Phillip	10:30AM: Bio/Bot/Zoo/Cell & Mol
Perry, Dalton	4:15PM: Sociology
Pham, Harrison	3:45PM: Consumer Science
Phillips, Caleb	4:30PM: Sociology
Phillips, Luke	2:00PM: Psychology, Sociology, and Consumer Science
Pitrois, Julien	12:00PM: Computer Science
Plakal, Evelyn	3:00PM: Biochemistry and Chemistry
Poola, Pranav	3:30PM: Engineering 3
Potts, Katelyn	2:00PM: Engineering 3
Rancu, Oliver	10:00AM: Physics, Engineering, and Mathematics
Raynor, Alyssa	4:30PM: Environmental Science 2
Reddick, Hunter	1:15PM: Environmental Science 1
Reyes, Parker	11:45AM: Psychology 3
Ricks, Davis	12:15PM: Physiology and Health 1
Robertson, Madeline	11:30AM: Physics, Engineering, and Mathematics
Rumfelt, Mattie	10:45AM: Bio/Bot/Zoo/Cell & Mol
Sale, Benjamin	12:15PM: Computer Science
Saracila, Ian	11:00AM: Microbiology
Sarkar, Soumit	12:30PM: Computer Science
Sen, Adeep	11:30AM: Microbiology
Senthil, Mritika	10:30AM: Computer Science and Physics
Shaw, Jacob	12:15PM: Physics, Engineering, and Mathematics
Sheftman, Aiden	4:00PM: Engineering 3

Sherburne, Andrew	12:45PM: Chemistry
Shin, YeJoon	4:45PM: Environmental Science 2
Smith, Kendall	4:15PM: Engineering 3
Soderlund, Kate	12:00PM: Psychology 3
Sorapuru, Jasmyn	12:30PM: Physiology and Health 1
Spiva, Freedom	5:00PM: Environmental Science 2
Stebbins, Kate	12:15PM: Psychology 3
Stewart, Ava	10:15AM: Environmental Science 1
Stremlow, Savannah	3:30PM: Psychology, Sociology, and Consumer Science
Strenk, Allison	12:30PM: Psychology 3
Stroud, Korinna	4:30PM: Engineering 3
Sullivan, Caroline	3:45PM: Physiology and Health 2
Sunilkumar, Gowri	2:45PM: Environmental Science 2
Swick, Robert	4:00PM: Consumer Science
Tang, Cathy	3:30PM: Biochemistry and Chemistry
Thiagu, Shreya	4:00PM: Botany and Zoology
Thomas, Sandra	4:15PM: Consumer Science
Thompson, Abigail	3:30PM: Botany and Zoology
Thumsi, Sai Siddharth	11:45AM: Microbiology
Tippabhatla, Simran	2:45PM: Physiology and Health 2
Tuppale, Bhavani	3:00PM: Physiology and Health 2
Tuttle, Charles	3:30PM: Physiology and Health 2
Tymoshevskaya, Tetiana	10:15AM: Physics, Engineering, and Mathematics
Weiss, Sara "Kate"	10:15AM: Computer Science and Physics
Wiggs, Aaliya	3:45PM: Botany and Zoology
Wing, Caleb	12:00PM: Microbiology
Wood, Eamon	4:45PM: Engineering 1
Wuori, John "Jack"	4:45PM: Sociology
Yu, Lyn	3:45PM: Biochemistry and Chemistry
Zheng, Winnie	4:15PM: Env Sci/Micro/Phys & Health

SCAS 2021 ABSTRACTS

Alphabetical by author

CREATING AND TESTING A HIV-DEPENDENT tBID EXPRESSION PLASMID

Nina Adams and William Jackson
University of South Carolina Aiken

The Human Immunodeficiency Virus (HIV) infects and kills CD4 positive T-lymphocytes resulting in a gradual loss of immune competence leading to AIDS. Worldwide, approximately 38 million people are HIV infected. Current treatments include various antiretroviral therapies, which reduce the virus load, but do not eliminate latently infected cells. Therefore, mechanisms designed to eliminate these cells could provide more effective treatments. A potential means of eliminating HIV reservoirs is by triggering apoptosis of infected cells. Pro-apoptotic gene therapy offers a potential means to selectively target and eliminate HIV infected reservoirs. Bid is a pro-apoptotic member of the B-cell lymphoma 2 (Bcl-2) gene family. Induction of apoptosis results in Bid cleavage forming tBid (truncated Bid), which binds the outer mitochondrial membrane where it interacts with Bak/Bax to release cytochrome C, resulting in activation of apoptosis effectors. Importantly, tBid has been shown to quickly induce apoptosis at low concentrations making it a good candidate for use in gene therapy. Here, we have constructed a HIV-dependent expression cassette to modulate tBid such that it is only expressed in the presence of the HIV-1 regulatory proteins Tat and Rev. In the absence of HIV-1 Tat and Rev, tBid expression is further inhibited by inclusion of the HIV-1 Gag inhibitory sequence (INS). Current work is underway to characterize tBid expression, its effects on cell proliferation, and induction of apoptosis.

THE PUZZLE OF ACCRETION DISKS AND THERMAL STABILITY

Jessica Anderson and P. Chris Fragile
College of Charleston

For years, there has been a discrepancy between theory and observation in the properties of low mass X-ray binary systems (LMXRB) in the soft X-ray state. The Shakura-Sunyaev thin disk model proposes a radiation-pressure dominated, and consequently thermally unstable, inner region. In this region, heating and cooling both depend on the midplane temperature but to different powers, leading to the thermal instability, a thermal runaway, and the expansion or collapse of the disk. When the disk is unstable, as proposed, it would be expected to undergo large changes in luminosity as it bounces between high and low accretion states. However, observers see the opposite - a stable disk with very little variability, and the question of what stabilizes these disks arises. Strong magnetic fields have been proposed as a mechanism to stabilize these disks. We simulate three different initially weak magnetic field configurations to test whether any of them can amplify to the point that they can support the disk: 1) a zero-net-flux, multiple-loop configuration; 2) a net-flux, vertical-field configuration; 3) and a zero-net-flux, radial-field configuration. The results from these simulations help us to address the discrepancy between thin disk theory and observation, giving us more insight into the properties of black hole X-ray binary systems.

RELIABILITY CENTERED MAINTENANCE
Matthew Beeler and Bethany Fralick
University of South Carolina Aiken

This project illustrates the Reliability Centered Maintenance process practiced on the Ice Plant, that is contracted by Savannah River Tritium Enterprise (SRTE) within Savannah River Nuclear Solutions. It entails researching components in SRTE databases, and through interviewing SRTE stakeholders. Detailed accounts of interviews and their benefits are included in this report, as well as detailed results of datamining in the SRTE databases. The team is also to complete a failure modes and effects analysis on the Ice plant and chiller water system. The Failure Modes and Effects Analysis is the process used to make maintenance plans more reliable and predictive based. The team completed modules on the lean six sigma approach through Six Sigma Global Institute. Methodology of lean six sigma practices and its benefits to the project are also included. To wrap up the project, conclusions from research conducted in Savannah River Tritium Enterprise and future work with goals are explained.

IMPACTS OF TIME AND WEATHER ON THE FLORAL SCENT EMISSION OF *GELSEMIUM SEMPERVIRENS*
Kyla Bonikowski, Haley Williams, Steven Weaver, Annette Golonka, and Bettie Obi-Johnson
University of South Carolina Lancaster

Gelsemium sempervirens (L.) W.T. Aiton, a distylous woody vine of the family Gelsemiaceae, produces sweetly fragrant tubular shaped flowers. The pin morphs (L style) have long styles with the stigmas protruding from the opening of the tubular flower and short stamens that remain within the floral tube. The thrum morphs (S style) have short styles with long anthers protruding from the opening of the flower. Previous research identified 81 different volatile organic compounds (VOCs) from these flowers, each emitting an average of 29 compounds. The most common and abundant scent compound in the VOC profile was benzaldehyde. These flowers also emitted terpenoids (compounds derived from isoprene), fatty acid derivatives (long chain ketones and aldehydes), and yeast associated compounds (i.e. ethanol). Previous work showed no relationship between geographic location or population type (wild or cultivated) and VOC profile, but did show significant differences between the L and S morphs. Some of the variation in overall scent profile was not explained by morph type. In this study, the impacts of weather conditions and time of day on floral scent emission were investigated. Wildflowers of both morph types were sampled during the months of March and April in 2018, 2019, and 2021 from a wild population located at USC Lancaster. Solid Phase Microextraction (SPME) fiber and SPME Arrow sampling methods were used in combination with gas chromatography and mass spectrometry (SPME-GC-MS). The floral scent emissions indicated significant variation with time of day and varying weather conditions. Peak scent emissions appear to coincide with times when pollinators are most active. Future research will involve evaluating the impacts of soil conditions, flower life cycle, and pollinator activity on scent emissions.

EXAMINING THE PERFORMANCE OF A HIGH PERFORMANCE COMPUTER AND A MULTI-CORE
WORKSTATION
Christopher Brunswick and Bethany Fralick
University of South Carolina Aiken

Every two years, Savannah River Site (SRS) examines the inside of the H-Canyon Area Exhaust Tunnel (HCAEX) under the Structural Integrity Program. Tunnel inspections have been performed using cameras on mounted crawlers or placed within the tunnel through access pipes. Currently, tunnel interior examinations are being performed with a LiDAR unit to evaluate the usefulness of the data collected. The

grounds for the LiDAR examinations are to ascertain if LiDAR data could be remotely transmitted to computers stationed above ground from within the walls of the HCAEX tunnel and whether the results from the LiDAR examinations would provide quantitative data of the tunnel's interior to determine the erosion rate over multiple deployments. Each deployment involves using a Leica BLK360 Laser scanner LiDAR unit to collect and analyze point cloud data processed on a Savannah River Nuclear Laboratory (SRNL) multicore workstation through the 3D point cloud processing software CloudCompare. This software will show 360° of HCAEX's interior surfaces. Unfortunately, CloudCompare's processing ability is hindered due to the limited cache size and core count of SRNL's multicore workstation. This ultimately increases the execution time of each data set tremendously, with the longest execution time being around 4 hours. High-performance computing is suggested in order to reduce the execution time. This report will detail the steps taken to access, analyze, and process point cloud data on CloudCompare through high-performance computation and compare the end results obtained by both the University of South Carolina (UofSC) HPC Hyperion and SRNL's multicore workstation.

MONITORING AND CONTROL SYSTEM DCS UPGRADE (SRNL)

John Bunch and Bethany Fralick
University of South Carolina Aiken

This report overviews the system changes for Y815 Savannah River National Laboratory (SRNL) DeltaV Control System Upgrade. Much of this report will dive into the idea of control systems. In this upgrade, SRNL is replacing the existing system of Quantum Controllers/800 Series I/O system with an Emerson DeltaV Distributed Control System (DCS). The new system will mirror the existing facilities monitoring and control (M&C) functions as well as new features. This upgrade will expand to 1600 existing, additional, and spare I/O points. With this project SRNL is tasked with creating a Gantt Chart for the timeline and work breakdown structure of this system upgrade before changes to the system can start. The software being used to create this Gantt Chart is MindView 7.0, this software is critical to the creation of the Gantt Chart which will be formed in the Spring semester.

ANALYZING THE FUNCTION OF A HIV-BASED EXPRESSION SYSTEM

Madison Carelock and William Jackson
University of South Carolina Aiken

The Human Immunodeficiency Virus Type 1 (HIV-1) infects CD4 positive T-lymphocytes. The loss of these cells ultimately results in complete failure of the immune system to recognize and defend against opportunistic infections, which are the hallmarks of AIDS (Acquired Immunodeficiency Syndrome). Current treatments effectively reduce viral load but fail to eliminate latent virus reservoirs. A key to eliminating viral reservoirs is to target HIV-positive cells without harming uninfected cells. We hypothesized that HIV-dependent expression of antiviral genes could be used to eliminate viral reservoirs. This project provides proof of concept for this hypothesis by creating and testing an HIV-dependent reporter cassette. The HIV elements used in this cassette include the viral enhancer/promoter (5' LTR), the Rev Response element (RRE), and the Gag inhibitory sequence (INS2). In the absence of HIV-1, the INS element greatly inhibits gene expression from the 5' LTR. The trans-activator of transcription (Tat) and the regulator of virion proteins (Rev) overcome this inhibition in HIV-positive cells by respectively interacting with the trans-activation response element (TAR) and Rev-response element (RRE). To test this, a reporter gene, green fluorescent protein (eGFP), was cloned into the HIV-dependent expression plasmid, p(LIR)X.BGHpA. To test HIV dependence, human embryonic kidney cells (HEK293T) were cotransfected with p(LIR)eGFP.pA and either the HIV-1 genomic clone, pNL43.Luc.R-E-, or the non-HIV plasmid

pcDNA3.1. HIV-dependent expression of eGFP was shown in both a quantitative and qualitative assay. Based on these results, p(LIR).BGHpA is being further studied as a gene therapy plasmid.

EFFECT OF EXERCISE ON HEART RATE AND BLOOD PRESSURE IN STUDENT ATHLETES AT USC SUMTER

Samara Castleberry, John Freeman, Pearl Fernandes, and Daniel Kiernan

University of South Carolina Sumter

It is well known that exercise is beneficial to health, more specifically cardiovascular health. Several long-term studies have shown that increased physical activity is associated with a reduction in mortality, an effect which is strongly linked to a decline in the risk of developing cardiovascular and respiratory diseases (Paffenbarger et al, 1986). Generally, the normal heart rate of an adult (at rest) is said be around 60 to 100 beats per minute (Guyton, 2006). Studies have shown that the resting heart rate of an athlete is lower than that of non-athletes of the same age. Regular exercise and/or physical activity causes a reduction in resting heart rate (Huang et al, 2005). The purpose of this study was to see if a difference in heart rate exists between student athletes and non-athletes at USC Sumter. Our hypothesis was that student athletes would have a lower heart rate before and after exercise as compared to students that are non-athletes. An anonymous and voluntary survey was conducted to gather information about the general health and training habits of the student volunteers. Height, weight and heart rate was recorded before and after moderate exercise on a treadmill for 40 student volunteers (20 athletes/20 non-athletes). Preliminary results support our hypothesis that heart rate will be lower in athletes as compared to non-athletes before and after exercise. An extension of this study also entailed recording blood pressure. Our results indicate that after moderate exercise non-athletes seem to experience a higher deviation from resting blood pressure as compared to athletes. Our results add to the growing evidence of the impact of exercise on the cardiovascular system.

USING MUSR WITH CDO TO DETECT HYDROGEN LIKE DEFECTS IN SEMICONDUCTORS

Samuel Cathcart and Dr. Brittany Baker

Francis Marion University

Muons are particles which were originally found in solar rays along with pions and other particles. These pions would decay into muons. Muons can be spin polarized by shooting them at a target. In doing so, their spins become polarized due to conservation of linear and angular momentum. Once they are polarized, these muons can be implanted into a sample where their spins will interact with the local environment of the sample. This can therefore be used to detect the effects of defects in materials such as semiconductors. This method of muon implanting was used to collect MuSR data of implanted muons in Cadmium Oxide. This data will be used to examine and study hydrogen like defects in semiconductor materials.

EMPIRICAL MODE DECOMPOSITION OF NONSTATIONARY OPTOGENETIC DATA

Xandre Clementsmith and Sorinel Oprisan

College of Charleston

In vivo recorded, biological signals are noisy and nonstationary. As a result, traditional spectral methods, such as Fourier and wavelet transforms, have limited applicability. We used a data-driven decomposition of nonstationary optogenetic signals recorded in vivo from the mice's medial prefrontal cortex (mPFC). The in vivo locale field potentials (LFPs) in response to a brief 10 ms laser pulse delivered to the mPFC

were recorded for 2 s. For each of the 17 mice in the experiment, we repeated the optogenetic stimulation 100 times. The empirical mode decomposition finds orthogonal intrinsic mode functions (IMFs) that allow frequency band separation for nonstationary data. We used seven-mode decomposition to match known brain wave frequency bands, i.e., delta (0.5-4 Hz), theta (4-8 Hz), alpha (8-12 Hz), beta (12-35 Hz), and gamma (> 35 Hz). We found significant changes in the gamma band between control and cocaine-injected mice.

CAUSALITY MEASURES AMONG HYPOTHALAMIC MCH NEURONS DURING REM SLEEP

Xandre Clementsmith and Sorinel Oprisan
College of Charleston

Hypothalamic neurons that synthesize the neuropeptide melanin-concentrating hormone (MCH) are active during waking and REM sleep. We used deep-brain calcium fluorescence imaging to identify individual hypothalamic neurons that contain MCH. Previous in-vivo electrophysiological studies established a linear relationship between neural depolarization and calcium fluorescence in MCH neurons. Spatial and temporal correlation maps of the change in fluorescence between pairs of MCH neurons revealed local coupling among neurons and the changes in connectivities that take place at the transition between REM sleep and exploratory behavior. In this study, we investigated the causal relationship among different MCH neurons and modeled the local network using a Generalized Linear Model (GLM). GLM is a generalization of linear regression. The calcium fluorescence z-scores were fed into the MLSpike package to extract spike trains from calcium fluorescence. MLSpike maps the continuous z-score values to discrete point process. We used normal distribution for calcium fluorescence and tested binomial, Poisson, and normal distributions for the spike trains. In each of these cases, a GLM was trained for each neuron, determining each neuron's effect on every other neuron. This approach differs from correlation measures of neural activity in that it is directional. Using the GLM, we were able to extract the directional (causal) couplings among neurons, i.e., the neural network's functional structure.

DOES EXPOSURE TO SUBLETHAL CONCENTRATIONS OF GLYPHOSATE, 2,4-D AND THEIR COMBINED FORMULATION INDUCE OXIDATIVE STRESS IN *EISENIA FETIDA*?

Mary Davidson and Edna Steele
Converse College

The herbicide chemicals glyphosate and 2,4-D are applied to crops globally, but they have previously been implicated as potential carcinogens. Enzymes like superoxide dismutase (SOD), catalase (CAT), and glutathione S-transferase (GST) mediate oxidative stress, and a change in the normal concentration of antioxidants is indicative of excessive levels of reactive oxygen species, which are potential carcinogens. Adult earthworms (*Eisenia fetida*) were exposed to artificial soil treated with sublethal concentrations of glyphosate, 2,4-D, or a combined formulation for one month to determine whether the chemicals induce oxidative stress. Samples were removed randomly from each jar every 7 days, and the levels of reduced glutathione (GSH), malondialdehyde (MDA), and the antioxidant enzyme activities of SOD and CAT were measured and compared to the control. An increase in GSH concentrations was observed in all collection days and treatment types, as well as an increase in MDA concentrations, and no significant change in SOD and CAT concentrations compared to the control. By day 28, CAT enzyme activity was closer to the control level. The change in antioxidant activity indicated that the organism underwent oxidative stress and may indicate possible enzymatic inhibition as well as possible enzyme recovery by week 4 when exposed to sublethal levels of glyphosate, 2,4-D, and its combined formulation.

NANOPARTICLES SHAPE EFFECT ON STABILITY OF AL₂O₃-WATER NANOFLUIDS

Caroline Dempsey and Titan C. Paul
University of South Carolina Aiken

Nanoparticles are incredibly small metallic particles which are becoming more popular in industry such as: high-density magnetic storage material, drug delivery system and medical materials, energy storage, micro-electromechanical system, interface characterization for thermal management, and structural. Nanoparticles can be suspended in typically used coolants to improve the thermophysical properties and thermal performance of the liquid. These nano-sized metallic particles can be made in various shapes such as spherical, hexagonal, block, platelet, and more. A problem with using nanofluids as coolants in heat exchangers is the tendency for the particles to agglomerate over time. It is important to find ways to synthesize nanofluids which remain stable for the longest period of time. In this study, block and platelet shaped nanoparticles are used to synthesize nanofluids. The stability of the nanofluids is investigated by visual inspection and UV-vis spectroscopy for different mixing time and different concentration. Furthermore, viscosity of the nanofluids with different nanoparticles shape is measured.

CHARACTERISTICS OF COMPETITIVE BATON TWIRLERS

Alexis Dicks and Andrew Hatchett
University of South Carolina Aiken

Competitive baton twirling is a sport that combines elements of gymnastics, dance and ballet while necessitating cardiovascular endurance, muscular endurance and power, hand-eye coordination, spatial awareness, kinesthetic awareness, timing and choreography. Approximately one million baton twirlers participating in the sport in the United States. Despite considerable participation in competitive baton twirling, little is known about the characteristics of the athletes. This work documents demographic and behavioral characteristics of competitive baton twirlers. Questionnaires were completed by 169 female twirlers from across the United States and Canada. Respondents reported a mean (\pm SD) age of 18.07 yrs. (± 6.08) and height of 63.89 in (± 6.24), weight 133.56 lbs. (± 32.49), BMI (22.92), GPA 3.73 (± 0.31), years of competing 8.02 yrs. (± 1.81). All (100%) qualified respondents reported experiencing injury due to competing in or training for baton. The extent of the injuries reported varied greatly. A diversity of training, recovery, hydration, and nutrition habits were also reported. These findings indicate that the competitive baton twirlers that participated in this research are adolescent females, diverse in physical profile, of normal BMI, high academic achievers, dedicated athletes, consistently overcome injuries and train by diverse means. Future research may consider the long-term physical effects and associations with mental health competitive baton twirling has on the athletes.

COMPARISON OF METHODS OF GENERATING PHOTON RADIATION IN HADRON SCATTERING WITH VARYING QUARK MASS

Matthew Dittrich and Scott Yost
The Citadel, The Military College of South Carolina

We examined the effects of different methods for generating initial state photon radiation (ISR) in hadron scattering at Large Hadron Collider (LHC) energies for individual quark flavors. Our program is rooted in a Monte-Carlo event generator and utilizes two sets of parton (quarks and gluons) distribution functions (PDFs) and their respective electroweak corrections to represent the momentum distribution of the quarks and antiquarks inside the colliding protons. We also tested the program KKMC-hh which was used

in correspondence with the original PDFs and is intended to be used for high precision LHC studies by accounting for any transverse momentum of the initial state quarks. We were able to find that ISR did have a significant effects on the invariant mass of the final state leptons. We also found a high agreeance with the KKMC-hh program and the electroweak corrected PDFs.

PRIME PROGRESSIONS

Aaron Fannin and Breeanne Swart
The Citadel

In this presentation, we will showcase our findings for the question: “How many primes does the progression $ap_n + b$ contain where p_n is the n th prime and $\gcd(a, b) = 1$?” We used codes in Mathematica to collect the data and best fit models for said data. Our data will be based on the question, using specific numbers for a and b which meet the standard of the greatest common divisor. For example, we will consider progressions of the form $3p_n + 7k$ such that $\gcd(3, 7k) = 1$ and $3p_n + 5k$ such that $\gcd(3, 5k) = 1$.

FLOW VELOCITY OF TIDES ON THE ASHLEY RIVER

Erin Garber and Kaelyn Leake
The Citadel

Our goal is to make an affordable flow meter kit for high schools as well as measuring the flow velocity of tides on the Ashley River. We are using a simple DC motor and measuring the back EMF from said motor to find flow velocity. Our procedure is to find velocity from back EMF by using a PASCO flow meter as a comparison. We will be using the fluid dynamics lab in the Citadel Civil Engineering Department do conduct these experiments. Our expected results are to be able to find velocity from back EMF in a quick and convenient way as well as to create an affordable flow meter kit for high schools to use.

THE COVID-19 SENTINEL PROJECT: MONITORING THE INCIDENT RATE OF COVID-19 ON CAMPUS

Madison Gentilo and Paul Richardson
Coastal Carolina University

The COVID-19 Sentinel Project was created to monitor the rate of COVID-19 infections in individuals who determined themselves to be healthy and an active member of the Coastal Carolina Community. During the summer of 2020 Dr Michelle Barthet and Dr Paul E. Richardson developed a tongue swab test that detects COVID-19. As well as COVID testing, the study also contained a survey that was conducted to ascertain participants actions before testing and personal feelings pertaining to the ongoing pandemic. Additionally, the survey asked participants if they had certain symptoms associated with COVID-19. The purpose of this study was to develop a monitoring program that could help determine the risk of infection in our campus community and any behaviors that might indicate risky behavior. The data collected shows that while there was a higher case number in a specific testing site, contract tracing never indicated that this particular site was associated with an outbreak cluster. This suggests that protocols put in place by Coastal Carolina University to limit the spread of the virus were effective in limiting the infection rate on campus. The survey also indicated some very unexpected attitudes from our participants toward the handling of the current pandemic.

EGG DEVELOPMENT IN THE INSECT VECTOR *STOMOXYS CALCITRANS*

Brittini Hall and Mary-Katherine Mills

University of South Carolina Aiken

Stable flies are a hematophagous dipteran that blood feed to get the proper nutrients needed for vitellogenesis, or egg development. Since egg development is directly related to blood feeding, it is important that this understudied vector becomes a main topic of research because they transmit pathogens while they blood feed. *Stomoxys calcitrans* stable flies can transmit pathogens to both humans and animals causing disease and livestock economic loss. By taking a physiological approach, we used immunohistochemistry to characterize the follicular egg development into the five Christophers' stages in *S. calcitrans* females. The flies would blood feed once a day for five days and ovaries were dissected 24 hours post each blood meal. Ovaries were stained to observe actin, lipids, and DNA structural composition, which were quantified using Fiji and compared to previous reports. We observed that stable flies required multiple blood meals to complete egg development, with follicular development arresting at each stage until the next blood meal stimulated progression to the subsequent stage. The data show how vitellogenesis is directly related to blood feeding and be used in future work to understand the underlying mechanism of vitellogenesis, providing the first step in finding a way to stop pathogen transmission.

21THE EFFECT OF WATER CONTENT ON THERMOPHYSICAL PROPERTIES OF IONIC LIQUIDS FOR SOLAR THERMAL APPLICATIONS

Melanie Howe and Titan Paul

University of South Carolina Aiken

The purpose of this project is to investigate the effect of water on the viscosity of ionic liquids to be used in a solar thermal system. 1-Butyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide ([C₄mim][NTf₂]) and 1-Hexyl-3-methylimidazolium-bis(trifluoromethylsulfonyl)imide ([C₆mim][NTf₂]) served as the base fluids. From these ionic liquids, solutions with mole fractions of water ranging from 0.14 to 1 were created. In [C₄mim][NTf₂], incremental changes of 10cP were observed with each addition of 10μL water until the mole fraction reached 0.45. Little change in viscosity was observed with mole fractions greater than 0.45. This trend was not observed in [C₆mim][NTf₂], in which the highest mole fraction of 0.94 differed from the viscosity of the ionic liquids by 20cP. For all tested samples, viscosity decreased with temperature.

DEVELOP AN AI-ASSISTED SMART SURVEY SYSTEM TO REDUCE SURVEY-TAKING FATIGUE

Andrew Hunt and Yilian Zhang

University of South Carolina Aiken

Low response rate has been a long-time issue for online surveys. Research shows the quality of data goes down as the respondent spends more time in a survey. And respondents are more likely to skip open-end questions due to the burden of typing response. In this paper, we present a novel approach to offer diverse smart suggestions to respondents as they type. A new hybrid Trie based search algorithm is introduced to provide accurate word autocompletion. Stochastic machine learning algorithm is utilized for sentence suggestion. Our smart system on average saves four keystrokes per word and provides closely related sentence suggestions on most occasions.

EFFECTS OF *ORIGANUM MAJORANA* ON MCF-7 & MCF-12A CELL LINES
Zoe Sanders, Madeleine Treaster, Chrissy Anderson, and Diana Ivankovic
Anderson University

Recently, new methods of treating cancer have developed from alternative therapies using natural compounds. One natural plant that has been shown to have antioxidant properties and potential in combating cancer is Marjoram (*Origanum majorana*). Components of marjoram, particularly, have been examined for their anticarcinogenic and antitumoral properties, including the ability to induce apoptosis. Because of its antiproliferative and apoptotic effects on various cell lines, components of marjoram are being studied extensively and applied to cancer therapies. This study investigates the effects of Soxhlet, Microwave assisted and Ethanol-incorporated extracts of marjoram plant, *Origanum majorana* (dried and pill form), on MCF-7 breast cancer cell lines and MCF-12A healthy breast tissue cell lines. After data collection and analysis, the marjoram pill extracts involving ethanol extraction displayed cytotoxic effects with the MCF-7 cells and mitogenic effects with the MCF-12A cells. Therefore, we can conclude that the marjoram pill extracts involving ethanol extraction have the most effective outcomes on both MCF-7 breast cells and MCF-12A breast cells.

THE GULF STREAM: CONNECTIONS BETWEEN TIDE HEIGHT AND SEA TEMPERATURES ALONG THE EAST COAST

Kaeley Johnston and Scott Curtis
The Citadel

I am looking at the connection between tide height and sea temperature along the East Coast of the United States. Using National Data Buoy Center for sea temperature and Permanent Service for Mean Sea Level (PSMSL) for sea level, I extracted data from these websites for 12 locations from Florida to Maine and used Excel to sort them. The data was given with monthly averages over the course of 10 years. After removing the 10-year monthly averages, I ran a Fast Fourier Transform (FFT) on the tide and temperature data. I also compared the monthly averages among all the stations. Our results are expected to show a connection between tide height and sea temperatures in the FFT frequencies.

MATHEMATICAL CHARACTERIZATIONS OF THE GENERALIZED LOMAX DISTRIBUTION

Denzyl Lastimoso and Sher Chhetri
University of South Carolina Sumter

In this work, we introduce a new four-parameter cubic rank transmuted Lomax (CRTL) distribution using the cubic rank transmuted map proposed by Granzatto *et al.* (2017). The expressions for several mathematical properties including maximum likelihood estimation, quantile function, reliability analysis, hazard rate function and order statistics are derived. We plan to use the cancer patient data to show the versatility and fitting of the model.

CREATION OF A CIP METHOD FOR THE HEAT EXCHANGERS AT ROLLS-ROYCE

Austin Locklear, Carly Dempsey, Melanie Howe, and Bethany Fralick
University of South Carolina Aiken

Rolls-Royce produces various engines which must be tested prior to their distribution to ensure a high-quality product. The manufacturing plant contains four test cells where the engines can be subjected to high levels of torque and extreme temperatures. A heat exchanger is necessary in this testing system and over time unwanted waste accumulates on the system's plates. The team is tasked with developing and implementing a system which can provide data to determine whether the plates need to be cleaned and a mobile cleaning cart. For this cleaning system to work, it must fully saturate the heat exchanger in cleaning solution, so the choice of pump is important to the planning process. Additionally, the pump must be self-priming, able to handle liquid containing silt and other debris, and possess a maximum flow rate allowing the plates to be saturated. The pump must have four connection points to the heat exchanger system, and the fitting nozzle will also impact the flow rate of the cleaning solution into the heat exchanger. The cleaning solution for the system must be strong enough to clean the waste from the heat exchanger, yet weak enough not to corrode the plates. Additionally, some cleaning solutions have standards regarding storage and disposal, so these factors must be considered as well. Various decisions will need to be made in order to ensure the pressure testing and cleaning systems will improve the life span and efficiency of the heat exchanger in each test cell.

A DEEP LEARNING NEURAL NETWORK FOR SUBVOCALIZED SOUNDS IDENTIFICATION FROM ELECTROENCEPHALOGRAMS

Maximus London-Kolb and Sorinel Oprisan
College of Charleston

Subvocalization is the inner vocalization within your mind, e.g., a process that occurs when reading a book silently. Although no motor activity occurs and no sound is generated, the brain seems to engage the same neural pathways as if reading aloud. Therefore, by analyzing the brainwaves extracted from electroencephalograms (EEGs) when subjects subvocalized sounds we can infer the neural connectivity of brain areas involved in that particular behavior. The EEGs were recorded using a standard 10-20 cap with the BIOPAC MP150 system equipped with three differential amplifiers. In this study, we designed a deep learning neural network to distinguish and correctly classify different subvocalized sounds. We tested a convolutional neural network that integrates Matlab with the pre-trained googlenet using a standard EEG dataset from existing databases. We redesigned some layers of googlenet convolutional neural network to match the preprocessed EEG signals. The preprocessing converted the EEG time series into two-dimensional images that were used for training and classification purposes. Using the short-time Fourier transforms preprocessing, we reached about 60% accuracy of subvocalization classification on a short dataset.

SRNL TOOL DESIGN PROCESS

Daniel Nwachukwu, Aaron George, Christopher Seigler, and Bethany Fralick
University of South Carolina Aiken

Savannah River National Laboratory transports processed nuclear waste material in 55-gallon barrel drums. However, a proprietary device covers the drum's bolt-ring enclosure and requires a specialized tool to remove. The contents of the drum can only be accessed once the device has been removed and the bolt-ring enclosure loosened. The team has been tasked with designing a hand tool for removing the

device, while also considering the future possibility of adapting the tool for robotic capability. The process of designing the tool includes defining the criteria for removing the device, generating and evaluating potential tool concepts, testing the most promising concepts, and selecting the best concept to pursue. Extensive 3D modeling of the chosen concept, with multiple iterations as the design progresses, can then yield the most viable solution to the problem.

STRUCTURE-ACTIVITY RELATIONSHIPS IN THE 2,4'-DIHYDROXYACETOPHENONE DIOXYGENASE REACTION

Faith Oladejo and Kenneth M. Roberts
University of South Carolina Aiken

2,4'-dihydroxyacetophenone dioxygenase (DAD) is an enzyme found in betaproteobacteria that catalyzes the oxidative cleavage of the substrate 2,4'-dihydroxy-acetophenone (DHA) into 4-hydroxybenzoic acid and formic acid in the presence of molecular oxygen. To study the role of the 4'-OH group of DHA on the activity of DAD, four substrate analogs were synthesized replacing the 4'-OH substituted with either a nitro, bromo, chloro, or a trifluoro group. We are currently working on synthesizing three more additional substrate analogs to broaden our library. We will be studying the effects of these substitutions on the activity of DAD by conducting steady-state assays to determine kinetic parameters (k_{cat} , K_m) for each analog.

THE EFFECTS OF CBD OIL ON THE MITIGATION OF STRESS IN RATS

Vienna Oswald and Michelle Vieyra
University of South Carolina Aiken

Many people and pets commonly suffer the physical and mental effects of daily stressful situations. Cannabidiol oil, widely known as CBD oil, has become a very popular remedy for symptoms of stress in both humans and companion animals, despite the small amount of research done to see if CBD can help alleviate everyday stress. Previous research has shown that CBD can have anti-epileptic, anti-inflammatory, anti-nausea, and anti-anxiety effects in humans and anti-epileptic and anti-inflammatory effects in dogs. CBD oil has also been shown to reduce aggression and reduce symptoms of depression in rodents, but few studies have looked at CBD oil and mild stress. The purpose of this study is to see if daily CBD supplementation can reduce symptoms of stress and anxiety in rats living in a mildly stressful environment. After one week of acclimation, two groups of six juvenile female rats each were used; one group received CBD oil while the other received coconut oil for a period of two weeks. During this time period the rat model of chronic stress was used to introduce mild daily stress. Behavioral tests including the Elevated Plus Maze and Light/Dark Exploration were conducted along with observation of the fur coat state and urinary cortisol levels to determine degrees of stress. Testing is currently being carried out and results are pending.

DETECTION OF TOMATO MOSAIC VIRUS USING A NOVEL AT HOME RT-PCR APPROACH

Kaylee Petraccione, Molly Tancini, Emma Lehmann, and Michelle Barthet
Coastal Carolina University

Tomato mosaic virus (ToMV) belongs to the genus Tobamovirus which consists of positive-strand RNA viruses. ToMV has put a constraint on tomato production around the world, destroying crops as it spreads. This detection method allows for confirmation of viral presence in a kitchen setting. In this present study, specific primers were made to detect ToMV genes within tomato leaves. A modified RNA extraction

protocol along with a simplified RT-PCR protocol with SYBR green was used to amplify and detect ToMV in a manner that could be replicated in a kitchen environment. Novel ToMV primers targeted against ToMV gene 2 and gene 4 were checked by BLAST analysis in GenBank for non-specificity to other viruses. The MatK maturase gene was used as an internal control of the reaction. Initial tests demonstrated the possible efficacy of the methodology. Using this combined RNA extraction and RT-PCR approach will help detect ToMV in settings outside of a typical laboratory and could lead to detection methods for various viruses when materials and facilities are lacking.

BIPLANE AERODYNAMICS
Samuel Poulin and Pat Briggs
The Citadel

Through altering wing separation distance, we analyze the lift and structural rigidity of a biplane at various air speeds. Using a wind tunnel, PVC pipes, and two symmetric wooden airfoils, we will study at what distance the wings have to be for maximum efficiency. Various components of the biplane will be held constant (camber, angle of attack of the leading-edge flaps, and stagger between the wings) in order to break down the effects of various wing heights. We expect the standard practice of having the wings 1 - 1.5 times the chord length distance apart to be reliable, yet we believe that creating a distance of .7 - .8 times the chord length will create more of a racing model.

METAL-ORGANIC FRAMEWORKS IN NUCLEAR PACKAGING: A DESIGN SUPPORTING THE PRACTICAL
USE OF EXPERIMENTAL MATERIALS IN NUCLEAR PACKAGING
Mallorie Prandy, Quin-Tasia Utsey, Alexander Hart, and Bethany Fralick
University of South Carolina Aiken

There are many challenges presented by the packaging and transportation of highly hazardous nuclear materials. Some of these challenges are related to the potential flammability resulting from radiolysis of hydrogenous materials. To alleviate these concerns, current methods include the use of hydrogen absorbers, inerting (i.e., diluting the oxygen or flammable gas to concentrations that will not support flammability), and restricting shipping durations. Innovative replacement technologies are being researched based on using different Metal-Organic Frameworks (MOF's) to either adsorb hydrogen, (i.e., perform a similar function to the currently used hydrogen getters), or be radiolytically decomposed and discharge carbon dioxide to perform inerting. Although, MOFs are ideal for storing gas particles due to their large surface area, one hindrance to the use of MOF materials is that many of the necessary physical properties to support their use in packaging have not yet been documented. In this project, a currently used aluminum packaging capsule design (i.e., a packaging peanut frequently used by Savannah River Nuclear Laboratory in nuclear packaging) is adapted to hold MOF to perform shock and vibration testing on several candidate designs.

CLONING AND TESTING THE EFFECTS OF SHORT HAIRPIN RNAs ON EXPRESSION OF THE HIV-1 TRANS-ACTIVATOR OF TRANSCRIPTION

Q'May Qourters and William Jackson
University of South Carolina Aiken

The Human Immunodeficiency Virus (HIV-1) infects and destroys CD4 positive T-lymphocytes. This infection results in the progressive loss of immune function and, ultimately, the Acquired Immune Deficiency Syndrome (AIDS). The HIV trans-activator of transcription (Tat) acts to upregulate transcription from the viral promoter and is therefore essential for virus replication. We hypothesized that Tat expression could be effectively inhibited through a gene therapy approach utilizing short interfering RNAs (siRNAs) to induce RNA interference (RNAi). Using this strategy, small interfering RNAs are formed following expression of short hairpin RNAs (shRNAs) expressed from RNA polymerase III-based plasmids. To test this, a shRNA was designed to target Tat mRNA (nucleotides 5834-5853 of the HIV-1 genomic clone NL43 (Accession number M19921). This shRNA was synthesized as a double-stranded DNA (TatDsh5834) and cloned into the RNA polymerase III plasmid, pH1.Stuffer (-). The silencing ability of Tatsh5834 was analyzed in HeLa cells co-transfected with pU3R-beta-galactosidase, a Tat-dependent reporter, and pCMV-Tat. In these experiments, decreased beta-galactosidase expression as a result of Tat silencing was measured following X-gal treatment of transfected cells. The results showed significantly less beta-galactosidase expression in cells co-transfected with pH1Tat5834, suggesting silencing of Tat expression. Current studies are underway to verify and quantify these results using an ONPG (ortho-Nitrophenyl-beta-galactoside) assay.

ANALYZING PERIODOGRAMS OF ASTRONOMICAL DATA USING THE LOMB-SCARGLE METHOD

Troy Ray and Todd Wittman
The Citadel

In analyzing the astronomical time series, we want to determine the frequency of rotation of different stars using the Lomb-Scargle method. We used the data collected from the Four College Automated Photometric Telescope (FCAPT) in Washington Camp, AZ in our analysis of real star data. Our goal is to determine the accuracy of the method in the presence of noise and multiple frequencies. We created synthetic data to run simulations with our method to see its effectiveness in processing different data. We will compare the Lomb-Scargle method to other period-finding methods such as VStar, Period04, and the Vanderplas multispectral algorithm.

REGULATORY ROLE OF MICRORNA-34A ON HUMAN MAST CELL INFLAMMATORY GENE EXPRESSION

Madison Ryan and Carole Oskeritzian
University of South Carolina School of Medicine

Tissue-resident mast cells (MC) are located around blood vessels where they initiate inflammatory processes through the release of vasoactive mediators, including the sphingolipid metabolite sphingosine-1-phosphate (S1P). We previously reported that in vitro S1P ligation of MC-expressed S1P receptor (S1PR)2 up-regulated inflammatory genes that promote vasculature network expansion or angiogenesis. Using a preclinical model, our laboratory established that S1P served as a MC stimulus in pre-symptomatic eczema, an inflammatory skin disease. We also established that S1P stimulation decreased the expression of microRNA-34a in mouse MC. Short noncoding RNAs, microRNAs act as post-transcriptional silencers. Based on predicted microRNA-34a target gene analysis, we hypothesized that decreased microRNA-34a may up-regulate MC angiogenic vascular endothelial growth factor-A (VEGF) and S1PR2 gene expression.

Human primary skin MC were in vitro activated with S1P and gene expression measured by quantitative real-time PCR (n = 4 donors). A 22.5% decrease of microRNA-34a expression was substantiated after S1P activation, normalized to SNORD96A housekeeping gene and unstimulated controls. We found a concomitant increase in target gene expression of 1.78-fold for VEGF (n = 4) and 1.53-fold for S1PR2 (n = 3). Next, human skin MC were transfected with a synthetic microRNA-34a inhibitor to mimic S1P activation (n = 3). After confirmation of microRNA34a inhibition in transfected MC, we found an increase of VEGF mRNA expression (1.25-fold) and of S1PR2 (1.28-fold for 2 out of the 3 donors). These results uncover a novel regulatory role for microRNA-34a on MC inflammatory gene expression. Funding: Magellan award to MRR and NIH/NIAMS-R21-AR0677996 to CAO.

IMPACT DEPTH OF 5.56X45MM NATO

Ryan Salter and Patrick Briggs
The Citadel

I am formulating a model for bullet penetration depth on steel based on recorded muzzle velocity and a calculated impact velocity. For this we have access to two different barrel lengths, a variety of bullets with different weights, a chronograph, high speed camera equipment, and steel targets. The procedure consists of shooting through the chronograph at the muzzle end and through the camera setup at the target end. Impact velocity will be determined through high shutter speed photos. The expected results are that the impact depth on an AR500 steel target will not be sufficient for building our model, but it will be on softer steels.

VECTOR MAPPING THE COEFFICIENT OF PRESSURE PROFILE OF A NACA-4 AIRFOIL

Brandon Shively and Pat Briggs
The Citadel

We will develop a low cost way to accurately measure and represent the coefficient of pressure across the NACA-4 airfoil and relate the measurement to the lift force generated. We are placing several BMP-280 pressure sensors inside the airfoil and connecting the sensor with small capillary tubing to the surface of the airfoil. This allows us to gather precise measurements flush to the surface on both the top and bottom faces while keeping the surface smooth. We are using resources derived by NASA and methods outlined in Matthew McCarty's master thesis. Using a wind tunnel, a 3D printer, the BMP-280 sensor, and an Arduino to process the calculations outlined on NASA's website, we plan to run several trials to create a vector map representation of the coefficient of pressure.

PREPARING FUNCTIONAL POLYMER SURFACES BY SURFACE-INITIATED ALKENE METATHESIS

Colette Sullivan and Nicholas Marshall
University of South Carolina Aiken

For many sensor designs, including ELISA and electrochemical readouts, surfaces with 'custom' functional groups are useful. By preparing functional polymer brushes, we are able to create surfaces sensitized for specific analytes. This work describes the use of surface-initiated ring-opening metathesis polymerization (SI-ROMP) as a technique for creating polymer-brush surfaces to which we are able to do further chemistry. We report manipulating the surface hydrophilicity of SI-ROMP surfaces through the use of capping hydrophobic or hydrophilic end or side groups. We also estimated the surface coverage of SI-

ROMP catalyst by cross-metathesis to attach ferrocene groups, which were measured by cyclic voltammetry.

PERCEIVED STRESS LEVELS AND BACTERIOPHAGE PRESENCE ON THE CAMPUS OF COASTAL CAROLINA UNIVERSITY

Kori Swanson and Paul E. Richardson
Coastal Carolina University

Approximately 2.8 million people each year are diagnosed with an antibiotic resistant bacterial infection, and more than 35,000 of those diagnosed die. In the 1920s, there was a surge in use of antibiotics to treat all bacterial infections. However, in 1947, penicillin resistance was observed and it was found that bacteria was rapidly evolving to evade antibiotics. Since this discovery scientists have been trying to discover innovative ways to treat antibiotic resistant bacterial infections, such as bacteriophage. Bacteriophage are naturally occurring viruses that are non-pathogenic to humans, whose hosts are bacteria. The isolation and characterization of bacteriophage will one day allow for the natural sourcing of bacteriophage, which can be used to fight antibiotic resistant bacterial infections like Methicillin Resistant *Staphylococcus Aureus* (MRSA). The purposes of this study was to isolate and characterize *Staphylococcus* and *Escherichia* bacteriophages and to determine possible correlations between the presence of bacteriophage on a human and their perceived stress level. Samples were collected from the nose and ears of students and faculty at CCU each month. The samples were then subjected to plaque assays and PCR to determine the presence of bacteriophage. Participants were also instructed to take a subjective stress survey to determine if there was a correlation between stress levels and bacteriophage population. Each sample was then run through a series of microbial and molecular tests to screen for the presence of bacteriophage. These results were correlated with the stress surveys to indicate any relationships that exist between phage presence and stress.

DESIGN, CLONING, AND TESTING OF AN ANTI-HIV-I REV SMALL INTERFERING RNA

Kylie Tager and William Jackson
University of South Carolina Aiken

The Human immunodeficiency virus (HIV-1) infects and kills CD4 positive T-lymphocytes causing a progressive loss of host immune competence ultimately leading to AIDS. A potential gene therapy approach to inhibit HIV replication is through the use of short hairpin RNAs (shRNAs) designed to target viral mRNAs, induce RNA interference, and silence the gene. The HIV-I Regulator of Virion Expression (Rev), which functions to export partially spliced and unspliced mRNAs to the cytosol for translation or packaging, serves as an excellent target for siRNA-mediated silencing. To test this hypothesis, a shRNA was designed to target Rev at nucleotides 8526-8545 of the HIV-1 genomic clone NL43 (Accession number M19921). Revsh8526 was converted to dsDNA, synthesized, then cloned into the RNA Polymerase III expression plasmid pH1.Stuffer(-). To test the ability of Revsh8526 to target and silence Rev, a beta-galactosidase reporter plasmid containing the Rev target sequence was created. For this, the HIV Rev exon 2 sequence was amplified from HIV-1 NL43 and cloned into the beta-galactosidase 3' untranslated region forming pCMV-beta.gal/Rev2. To test shRNA silencing, HeLa cells were transfected with various reporter/shRNA combinations and beta-galactosidase expression was assessed using an X-gal assay. In this assay, Revsh8526 was expected to target beta-gal/Rev2 mRNA, thereby resulting in lower expression and fewer X-gal positive cells. The results indicated significantly fewer X-gal positive cells in cells cotransfected with Revsh8526 as compared to controls suggesting siRNA-mediated silencing. Current

studies are underway to verify and quantify these results using an OPNG (ortho-Nitrophenyl-beta-galactoside) assay.

THE EFFECT OF A MAGNETIC FIELD ON A COMPUTER

Ben Walker and Pat Briggs
The Citadel

This project will test whether or not a magnet is capable of destroying a computer. My resources are copper wire and an iron core. The iron core will be wrapped in copper wire and a current will be applied to the wire. If the magnet can produce a field of .3 Teslas, then it will wipe the computers memory.

INVESTIGATING CRITICAL OXYGEN USING MAGNETIC LEVITATION

Seth Zoppelt and Ana Oprisan
College of Charleston

In this study, we show that light transmission measurements directly on the image of a critical fluid sample under magnetic compensation of gravity as provided by a solenoid can give turbidity data with the same precision as the classical techniques using a laser beam. The novelty of this technique is noticeable as it also authorizes both a detailed observation of the sample and the local measurement. When density gradients exist, as it is often the case in space experiments, different image zones can be chosen and compared, the more turbid zone corresponding to a density closest to the critical density. It was shown that light turbidity data, a quantity due to density -induced refractive index fluctuations, could be directly obtained from image analysis. As an example, images of oxygen taken near their critical temperatures of 155K are analyzed and values of isothermal compressibility and fluctuation correlation lengths are compared with literature values.

END

SC Academy of Science Abstracts
(Sr. Academy)

SCJAS ABSTRACTS

(Listed alphabetically by first author's last name)

THE EFFECTIVENESS OF MUSIC THERAPY ON THE SHORT-TERM MEMORY OF ALZHEIMER'S PATIENTS

Angela Acateca

The Center for Advanced Technical Studies

The main purpose of this project is to see if the short-term memory of Alzheimer's patients can be built up with music therapy. This is important because if it shows short-term memory over time is affected by music therapy, caregivers and loved ones can start integrating this in their own facilities or daily care. Alzheimer's disease affects over 5.8 million people in the United States. The hypothesis for this research is the participants that are exposed to music therapy will have better short-term memory. This research will help the push towards ways Alzheimer's patients can improve their short-term memory. In this research there were memory tests conducted in three different groups, group 1, classical music being played, group 2, white noise being played and group 3, no sound at all. The short-term memory tested was visual memory, each participant was shown three picture cards (containing a number, color, object) for a brief period of time and were tested if they could remember them. The independent variables were the music and cards and the dependent variable is the results. The control group was group 3. The results disproved the hypothesis. Groups 2 and 3 showed most results for remembrance. Music is more of a distraction but these sessions were done virtually. The expectation was when there are more sessions and participants group 1 will show better results. The research's significance was to provide a way for Alzheimer's patients to have better short-term memory.

MODIFYING SERIOUS GAMES USING REINFORCEMENT LEARNING FOR DATA COLLECTION

Evan Ackerman

SC Governor's School for Science & Mathematics

Serious games came to fruition within the past fifty years or so; their predecessor and/or relative is better known as a simulation. Serious games gather important data through putting users in certain conditions and situations, gathering reactions and choices, and often testing against an artificial intelligence agent. To create these data collection testing environment, my software team and I made a modification to an existing game that used disease propagation to model a zombie and flu-like pandemic. We approached the modification with ideas on how to make the rudimentary data more valuable through creating a better environment for the player. We accomplished this through three changes: creating a graphical user interface to increase ease of use, implementing a trust system to increase realism, and generating random events to better analyze impulse user decision and again further realism. We tasked an artificial intelligence agent to find the best possible score using reinforcement learning, which is a category of machine learning that utilizes trial and error to discover trends, exploits, and non-human results. Given that my research experience was not focused on gathering specific data or testing a certain hypothesis but was rather a chance to gain valuable professional and educational experience with computer science while also creating a feasible project, I only have proposed theoretical data claims that I can make. Our modification does indeed present a more detailed account of both general disease propagation and our specific chosen zombie and flu viruses and human behavior when put in these scenarios.

IDENTIFICATION OF MICRORNAS AS BIOMARKERS FOR STRESS CONDITIONS IN MAIZE (ZEA MAYS)

Toluwanimi Ariyo
Ridge View High School

Over 2,000 microRNAs (miRNA) have been discovered in plants and animals, and these miRNAs regulate various biological processes. However, there is no definitive conclusion regarding the certain types of miRNAs expressed under different stress conditions in plants and animals. Although, one study has made efforts to construct artificial miRNA in potatoes (*Solanum tuberosum*) [7], adequate knowledge of miRNAs prevalent in drought stresses was lacking. This study aims to identify miRNAs expressed under different stress conditions in *Zea mays*. TotalRNA was isolated from *Zea mays* under different stress conditions, namely, darkness (etiolation), salinity, drought, and control (no stress). Isolated totalRNAs were reverse-transcribed (RT) into cDNA ends, using stem-loop pulsed RT protocol, and were tested using end-point PCR protocol for the presence of targeted zma-miRNA, using designed primer pairs. It was found that plants under stress conditions declined in average height (cm) and number of leaves approximately 16 days after planting, with exception to control (no stress). Zma-miRNA 167a, 168a, and 169a were prevalent under abiotic stress treatments. Amplicons obtained under control (no stress) were lower than the 600 base pairs in comparison to other stress conditions. Prevalence of these zma-miRNAs in abiotic stresses further imply that they play a crucial role in abiotic stress regulation and assist in future efforts of constructing artificial miRNA for stress tolerances in plants, providing knowledge of novel miRNAs. However, unusual trends in control (no stress) amplicons may be the result of possible error and further analysis will be done to examine this trend.

THE EFFECT OF QUALITATIVE VERSUS QUANTITATIVE NUTRITION EDUCATION ON THE EATING HABITS OF FEMALE HIGH SCHOOL ATHLETES

Brantley Aycock
Spring Valley High School

In order to perform well and maintain their health, athletes must ensure proper nutrition. However, female athletes are prone to disordered eating behaviors (Birch, 2005), which put the athletes at risk of acquiring the female athlete triad (Day et al., 2015). Although the effect of nutritional education on collegiate female athletes has been explored, with differing conclusions, the effect of different types of nutritional education on high school athletes has not been investigated. In this study, the eating habits of high school female athletes were compared before and after watching either a quantitative or qualitative nutrition education. The participants were asked to use a smartphone app to track the amount of each food group they consumed over two weeks. These reported amounts were then analyzed using nutritional guidelines set by the Automated Self-Administered 24-Hour Recall (ASA24) to determine the healthiness of participants' eating habits. It was found that the quantitative presentation ($M=-0.26$, $SD=0.97$) did not have a significant effect on eating habits; $t(17)=-1.13$, $p=0.86$. The qualitative presentation ($M=-0.21$, $SD=0.82$) did not have a significant effect either; $t(18)=-1.12$, $p=0.86$. It was additionally found that the participants' eating habits largely failed to meet nutritional guidelines. These results suggest that high school female athletes do not practice proper nutrition and are generally unaffected by nutritional education, putting them at risk for the female athlete triad. By garnering a greater knowledge of how female athletes practice nutrition and are impacted by nutritional education, the medical and sports communities can implement strategies to improve athlete health.

THE EFFECT OF COLLABORATIVE ELECTRONIC USE ON LONELINESS IN A VIRTUAL SCHOOLING ENVIRONMENT

Carson Aycock
Spring Valley High School

The coronavirus, COVID-19, is an airborne virus that has caused government officials to demand that people stay inside. Being locked inside may lead to increased feelings of loneliness, but the use of technology may lessen isolation's effects. Many highschoolers have been forced to go from in-person schooling to virtual schooling. This transition causes students to lose upwards of 7 hours of face to face social interaction daily. Collaborative technology use may be able to lessen the amount of loneliness that students are feeling. Student participants were sent a 55 question survey and the University of California, Los Angeles (UCLA) loneliness scale to complete anonymously (Russell et al., 1980). Results demonstrated that technology use did not significantly decrease how lonely someone is. This research is important because although technology may help to distract highschoolers, it does not lessen their loneliness. In spite of this result, technology that is used for communication can still be beneficial to well-being. The findings suggest that other studies need to be conducted on specific types of technology use and on other age ranges. Moreover, conducting studies over a period of time and testing people's different levels of loneliness during the pandemic and how they feel after a return to normal would also be beneficial.

LONG-TERM MEMORY AND PATTERN RECOGNITION IN MYXOMYCETES

Isabella Ayers
Chapin High School

Myxomycetes, or slime molds, are a form of macroscopic, multicellular amoeba. It lacks any form of organs, and has no central nervous system or brain. Despite this, slime mold has shown to possess a surprisingly high intelligence level. They are capable of solving mazes and efficiently and accurately map railway maps during controlled experiments (Ferguson, 2019). In an experiment in which a slime mold was exposed to cold, dry stimulus for regular intervals of time, the organism prepared for the stimulus by slowing its growth. After the stimulus stopped occurring at these intervals, the slime mold prepared for cold air that did not come, showing it had a concept of time and was capable of using this to make predictions in its environment (Tetsu, 2008). This experiment's success implies the possibility of both long-term memory storage and pattern recognition. This concept will be tested for by collecting data from a group of myxomycetes that will be exposed to cold air in a similar manner to Saigusa Tetsu's experiment. The samples will be exposed to dry stimulus every thirty minutes for three intervals, and growth rates will be observed using time lapse cameras and grids to help in calculating the area of the growth progression. The three-interval pattern will be repeated, and monitoring will continue afterward to observe the effects of the pattern on long-term growth rate.

THE EFFECT OF SOCIOECONOMIC STATUS (SES) ON PERCEIVED STRESS DUE TO ONLINE AND HYBRID LEARNING IN THE MIDLANDS OF SOUTH CAROLINA

Stephanie Babiniec
Spring Valley High School

Students from a low socioeconomic status (SES) have been shown a multitude of times to be at a disadvantage within the education system. With the spread of COVID-19, access to education has become an even bigger issue for those students (Daniel, 2020). School closures led many students from a low SES to be taught either completely virtually in an e-learning environment, or, more recently, in hybrid

schooling where at least one day each week was spent in-person and one at home. However, many of these students in an e-learning environment also tend to have a chaotic household. Therefore, this study addressed the perceived stress levels of students due to their learning environment as well as their SES. Because a significant value $F(3, 136) = 3.45$, $p = 0.018$, was received, a post-hoc analysis was run to show that significant difference was shown between online-low and online-high students. This is different from what was hypothesized, which was students with a low SES in an online environment to be the most stressed due to working in an increased chaotic household. The results show that hybrid schooling appears to be more stressful than online schooling. This experiment could open the pathway for targeted programs specifically designed to equalize the learning platform for those students with a low SES and participating in online learning. Furthermore, this study could provide the foundation to providing students struggling with altered learning environments the help they need.

CORRELATION BETWEEN SLEEP DEPRIVATION AND MEMORIZATION

Ashlynn Bagnal
Chapin High School

The following research paper attempts to explore the connection between highschool students' sleep schedule and the way they score on the Medical terminology test. The research is intended to find the connection between the students' sleep times, study times, and how the students' scores differ based on those two variables. The research method used was that of a correlational study and focuses more on the qualitative side than the quantitative results. This choice is based off of previous research studies that show that the quality of the results trump the quantity of the number of results. Previous research shows that sleep plays a very large role in students' overall academic achievement. Mainly tested through college students, lack of sleep creates a barrier in the mind, which can cause a decline in academic achievement. Based on the findings of previous studies, it can be concluded that academic performance has a major correlation with sleep and studying. With this particular study, highschool students were asked to take familiar medical terminology tests. They were also given a survey to record their sleep process throughout the week. From these surveys, the study was able to show a decent correlation between the sleep cycle of a student and the performance of the same student. The analysis hints towards the idea that there is a connection between sleep, study time, and the score that students receive on tests.

EXAMINATION OF NUTRITIONAL INTAKE AMONG COLLEGIATE MARCHING BAND ARTISTS

Raeva Bali and Lillian Coats
SC Governor's School for Science & Mathematics

Statistics show that marching band artists do not receive enough information on basic physiological guidelines to stay healthy, so this research was utilized to examine the low energy availability, to examine low energy availability and macronutrient intake, and to examine hydration status and micronutrient intake (Potassium, Sodium, and Calcium) in collegiate band artists. MB artists from the University of South Carolina "Carolina Band" completed a survey and measured their bodily dimensions. For one week, participants were asked to complete food logs to measure energy intake (EI), wore a Polar m200 watch to estimate the energy exercise expenditure (EEE) during performances, and provided a urine sample to measure urine specific gravity (Usg). Basic statistics analyzed all energy needs and Usg for subjects in the study. Chi-square was used to identify proportions of participants "at risk" for LEA and dehydration and compared the variations with sex. Significant differences were found for EI between males and females in the study. No significant differences were found for EEE and EA between males and females. Overall, 73.7% of participants ($n=28$) were at risk for LEA. No substantial differences were found for Usg and sex,

however, 36.8% (n=14) reported being chronically dehydrated ($\geq 4/7$ days > 1.025). Of those with LEA (n=28), 31.6% (n=12) also reported as chronically dehydrated. Due to performances in hot and humid environments while also wear heavy and hot uniforms, and the actual physical demands associated with MB, healthcare professionals should provide appropriate nutritional resources and education on hydration and proper fueling for MB artists.

POVERTY LEVELS AND LEAD CONCENTRATIONS IN PUBLIC SCHOOL DRINKING WATER

Kathleen Barfield
Chapin High School

Increased drinking water lead concentrations have been frequently reported in communities with higher minority percentages as well as those with lower average incomes, causing numerous adverse effects. This study expands on this knowledge, examining lead concentrations in public school drinking water as it compares to each school's percentage of minority and poverty students, using a linear regression for each factor. Twelve schools participated in the study and provided three water fountain samples each, totaling 36 samples. The former regression regarding minority percentages yielded a p-value of 0.000 as well as a r-value of 0.873. The latter regression yielded a p-value of 0.001 and a r-value of 0.831. Both regressions showed significant correlations between socioeconomic factors and lead concentrations (p-value < 0.005 and r-value between 0.7 and 0.9). A linear regression was also conducted between minority and poverty percentages and yielded a p-value of 0.000 and a r-value of 0.964. While these socioeconomic factors are highly significantly correlated, the factors are not identical and yielded different p-values and r-squared values. The regression argues that while minority and poverty percentages in student populations significantly correlate with lead concentrations in drinking water, minority percentages are more significant, and therefore a better predictor of lead, than poverty percentages. This suggests that there is a systemic problem in water access, where lower income and largely minority populations endure lasting health effects that higher income and minimally minority populations endure less.

LITERATURE REVIEW ON COVID-19 IN SEARCH FOR POSSIBLE TECHNIQUES TO DEVELOP SARS-COV-2 MIMETIC PARTICLES

Karthik Beeraka, Caspen Gregory, Ethan Mills, and Savannah Pender
SC Governor's School for Science & Mathematics

SARS-CoV-2, the novel coronavirus that causes the disease COVID-19, has had a devastating impact on peoples and nations across the world. COVID-19 shows high rates of human-to-human transmission and can be deadly, causing the World Health Organization to declare a global pandemic on March 11th, 2020. Researchers have had to scramble to adapt as the virus rapidly spreads and new information is found. Here, we review recent publications on COVID-19 with the intention of understanding the structure of the SARS-CoV-2 virus, its impact on the human body, its modes of transmission, contemporary treatments for those affected by COVID-19, and the difficulties of researching the virus. One of the chief goals of our literature review is to study how so-called "mimetic particles" may be developed to study the SARS-CoV-2 virus and potentially aid in the development of treatments or vaccines for COVID-19.

THE EFFECT OF DIFFERENT WAVELENGTHS OF LIGHT ON THE SURVIVAL OF AMPHIDINIUM UNDERGOING THERMAL STRESS

Bethany Benjamin
Spring Valley High School

Coral bleaching is a phenomenon in which corals are exposed to water temperatures higher than the average for their environment, which poses a serious threat to the health of the coral. Corals possess a symbiotic relationship with zooxanthellae, also known as dinoflagellate algae. When the algae are exposed to these increased ocean temperatures, the coral also suffers the loss of energy from the algae's photosynthesis. This experiment was conducted to observe if light therapy could be effective in rehabilitating corals and their symbionts that are suffering the effects of bleaching. The hypothesis was that if Amphidinium cultures were placed under stressful temperatures and simultaneously treated with different wavelengths of light, then the Amphidinium culture treated with 400 nm light would receive and absorb the most light. Cultures of algae were placed under various wavelengths of light for one week while undergoing stressful water temperatures, and then observed through spectrophotometry to see if there was a possibility that the algae could continue to photosynthesize. It was concluded that the hypothesis was not supported by the data. Due to contradictions in mean values and overall absorption rates, there was not substantial evidence that violet light was able to alleviate the damage caused by heat stress. An ANOVA test also showed that it is unlikely that light therapy will be effective in most wavelengths. However, blue and red light, which are 450 nm and 650 nm respectively, showed a possibility that they may be effective in continuing absorption during thermal stress.

ACADEMIC CHANGES DURING COVID-19: ANALYSIS OF THE RELATIONSHIP BETWEEN TEST ANXIETY AND EDUCATION MODALITY

Aubrey Best
SC Governor's School for Science & Mathematics

This research project considered student preferences on testing in the virtual environment, and factors contributing to student test anxiety. To gather student opinions, a three section survey was distributed electronically to seniors at the South Carolina Governor's School for Science and Mathematics in September of 2020. Due to COVID-19, these student respondents had experienced a switch from residential to a completely virtual environment in the spring of 2020. The first section of the survey utilized questions from the valid and reliable Test Anxiety Inventory, written by Charles Spielberger, to gauge a general measure of student test anxiety. The second section asked the students to respond to statements regarding the effectiveness of online learning. The final section elicited responses concerning online and in-person testing. The survey results show that students with higher TAI scores are less likely to agree that online education is as effective as in-person education. These results may be used to improve future effectiveness of online learning and to reduce student anxiety surrounding testing.

PSYCHOLOGICAL EFFECTS OF BODY IMAGE ON PRIMARY AGED GIRLS.

Anselle Blackmon
Chapin High School

The goal of this research will be aimed to answer the question of "to what extent does the choice of first-grade girls between a plus-sized doll and a skinny doll show their prejudice towards the weight of women?" The main goal of this research is to see if young girls will pick the bigger or smaller doll when it comes to positive or negative questions such as "which one is prettier", "Which one is nicer" and "which

one would you want to play with". I hypothesize that most young girls will pick the thinner doll when it comes to the positive questions and the plus-sized doll when it comes to the negative questions. The motivation for this study is to see if advertisements and the social views of the "pretty women" play a role in how young girls see body image and weight status. According to The American Academy of Pediatrics, the average young person growing up in the United States sees anywhere from 13,000 to 30,000 television advertisements every year. It is because of statistics such as this that explains why 42% of girls in first through third grade want to be thinner. This research was conducted through a series of short questions that correlate to the barbie dolls and then a few about the young girl's home life and whether she has a television at home.

COMPARING ECO-FRIENDLY TO CONVENTIONAL DISPOSABLE DIAPERS

Hope Blackmon

The Center for Advanced Technical Studies

Research has shown that diapers are now the second biggest generated waste, being surpassed only by clothing and shoes. If by comparing regular conventional to the more approached eco-friendly diapers, then more parents will be more accepting to making the switch for the benefit of the environment. Comparing and contrasting these nappies will factor up to cost, availability, durability, and absorption. Six various diapers - three eco-friendly and three conventional diapers - will be tested for the greatest absorption. How will durability and absorption compare? What are the biodegradability claims for the eco-friendly diapers? While the majority of parents throw away trash without a second thought, standard diapers will be stuck in landfills for many generations - which environmentally friendly diapers are trying to counteract, decomposing toward a shorter time interval.

THE EFFECT OF VARIOUS ESCHERICHIA COLI AND HEAVY METAL SOLUTIONS IN WASTEWATER ON THE FILTRATION THROUGH FOAM GLASS

Ella Blalock

Spring Valley High School

After a glass bottle is recycled, many people do not think about where it goes or what happens next. Due to the amount of recycled glass increasing, companies are looking for alternative ways to repurpose the glass. One of those ways to repurpose recycled glass is transforming it into foam glass. The purpose of this analysis was to determine whether foam glass can be used to filter out harmful bacteria such as Escherichia coli and toxins from wastewater in the environment. It was hypothesized that "If the E. coli is present in the wastewater, then the foam glass would filter it out because it will choose to filter out the harmful bacteria compared to the other substances." Four solutions were created by combining heavy metals, such as iron and copper, E. coli, and wastewater. An unpaired two-tailed t test was run to study the effectiveness of the foam glass on filtering out E. coli from the solutions. The amounts of heavy metals were recorded with a water quality testing kit and observed before and after the solutions were filtered through the foam glass. The results of this experiment showed that the foam glass does not filter the E. coli out, but it does filter the heavy metals out. The hypothesis was not supported, but the t-test showed that the results were statistically significant.

THE EFFECT OF DIFFERENT TYPES OF BACTERIA ON HYDROPONICALLY GROWN THINOPYRUM INTERMEDIUM

Rithika Boinapalli
Spring Valley High School

The objective of this research was to identify whether adding bacteria to hydroponic systems provide more growth than normal hydroponic systems. It was hypothesized that if beneficial bacteria were to be added into the water solution, bacteria release carbon dioxide which helps plants to grow plants faster. The nutrient solution was placed at the bottom of the netted seed tray, so the solution was slightly touching the seeds. After three days, the bacteria were added to the solution. In the second tray, *Bacillus Subtilis* was added to the solution. In the third tray, *Rhizobium leguminosarum* was added to the solution. After the bacteria were added, data was recorded by averaging the height of the wheat plants, and this was measured in centimeters. Batch two's data proved that all the groups were not significantly different. The batch one's plants died causing the data to be unable to be used. The change in batch one is mostly due to the outside factors such as over watering, over addition of fertilizer, fungus production, UV lights, or some type of spray used in school for electrical equipment. These factors may have caused the plant's to die. These results did not clearly conclude whether adding bacteria helped the growth of the plant, as not much difference in the height of plants between groups, so further research needs to be done in order to specify if bacteria can help plant growth.

OPTIMIZING THE COMPUTATIONAL PARAMETERS OF FERRITE COMPOUNDS

Jada Bonds
SC Governor's School for Science & Mathematics

The compounds nickel ferrite (NiFe_2O_4), cobalt ferrite (CoFe_2O_4), manganese ferrite (MnFe_2O_4), and zinc ferrite (ZnFe_2O_4) have many useful magnetic properties. We have experimented with these compounds to try and stabilize them to make them easier to use for medical purposes – such as magnetic drug delivery, radio-frequency hyperthermia, magnetic resonance imaging (MRI), medical diagnostics – and materials like loud-speakers, small electric motors, and refrigerator magnets. In order to make these compounds stable, we tried to optimize the magnetic moment and lower the energy. Doing these two things will change the structure and distribution of ions in the compound, making it more efficient and stable. We adjusted the magnetic moment and energy of these compounds through computational parameters such as the mixing flags in the INCAR coding file. Mixing flags change how the ions in compounds are distributed and structures. This directly affects the energy and magnetic moment of the compound. We tested multiple different combinations of values with these mixing flags to see how they affected the compounds. We used values specific to each mixing flag according the VASPwiki website. We found that mixing flags do not affect the values of the magnetic moment or energy of the compound, therefore not affecting how stable the compound is as well. In the future we will experiment with other methods and parameters to see what can affect the stableness of a compound and how it is affected.

DEMOGRAPHICS OF HIGH SCHOOL STUDENTS WITH MISDIAGNOSED MENTAL ILLNESSES

Alec Bowie
The Center for Advanced Technical Studies

The objective of this research project is to discover and analyze the demographics of high school students with a self-proclaimed misdiagnosis of a mental illness. A misdiagnosis of a teen can have a big impact on their lives and reinforce their mindset. The stigma that revolves around having a mental illness can act as

a label isolating teens. The method used will be a survey to ask the taker if they have received any other previous diagnosis, and If they feel their previous or current diagnosis was a misdiagnosis. Other studies similar to this one are able to rescreen the patients and use their tests to conclude whether or not there was a misdiagnosis, but my test relies on the patient's response to the survey. The results so far conclude that white females are the most likely group to be diagnosed with a mental illness and the most likely to be believed to be misdiagnosed. 7/8 patients who have received a previous diagnosis are white females. The survey is meant to better understand the demographics in high school that are more commonly misdiagnosed with a mental illness in order to correct possible factors leading to this problem.

THE EFFECT OF THE COVID-19 QUARANTINE ON THE DISTRESS LEVELS OF HIGH SCHOOL VARSITY ATHLETES VS. JV ATHLETES VS. NON-ATHLETES

Andrew Boysia
Spring Valley High School

2020 was hit with the COVID-19 outbreak, which caused a mass quarantine. Evidence from previous quarantines suggest that mental health issues are imminent. To further investigate the mental health implications, the effect of the COVID-19 quarantine on the distress levels of high school varsity athletes vs. JV athletes vs. non-athletes were investigated. A survey was created which gathered demographic information, current athletic situation, and then measured distress caused by quarantine through an adapted IES-R. This provided a 0-44 distress score which was compared to the three athletic groups. It was hypothesized that varsity athletes would have the lowest distress because they are the most committed to athletics which has been proven to help mental health. Junior varsity athletes would have the next lowest distress levels because they still participate in a team sport, but it does not have as much importance in their lives. Finally, non-athletes would have the highest distress because they do not utilize the benefits of athletic activity on mental health. A one-way ANOVA was conducted on these groups and it was found that athletics did not have a significant influence on distress score with an alpha value of $\alpha=0.05$ ($p=0.47$). Despite this, the mean and median distress score went up as physical activity increased. A possible explanation for this is that athletes had a more difficult time adjusting to the sedentary lifestyle of quarantine.

INSPIRING STEM: LARGEST CONSTRUCTION SET Porshay Bracey, Jarrod Neal, and A'leiria Feaster The Center for Advanced Technical Studies

The problem of our project is making STEM appealing to underclassmen, so they may consider participating or consider taking STEM in the future. The goal of our project is to interact with underclassmen and motivate them and see if they would be willing to consider STEM, which is why another one of our goals is to make stem appealing and bring them in using The Largest Construction Toy set. We want to start with a smaller set first and see if this appeals to the underclassmen and if they happen to enjoy it we will make a bigger version and see if it grabs their attention or intrigues them. We expect to accomplish this project is to get at least 65% of students to love the large construction set rather than the smaller construction set. Also, get students to love the idea of STEM and becoming and studying engineering in the future. Even today we are in need of engineers and by the time of 2027, there will be a lot more jobs for each and every one.

THE CORRELATION BETWEEN FAMILY STRUCTURE AND STUDENT ACADEMIC ACHIVEMENT

Brandon Bravo
Chapin High School

In response to the Covid-19 outbreak of 2020, many school districts across the United States have implemented new learning methods as the primary method of instruction/learning. However, little research has been conducted on the effect of virtual or hybrid learning methods on single-parent households, households which tend to struggle or be at a disadvantage within traditional learning methods. This study investigated this gap as it conducted a study focused on the question: "How have students of single-parent households fared during distant learning compared to students of traditional households?" The study collected qualitative and quantitative data through a survey completed by high school students of both single-parent households and traditional households. Afterwards, a chi-square test of independence was used to analyze collected data. The results indicated that students in single parent households often appear to experience greater difficulty in new learning methods compared to their peers in traditional households. These students are more likely to experience lower academic performance as well as encounter issues, such as internet liability, that reduce the effectiveness of their learning. In conclusion, further research should be conducted on specific aspects within single parent families, such as internet liability, to identify and solve issues affecting single parent family students.

VISCOSITY STUDIES OF VEGETABLE OIL BASED BIODIESEL

Isaac Brewer
The Center for Advanced Technical Studies

Transportation, particularly in personal vehicles such as cars, adds huge amounts of carbon to the atmosphere. As of this day and age, this is the case because most cars are fueled with fossil fuels instead of the more environmentally conscious alternative, biodiesel and other biofuels. One issue with the use of biodiesel is its unreliability in cold temperatures due to a change in viscosity. It is hypothesized that biodiesels made from vegetable oils will have a lower viscosity at lower temperatures and the type of vegetable oil used will not have a significant effect on viscosity. The methods used to test the hypothesis were to first synthesize five different types of vegetable oil based biodiesels. The next step is to measure the viscosity of all the biodiesels at varying temperatures with the use of a viscometer. Finally, the results will be analysed to prove or disprove the hypothesis. It has already been found that all the biodiesels have a similar viscosity at room temperature, or about twenty two degrees Celsius. This is predicted to cause a trend where the different vegetable oil based biodiesels have a similar viscosity to each other at colder and warmer temperatures. Future research will be utilized to prove or disprove every part of the hypothesis. There will also be possible research into additives to help the viscosity of biodiesel at cold temperatures.

NATIVE BEADS AND BURIALS

Camryn Brown and Emily Geraghty
SC Governor's School for Science & Mathematics

Native burials require meticulous sensitivity when unveiling their secrets. Every piece of them counts in the search for conclusions on native culture and connections. Burials appear in all shapes and forms, and are not necessarily an individual thing. Commingled burials have been a common occurrence between many different tribes. Through our readings, we put together spreadsheets about a variety of burials through the Carolinas and surrounding areas. This allowed an effective analysis of the various

methodologies and different relationships between burials. This also allowed us to see similarities between tribes in the Southeast. Covid heavily affected our research as well. Instead of physically going to the Native American Studies Center to conduct our research, all materials were set to us. However, we were lucky enough to receive field experience on an active dig site in South Carolina. Most of the commingled burials we have studied are family members, such as the mother and child, or the siblings found at the Kobe site. Analysis of this data had to consider the sensitivity of intrusive burials and what to take from those burials. We also investigated the significance of shell beads found in burials across the East. Shell beads were not found in all burials, only select ones. Our research can help explain the long process of making shell beads, trade between tribes, and shell beads designating certain accomplishments or affiliations.

SYNTHESIZING SEIR DIFFUSION AND ERLANG DISTRIBUTION TO DEVELOP A MORE REALISTIC, APPLICABLE EPIDEMIOLOGICAL MODEL

Lucia Brown and Vansh Nagpal
SC Governor's School for Science & Mathematics

The creation of effective, comprehensive models is critical for understanding the spread of disease. The basic SEIR model is commonly used in epidemiology, with a crucial application being disease policy development. The SEIR model compartmentalizes the population into four groups—those who are susceptible, exposed, infected, and recovered. The model can be made more realistic by considering further variables. Using the computer software MATLAB, this study analyzed variables for two main SEIR modifications, the SEIR diffusion model (SEIRD) and the SEIR Erlang distribution model, with the goal of synthesizing the two to create a more realistic SEIR model. To investigate the SEIRD model, initial conditions and distribution spread values for Gaussian models were first altered in MATLAB and graphs were produced. The results of different modifications to the SEIRD model were further investigated by examining altered diffusion constants. A similar approach was taken to the analysis of the Erlang distribution model. Through alterations in initial variables, including spread of the disease, coefficient of migration rate, and contacts per unit time, differences in the SEIR curves were analyzed. In combining the ideas investigated for the SEIRD model and the Erlang distribution model, a framework for a more applicable model was created, with the flexibility to alter both the diffusion variables and those of contact and spread in the same model.

TO WHAT EXTEND DOES TIME-OF-DAY PREFERENCE AFFECT ACADEMIC PERFORMANCE IN HIGH SCHOOL PRE-CALCULUS STUDENTS?

Georgia Brownfield
Chapin High School

Every year, students begin the transition from middle school to high school where they learn to adjust to a very different schedule, work load, and environment. These factors all play into an adjustment in the circadian rhythm which affects a person's time-of-day preference. These time-of-day preferences can take a toll on the grades of many students. An effect on grades can be explained due to the way that the school schedule is built as it is meant to line up with the 9-5 jobs that the parents of many students have. In January of 2021, a group of 60 pre-calculus honors students and their grades were tracked during the period of a month. The grades as well as the time-of-day preference of each of these students were recorded every 1 ½ weeks. To determine if there was a correlation between time-of-day preference and student's grades, the data was entered into the MiniTab Anova and Tukey Tests. The data so far has revealed that students who are taking a class at their preferred time-of-day had higher grades than those

in the class at the time they don't prefer. The data also revealed that many students in pre-calculus honors have a preference for the late morning (10 am-11am) than any other time of day.

TO WHAT EXTENT DOES AEROBIC FITNESS HAVE AN EFFECT ON CHAPIN HIGH SCHOOL CROSS COUNTRY RUNNER'S ACADEMIC PERFORMANCE

Samuel Bryant
Chapin High School

In America, the rates for heart disease and heart related issues are at an all time high with no sign of slowing down given America's equally high rates of obesity in adults and adolescents. While aerobic fitness serves to reduce obesity and heart disease rates, this study provides a new estimate on the possible psychological effects of cardiovascular exercise through high school cross country runners attending Chapin High School. The hypothesis was that runners with a faster, collective, five kilometer (5K) race time had higher Grade Point Averages (GPA) compared to their running counterparts. Conditions not allowing access to National/ State test records make GPA a compelling analog for inputting academic data. My research methods include using Google Spreadsheets to find each runner's mean 5K time and have each runner participate in a Google Survey to take both academic and psychological effects into account. This study estimates the correlation between each runner's mean 5K race time and their corresponding, self-reported GPA. The estimate indicated that runners with faster 5K race times had higher GPAs, which was consistent with the proposed hypothesis stating that there is, in fact, a positive correlation between aerobic fitness and academic performance.

MANDATORY MASKING: LIBERTY VS. LAW

Anna Caddell
SC Governor's School for Science & Mathematics

The COVID-19 pandemic brought various concerns about supporting the safety and health of the public. One such question is the required wearing of masks. It has been argued that the government cannot force the public to wear masks on grounds of abridging Constitutional rights. However, state governments have the liberty to enforce a mandate, as specified by the 10th Amendment of the Constitution. There is court precedence, where such matters have been fought and discussed. Most notably, *Jacobson v. Massachusetts* of 1905. "Mandatory Masking: Liberty vs. Law" discusses these matters and adds the perspective of the Influenza Pandemic of 1918 that killed at least 2.5% of the global population. Within this paper, a reflection and comparison between the COVID-19 pandemic and the 1918 pandemic is offered with regards to public reactions and government measures taken. It addresses and reflects upon actions that states have the power to use when refusal to comply with mask wearing mandates occurs. This comparison reveals different approaches and possibilities a government could take with enforcing these directives.

THE LIFT
Asia Caldwell and Adam Wheeler
The Center for Advanced Technical Studies

We are working to solve the problem of getting clothes out of the top loading washer for short people, elders, amputees, and those with back problems. Our design will eliminate the height problem by creating an adjustable lift for clothes to raise up in a top loading washing machine for easier access. We want the design to be adjustable so that it can be a universal device for all top loading washing machines.

THE EFFECT OF MUSICAL GENRES ON A HIGH SCHOOL STUDENTS MENTAL STATE
Eva Camlin
Spring Valley High School

The purpose of this research project is to observe how different genres of music affect a person's emotions, and to determine what genre is most effective in improving mental state. It was hypothesized that classical music would be the best kind of music to listen to to improve your mental health. This is due to the fact that classical music has slower tempos, which is shown to increase productivity in some cases. It was also hypothesized that rap music would be the least effective genre of music for improving the mental health of high school students. This is because it encourages more aggressive thoughts and criminal behavior. It also tends to have faster tempos and more aggressive lyrics. The six most popular genres among high school students were studied in this experiment: pop, hip-hop/rap, rock, country, alternative, and classical. This research was conducted using a survey that consisted of a series of questions regarding the participants favorite genres of music, why they choose to listen to certain genres, and how they feel when a clip of a song is played. The results showed that pop, hip-hop/rap, and classical music would classify as beneficial for a high school students mental state. A chi squared test for independence showed that the p-values were less than 0.001 showing that the null hypothesis was rejected. There is a significant association between music and emotion.

REDUCTION OF CARBON EMISSIONS FROM CONVENTIONAL OVENS/GRILLS UTILIZING PYROLYSIS
Silas Campanella
The Center for Advanced Technical Studies

The purpose of this research project is to show how common grills produce so much carbon compare to pyrolysis stoves. I want to look into pyrolysis because it is actually a carbon-negative process where it doesn't harm the environment as much as a common grill or wood burning. I will be using 3 grills for testing and they will be charcoal, wood pellet, and pyrolysis. Each type of grill will be loaded with a fuel source, lit, and burned for 1 hour period while using a CO2 monitor to see how much CO2 is produced over time. then I will attempt to design and fabricate a pyrolysis grill that produces less compared to the common conventional grills. by each one and see if I can make a pyrolysis grill that produces less carbon compared to the common grill. Over the course of this year, I will be obtaining results for this research project. results so far indicate that the pyrolysis produces less CO2 but research is still underway.

THE CHANGE IN LEVELS OF DATING ANXIETY AMONG HIGH ACHIEVING ADOLESCENTS

Emma Carter
Chapin High School

The goal of my research will be aimed at answering and discussing, "To what extent has dating anxiety in academically gifted adolescents changed over the last 20 years?" The goal of this research is aimed at analyzing how modern times have affected or changed dating anxiety for adolescents. The main hypothesis of this study is that the majority of teens will display an increase in dating anxiety in heterosocial situations with individuals of the opposite sex. The motivation for this study is to look at how dating anxiety has changed while acknowledging variables such as social media use, sex, and age. According to researchers Jessica Kansky and Joseph Allen from the University of Virginia, during late adolescents is usually when romantic relationships grow in significance and adolescents are more susceptible to the possible effects of these relationships. Because the majority of research related to dating anxiety in adolescents was conducted in the early 2000's, it is important to gather modern data in order to be able to form efficient solutions to the dating anxiety that adolescents experience. According to researchers from the University of Miami and the Children's National Medical Center, Glickman and La Greca (2004) conclude that dating anxiety includes a fear of being judged in heterosocial or dating situations, social avoidance, and distress that is related to interactions with someone of the opposite sex or a romantic partner as well as social avoidance and distress specifically related to heterosocial experiences. In this study the Dating Anxiety Scale for Adolescents (DAS-A) is used in order to accurately determine the levels of dating anxiety in each participant. The questionnaire includes elements of social anxiety and anxiety related to self esteem in order to determine levels of dating anxiety.

AN INNOVATIVE SOLE THAT ADAPTS TO FLAT FEET IN RELATION TO APPLIED PRESSURE

Isabella Castellanos
The Center for Advanced Technical Studies

There are millions of people in the world who struggle with flat feet, and yet, there still isn't an adaptive solution to deal with flat feet. Flat feet, or pes planus, can lead to knee, hip, and lower back pain, as well as abnormal walking patterns which can worsen over time and limit mobility. This project was created to address that. Counter pressure was used in the form of air pockets that were spaced in the sole of a tennis shoe. The air pockets were made from the air pockets of an Aircast that were cut to size and resealed so they would fit properly. The valves from the same Aircast were used as a point of inflation for the pockets so the foot was supported by the air, while having corrected the placement of the foot in the process. Pressure sensors were installed on another layer in order to gather the pressure reading from the person. This data was made readable through the use of an Arduino, so the person knew what air pocket needed to be inflated. It was found that the air pockets helped in keeping the foot in a correct position, and reduced the amount of pressure that was exuded on the foot at a certain point. As a whole, the sole corrected and supported flat feet through the use of counter pressure applied to the wearer's foot, all while allowing the wearer to adapt the pressure to their needs, making orthotics more innovative and adaptive.

DESALINATION OF WATER
Blake Cecil and Preston Folger
The Center for Advanced Technical Studies

In the year 2018 alone, 46 ships were lost at sea leaving any surviving crew members stranded at sea. Living on a raft in the middle of the ocean is no simple task. In order to survive, one has to find ways to nourish their basic survival needs; Food, water, shelter, and warmth. Finding water in the middle of the ocean seems easy at first glance, but seawater is 3.5% salt. Drinking high amounts of salt can cause nausea, vomiting, and loss of appetite and fluids, eventually leading to death. Not to mention losing your fluids makes you want to drink even more. Our project aims to easily desalinate the surrounding water using nothing but solar energy. We expect to build a system that when set afloat on the ocean surface, will autonomously desalinate saltwater into clean pure water. This will not only be used on life rafts but can be used in any situation where drinking water is needed as long as a source of water is available.

ROTATIONAL CONSTANTS OF 2-FLUOROBENZOTRIFLUORIDE FROM MICROWAVE SPECTROSCOPY
Josue Cervantes, Anish Kanthamneni, and Garrett Youngblood
SC Governor's School for Science & Mathematics

Microwave spectroscopy is the study of how electromagnetic radiation with frequencies within the microwave range interact with molecules. In general, the purpose of such studies is to determine a molecule's rotational constants, and thus its structure. Our team used a chirped-pulse Fourier transform microwave spectrometer to measure the microwave spectrum of 2-fluorobenzotrifluoride. The molecule was measured over a range of 8 to 18 GHz in 1 GHz intervals, with each interval consisting of 10,000 averages. The measured spectrum was then compared to an expected spectrum made from Gaussian 03W software calculations, and the measured spectral lines were assigned to their calculated counterparts. As more data points were assigned throughout our analysis, we developed an increasingly accurate set of rotational constants for the molecule. The results of our completed analysis found the rotational constants A, B, and C of 2-fluorobenzotrifluoride to be 1906.22269(28) MHz, 938.93636(19) MHz, and 707.12957(15) MHz respectively.

EFFECTS OF MEDIA MISINFORMATION AND CONSPIRACY THEORIES ON THE BELIEFS OF PEOPLE WITH
VARIOUS POLITICAL ALIGNMENTS
Aleena Chattha
Spring Valley High School

Conspiracy theories stem from a distrust in government or the idea that knowledge may be hidden from the public. As media has become more usable, conspiracy theories have become common throughout media platforms. However, they can often be harmful when certain demographics are targeted instead of just the government. In the U.S., there is prejudice against those who are different, and this study focuses on the clash between people of different political affiliations (Lee et al., 2019). The purpose of this experiment was to determine if there is a correlation between political viewpoint and belief in conspiracy theories. It was hypothesized that authoritarians believe less in conspiracy theories due to their obedience to the government. In this experiment, participants were given a political alignment test. They were then asked to read about conspiracy theories and complete a survey regarding their belief in these theories. A regression test found a strong negative correlation between right-libertarians and belief in conspiracy theories ($r^2 = 0.863$, $p = 0.022$), as well as moderates and a belief in conspiracy theories ($r^2 = 0.8734$, $p = 0.0199$). There was not enough evidence to reject the null hypothesis for the other political

affiliations, but it was still evident that left-libertarians slightly disagreed with conspiracy theories, while left-authoritarians slightly agreed. There were no correlations discovered for right authoritarians. Overall, libertarians tended to believe in conspiracy theories less than participants on the authoritarian side.

THE EFFECT OF POLYESTER AND COTTON ON THE GROWTH OF STAPHYLOCOCCUS EPIDERMIDIS

Dylan Chau
Spring Valley High School

Staphylococcus epidermidis (*S. epidermidis*) is a normal microbe on the human skin, and is even quite helpful to the human immune system, as it can help the human body fight pathogens. The purpose of this study is to determine the effect of different textiles on the population of *S. epidermidis*, as the potential growth of this microbe could provide additional support for the human immune system. This study would determine whether cotton, polyester, or bare skin would be the most effective in accelerating growth of this microbe on the human skin. It was hypothesized that cotton would promote the growth the most because it is a less synthesized product than polyester. The experiment was set up using sterile chicken skin, sterile fabrics, agarose plates, nutrient broth, and a microkwik culture of *S. epidermidis*. Four by four centimeter squares of agarose gel were put on petri dishes, where inoculated chicken skin was placed on top, and then covered by fabric. To measure which was most successful, the number of colonies were counted after a ten to the negative third dilution because the original would have been too numerous to count. After running a one way ANOVA test on the results, the P-value was 0.346425 which is not significant at alpha level 0.5. Therefore, there is no significant difference between cotton, polyester, and bare skin on the growth of *S. epidermidis*.

RAISING CRISPR AWARENESS FOR THE SCHOOL CURRICULUM

Zachary Cheek
The Center for Advanced Technical Studies

The intention is to encourage school boards to adopt a lesson about CRISPR into their curriculum. This is important as CRISPR will play a huge role in the near future for the health science field. This will impact teachers, students, and hopefully create a generation of genetic engineers. The problem is that nobody teaches about CRISPR in highschool. If the school board were to adopt a lesson about CRISPR, then it would inspire many students to go on into some field using CRISPR, and inadvertently cause a boom in the health science field. This project plans on testing 3 different kits against each other to find which kit is most fitted to a classroom environment. This testing will reveal the kit best suited for teaching purposes. The methods used are as follows. First, there is an inventory check to see what items are included. Second, a review of the experiments in which each kit uses to teach. Finally, the results of each experiment in the kits. Each of these methods will be used to learn which kit is best suited for CRISPR awareness. At the time of writing this all three kits have arrived. The strongest contender was kit #2. Kit #2 has a week-long lab process in which the students learn, see, and perform the process of CRISPR. It is assumed that kit #1 is the weakest contender. Kit #3 is less suited for teaching than it is personal experimentation. Kit #2 is what I recommend for the curriculum.

DISCOVERY OF SARS-COV-2 MAIN PROTEASE INHIBITORY COMPOUNDS FROM MEDICINAL PLANTS

Eileen Chen
Spring Valley High School

The novel coronavirus (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has evolved into one of the largest and most destructive pandemics in human history. Except for remdesivir (Velkury), which appears to be limited in efficacy, no approved therapies have emerged. Thus, identification of efficacious antivirals is of pressing importance. The purpose of this study was to screen antiviral activity of extracts from four plants (i.e., *Lonicera japonica*, *Glycyrrhiza glabra*, *Isatis indigotica*, and *Scutellaria baicalensis*) and to identify the potential bioactive compounds against the SARS-CoV-2 main protease. It was hypothesized that at least one extract would exhibit inhibitory effects on 3C-like protease (3CLpro), the main protease of SARS-CoV-2. Butanol and ethyl acetate (EtOAc) fractions of crude extracts of these plants underwent high throughput screening for their inhibitory activity on 3CLpro. The screening revealed that the EtOAc fraction of *L. japonica* exhibited the highest inhibitory activity at 81% among tested groups. A one-way ANOVA showed that mean inhibitory activity effects were significantly different from each other ($p < 0.05$). A Fisher's Least Significant Difference test demonstrated that the EtOAc fraction of *L. japonica* extract displayed significant higher inhibitory activity on 3CLpro compared to all screened groups. The *L. japonica* EtOAc fraction was further analyzed using liquid chromatography and mass spectrometry with the GNPS molecular network and revealed 5 potential compounds for the identification of a potential novel SARS-CoV-2 main protease inhibitory candidate. These results suggest that *L. japonica* could be a potentially promising drug development target for COVID-19.

TO WHAT EXTENT DOES VIRTUAL DISTANCE-LEARNING INFLUENCE STUDENT PARTICIPATION AND FOCUS

Catherine Chu
Chapin High School

Due to the COVID-19 pandemic, educational institutions have adopted safe learning methods to ensure the safety and security of the student body and faculty. The safe learning methods include different forms of socially distanced environments: virtual learning and hybrid learning. This research investigated the potential influence of virtual learning with the student's engagement and on the student's academic performance. It was hypothesized that virtual students who use the online class features would have a higher academic performance than those who do not. Online class features include using the web camera, microphone, and chatbox feature. A case study method was utilized to explore the potential relationship. Students attending a fully virtual school were asked to log in personal feedback based on a few of their classes. The students were required to complete a Google Form for specific classes for five consecutive school days. To examine the extent of active engagement, three students sharing a few of the same class blocks were asked to participate. Additionally, the three teachers that the students shared had different camera regulations and teaching styles. Through this experimental method, the results found that students who actively participated using the online class features were more likely to have a higher grade in that class compared to those who did not use the online class features.

LOWERING THE PROTEOGLYCAN TO COLLAGEN RATIO IN AN IMPLANT TO MIMIC NATURAL CARTILAGE

Katie Chung and Devin Laye
SC Governor's School for Science & Mathematics

Osteoarthritis caused by untreated cartilage defects affects thirty-one million Americans. Current scaffolds on the market only provide short term relief without combatting the cause of osteoarthritis, whereas our scaffold, involving a decellularized nucleus pulposus, works to stop the source of pain while treating the defect. We worked to reduce the proteoglycan (GAG) to collagen (HYP) ratio in the scaffold to mimic natural cartilage. The primary material utilized for our research purposes was the decellularized nucleus pulposus extracted from an oxtail due to its role in the cartilage analog. In order to improve the mechanical properties of the implant, important steps include the use of natural cartilage components, the increase in collagen content by swelling in a PureCol solution, the use of Hexosamine and Hydroxyproline assays to identify the GAG: HYP ratio, and the development of a proposed in vivo animal model for future testing. After undergoing fibrillogenesis, Test1 samples yielded a final ratio of 4:1, while Test 2 samples yielded a final ratio of 5:1. The original ratio of the acellular bovine nucleus pulposus (ABNP) was 15:1 so the tested conditions were successful in lowering the GAG: HYP ratio and supported our hypothesis. The aforementioned results suggest a future focus on fine-tuning of the PureCol swelling solution, improving in vitro testing, and ensuring that the mechanical properties of the implant and natural cartilage are as similar as possible. In order to ensure the effectiveness of future in vivo testing, we propose a dual-phase animal model, including a first phase rat model and second phase goat model.

DESIGNING SEROTONIN NOREPHEDRINE DOPAMINE REUPTAKE INHIBITORS FROM EXISTING ANTI-DEPRESSANTS

Lillian Coats
SC Governor's School for Science & Mathematics

The main goal of this project was to create a new anti-depressant that would bind to serotonin, norepinephrine, and dopamine transporters (SERT, NET, and DAT respectively) with a high binding affinity. Existing anti-depressants were hybridized by using existing features of Bupropion and Paroxetine. All three derivatives were made by taking the basic structure of Bupropion and adding elements of Paroxetine to make it bindable to SERT. This created a novel anti-depressant that is classified as an SNDRI - Serotonin Norephedrine Dopamine Reuptake Inhibitor. To do this, AutoDock VINA, a virtual screening and docking program that allows flexibility in the ligand, was used to compare the binding affinities of the control SSRI/NDRI against the drugs created in this research on all receptors. Paroxion – the drug created in this study – has three derivatives differentiated by being called Mark I, II, and III. The results showed stronger binding to all three transporters than the original drugs it was based off. Paroxion bound at a significant -9.1 kcal/mol compared to the value of -7.2 for Paroxetine. All dockings showed a lower binding energy than the NDRI/SSRI the drug was based off of, for all three Marks. In future work, Paroxion should be further modified to increase binding affinity, examine all Marks using molecular dynamics simulation NAMD. In addition, experiments should be run to test biological compatibility, with the ultimate goal of reaching a clinical trial.

CREATION OF NEW AND IMPROVED PERSONAL PROTECTIVE EQUIPMENT FOR INTERVENTIONAL RADIOLOGISTS

Hallie Cohen

The Center for Advanced Technical Studies

The research project was directed towards Interventional Radiologists that are in danger of exposure to ionizing radiation. This is immensely important because there is an increased risk of cancer (Lymphoma and Osteosarcoma) and radiation poisoning if exposed to harmful doses of radiation. Since the current lead aprons were heavy and caused a lot of stress on the shoulders, lots of specialists decided not to wear them, ultimately increasing the risk of cancer. The main goal of the research was to create an improved lead apron with cap sleeves and a longer length to prevent the risk of different types of cancer, as well as promote the comfort of the apron so more Interventional Radiologists will want to wear the product. The materials used for this product were vinyl fabric and velcro to make the sizing adjustable to fit all shapes and sizes in the workforce. These materials were used to ensure the comfort of the apron to encourage usage of the product. When the expected results were analyzed, the desired outcome is that the product was comfortable enough to wear during minimally invasive procedures, while not causing long-term stress on the back, neck, and shoulders. The result of the continued work done was the increased usage and comfort of Lead Personal Protective Equipment in the Interventional Radiology field.

OPTIMIZING PLANT MICROBIAL FUEL CELLS

Italia Collazo

The Center for Advanced Technical Studies

Plant microbial fuel cells have now been looked up as a potential use for bioenergy. Plant microbial fuel cells have been used on abundant plants such as grass. But not much other research has been done on other plants. Different plants improve the voltage output of the plant microbial fuel cells. If different plants tested in a controlled environment give off different voltages then the plants will show which type gives the most voltage output. This research will be done by placing four different plants in containers and the progress of the plant growth, as well as the voltage produced by the plants, will be monitored. The data obtained so far shows that the plant microbial fuel cells give off different voltages with the different plants grown in the same environment. The results will give the information on if plants can give different voltage outputs and which plant is best for the microbes in the containers. This matters because it's an inexpensive and non-pollutive way to make energy. This will help with not creating scarcity for certain food products ,farmers can still grow products while creating energy, clean bioenergy can help reduce contaminants in wastewater, and reduce dependency on fossil fuels. The future of this project will test different plants and the voltage outputs the different plants give out.

PUMPING WATER FROM DIFFERENT ELEVATIONS USING SOLAR PHOTOVOLTAICS

PJ Comose

The Center for Advanced Technical Studies

The goal of this project is to see how well water can be transported from one elevation to another, using the power of solar energy. This project will use solar photovoltaic panels that will capture energy from the sun, that energy will then be stored and used to pump water, then the water will be pumped up to a higher elevation until it is needed to be dropped down again where it will pass through a turbine that generates additional needed electricity. Future work on this project includes refining the experimental design and layout. Methods to do these tasks are by using solar panels, buckets with water, and tubing to

transport the water, along with using different generators, and turbines. In conclusion the water will transport efficiently from one elevation to another, and be able to flow throughout the system, generating electricity.

ADJUSTING YOUR RIDE

Joseph Conrad and Logan Breedlove
The Center for Advanced Technical Studies

The problem we are investigating is flywheel performance. We are attempting to create a type of flywheel that can perform the same abilities that both the light and heavy flywheels can't do by themselves. Our hybrid flywheel would have the performance of the light and heavy flywheels. Such as the light flywheels' ability to start off the line faster and increase the RPM quicker while also having the heavy flywheels' ability to start easier, ride smoother, and store more energy.

THE EFFECT OF PROLONGED TIKTOK USE ON YOUNG ADULT ENGAGEMENT IN RISKY BEHAVIORS

Kennedy Corbin
Spring Valley High School

The purpose of this study was to discern the negative effect social media, specifically Tik Tok, can have on young adult's behaviors and to bring awareness to the great influence social media can subconsciously have. Also, this study aimed to determine the correlation between prolonged usage of TikTok and the increase or presence of risky behaviors. It was hypothesized that since young adults that are high users/spend 10+ hours on TikTok are more likely to engage in risky behaviors. This is due to the fact that social media has been shown to broadcast these behaviors. This constant exposure can be very influential to the users own behaviors.(Amedie, 2015). Participants were asked a 5-10 minute questionnaire regarding their TikTok usage and risky behaviors. Participants fell into four categories based on their TikTok usage (control/non users, low user, medium user, and high user). A non user spends 0 to less than one hour weekly hours on the app, a low user spends 1-5 weekly hours on the app, a medium user spends 5-9 weekly hours and a high user spends 10+ weekly hours on the app. The participants were asked questions on drug and alcohol use, sexual behaviors, physical activity and truancy they have engaged in. A chi square test was conducted to determine the statistical significance of the findings. The data determined that the p-value was less than 0.001 ($p < .001$). This means that the hypothesis was rejected and the results were proven to not be statistically significant.

TO WHAT EXTENT DO ALA STUDENTS HAVE ASSOCIATIONS AKIN TO GRAPHEME-COLOR SYNESTHESIA WHEN COMPARED TO NON-ALA STUDENTS?

Dawson Coutsos
Chapin High School

Synesthesia is a mental condition in which two unrelated senses are linked in an uncommon manner, with there being over sixty varieties of the condition. It is present in approximately 2% to 4% of the population, and those individuals who have the condition were born with it. However, there are multiple studies that demonstrate the acquisition of associations similar to synesthesia in individuals born without the condition. With this acquisition comes certain cognitive advantages, with these advantages being synesthesia type specific. With grapheme-color synesthesia, which promotes a color relationship to varying graphemes, individuals have been found to experience a profound advantage in memory, allowing

for improved recollection of past events and information. Regardless of if studies of acquired synesthesia are valid, if a non-synesthete could successfully recreate the color associations of grapheme-color synesthesia, it is possible for them to have a similar memory advantage as nature synesthetes. The chosen focus group for this research is comprised of two groups of students in a South Carolina high school. One group belongs to the Academic Leadership Academy (ALA), a program which encourages students to pursue rigorous challenges related to both academics and leadership, and the other group will be derived from the general school population outside of the ALA program. After being tested by a survey known as the Synesthesia Battery, the goal of this research is to determine whether more synesthetes are present within or outside of the program.

THE EFFECT OF CANNABIDIOL ON LACTOBACILLUS ACIDOPHILUS

Xavious Coyle Vega
Spring Valley High School

An ineffective human microbiome that does not give proper health benefits can have many harmful effects on the person. Different types of bacteria can impact some that harm, some that help, and others that just take up space. Cannabidiol (CBD) is a phytocannabinoid that is anti-bacterial(Kosgodage et al., 2018). The purpose of this research is to find out if CBD affects the growth of bacteria that can be found inside the human gut microbiome which if proved it does, could impact health significantly(Kurzgesagt, 2017). It was hypothesized that Cannabidiol (CBD) would not impact the growth of the bacteria in a significant way where it would give data proving CBD to be harmful to the growth of the bacteria. The experiment was conducted over two weeks where Petri Dishes were prepped with bacteria 30 trials are control and the other 30, out of the population of 60, are a test group to which CBD will be added to. The results were found by using spectrophotometry and the concentration of the groups were compared in a Z-test. The mean absorbance for the results shows that the CBD lowered the concentration of bacteria in most of the test trials. It was found that there was a significant change in the concentration with a 1.645 Z-score. This supports that the hypothesis was wrong and CBD may have an impact on this specific species, but it does not support if the data is significant on the full microbiome human scale which has millions of species in itself.

REDESIGNING THE CONVENTIONAL PROPELLER TO IMPROVE FUEL EFFICIENCY

Pierceton Cruz
The Center for Advanced Technical Studies

The objective of this project was to explore the idea of creating a new propeller that would increase thrust and in return would decrease fuel use and therefore pollution. The hypothesis is that the new design will have a drastic impact on the aviation market and will be superior to previous designs. This would do this by the enhanced propellers was planned to continue by following the engineering design method. Research for the project was gathered from corporations including NASA. Approaches for collecting the data would be by building a testing device to gather data on its performance. No major test results or conclusions have yet happened because the project is not finished. Data will be put into graphs that would best express it. Due to what testing has taken place data regarding Angle of attack and propeller count has been distinguished. Future work regarding a new preferred aircraft fuselage shape may also occur if time permit.

DEGRADING PLASTICS: THE PETASE ENZYME VS. ITS MUTANTS

Elise Curran

SC Governor's School for Science & Mathematics

Interest in this research began with an interest in solving the enormous plastic waste problem in the modern world. The biggest problem with plastic is that it can take decades to centuries for it to degrade in the environment. Enzymes that break down plastic into molecules more digestible for nature are of interest for solving this problem. PETase (6ANE) can break down Polyethylene terephthalate (PET), which is a common form of plastic that is often used in bottles. Due to extensive research in this subject area, many mutations have been made of the 6ANE enzyme. The research's goal was to computationally compare the bonding energies of four PETase mutants and PETase with a 2-monomer polymer. This was done using a method called molecular docking. Docking is a computational modeling technique that predicts how an enzyme and small molecule interact. Docking was applied to all five of the enzymes using an exhaustiveness of 16 (the default is 8), which is somewhat proportional to the time the computer puts into searching for interactions. One mutant, 6KUS, had a significantly lower bonding energy than the rest of the enzymes. Computationally, 6KUS was the most effective out of all of the enzymes and even performed better than the original PETase. This means the enzyme could bind quicker and break down PET faster, which allows for more practical use of PETase.

AN APPROACH TO 3D PRINTING N95 MASKS

Parth Desai

Spring Valley High School

Masks are a necessary method of controlling the spread of respiratory diseases. However, due to SARS-CoV2 (the virus that causes COVID-19), the demand for masks has exceeded the present supply leading to the production of ineffective masks. Cotton masks and masks made out of other materials such as fabric or polyester have risen in popularity while not providing efficient protection. This has led to the investigation of alternative masks such as 3D printed masks. The goal of this experiment was to test the efficacy of a hypothetical 3D printed mask created in the FreeCAD software. A two-dimensional fluid analysis of the mask along with a face was done to evaluate whether the mask could be used. FreeCAD software was used to design a 3D printed mask. The mask was designed to be replicable to and proportional to allow for larger or smaller face sizes to ensure a secure fit. It was assumed that the mask had proper face fit. The design process showed that a mask can be made and reproduced for commercial use.

THE EFFECT OF SALINITY ON THE AMOUNT OF PHOSPHORUS BOUND BY ALUM IN WATER

Scott Dillon

Spring Valley High School

Alum (aluminum sulfate) is applied to lakes to mitigate the effects of eutrophication by binding phosphorus (P). This research intended to determine the effect of salinity on the amount of phosphorus bound by alum. It was hypothesized that alum would bind the least phosphorus at a salinity of 32 parts per thousand (ppt). Because a spectrophotometric determination of phosphorus was used, a P calibration curve was made by adding the reagent to distilled water samples of known P concentration and measuring the absorbances with a spectrophotometer at 690nm. The absorbances of NaCl standards were also found to ensure that salinity had no effect on the spectrophotometer. The samples were distilled water with a P concentration of 2 mg/L and a salinity of 0, 4, 16, or 32 ppt. An alum treatment of 5 mg/L was applied and the resulting absorbances were found using the spectrophotometric

determination process. Using the calibration curve, these absorbances were then converted to P concentration. The resulting P concentrations for each salinity level were at or slightly above 2 mg/L. A one-way ANOVA test ($F(3, 115) = 2.7, p = .05$) showed that there was a significant difference between the means. The Scheffe test showed that this was present between all comparisons except for 0 vs 32 and 4 vs 16 ppt. However, a conclusion regarding salinity's effect on alum could not be made because the alum treatment did not work as intended and no P was bound.

THE EFFECT OF 100% COTTON, 100% POLYESTER, 60% COTTON 40% POLYESTER, 100% SILK, 100% COTTON 100% POLYESTER LAYERED, AND 100% COTTON 100% SILK LAYERED MASKS ON THE FLOW RATE OF A MASK: A MODEL TO PREDICT WATER PERMEABILITY

Kathleen Dotson
Spring Valley High School

The COVID-19 pandemic has caused much debate over the use of homemade masks when in public places or with other people when surgical masks may not be available. The purpose of this study is to examine the flow rates of each mask in order to predict how water permeable they are, since an important factor in choosing an effective face mask is for it to have a low water permeability. It was hypothesized that the 100% cotton mask would yield the lowest flow rate, and therefore be the least water permeable out of all of the masks. In order to calculate the flow rate of each mask, each fabric was tied to a plastic water bottle with 100mL of water inside. The water bottle was turned upside down to allow the water inside to flow through the fabric. A surgical mask was used as the standard. After analyzing the results from the ANOVA and Tukey test, it was found that the masks had significant differences despite there being insignificant differences between some of the masks when compared in pairs, since the p-value was <0.01 . The 100% cotton mask had insignificant differences from the 100% Cotton 100% Polyester Layered mask, the 100% Cotton 100% Silk Layered mask, and the 75% Polyester 25% Spandex mask. Therefore, these four masks all have similar flow rates, meaning they work well as facial masks because they are the four least water permeable in the study.

EXAMINING VALENCE AND AROUSAL IN RELATION TO NATURALISTIC EMOTION IN VISUAL STIMULI

Nika Eichhorn and Jordan Veurink
SC Governor's School for Science & Mathematics

The two key components of the affective state examined in this project were valence and arousal. The authenticity of the stimuli as perceived by participants- e.g. whether an emotional response is acted/fake or authentic/real- is also a crucial component. This project attempted to explore valence and affect in relation to the authenticity of variables within purely visual stimuli. Valence assigned to audio-visual stimuli is highly arbitrary and can be drastically different between individuals; this is partly due to the individual's past associations and their influence on the perception of new stimuli. To avoid this, the audio tracks were removed from four-second clips of a person or people exhibiting a particular emotion. Video clips were sourced from YouTube and were controlled for the appearance of logos, text, brands, actions of the subjects, as well as perception of language through lip-reading or text. Through an online portal, participants were instructed on how to rate each stimulus for the emotion they thought was presented, intensity of arousal and valence across a 4 quadrant 2-axis graph, and how to rate a 1 to 9 scale for authenticity. Many aspects of this study were inconclusive due to the nature of removed interaction and research in compliance with COVID safety guidelines. This project is incomplete and the research is ongoing; however, the results of this experiment may have significant benefits for the psychiatric and

medical fields, especially in understanding conditions on the Autism Spectrum where authenticity is not perceived in the traditional manner.

REDUCING THE NOISE FROM PORTABLE ELECTRIC GENERATORS

Ismail Elsahli

The Center for Advanced Technical Studies

Portable electric generators are being used everywhere now, and are needed to supply power to objects that need electric power. Portable electric generators are noisy and could be improved. In this project, the question that is to be solved is how can portable electric generators be improved, specifically the fuel source? If there's different fuels in a generator such as a mixture of ethanol 85 and octane 93 for example, then the generator will make less noise and be more efficient because of that type of fuel and the way it burns. The generator will be set up with a different series of fuels and mixed fuels such as octane 87, octane 89, octane 93, ethanol 0, and ethanol 85 fuels. Some of these fuels will also become a mixture with each other and be tested. Next will be set up and collect quantitative data from my generator based on the sound of the generator in different trials. It will then run about 15 minute trials for each fuel type 3 times. The same with the mixture. If anything that doesn't run properly or anything that malfunctions, than that fuel or mixture's trial would be redone. The results so far were somewhat expected. The octane 89 performed the best overall in the distance tests. In this project, it was believed from the hypothesis that a higher octane than 87 would make the generator quieter. Mixtures have been proven to do well with portable electric generators in the past as well. This is a good starting point for future work later on, because the best fuel source is already figured out, and the generator can be modified based on these preliminary results.

THE EFFECTS OF INTRINSIC MOTIVATION ON ATHLETIC PERFORMANCE

Jesma Evans

Chapin High School

The purpose of this project is to analyze the connection between athlete goal disposition on the individual level and overall athletic success as a team. There is little prior research examining the effects of the goal disposition of individuals in a particular athletic team on overall team success, and thus the aim of this research project is to explore this gap in previous research. With the varsity high school athletic teams serving as selected groups and with goal disposition serving as the examined variable, this study uses a quasi-experimental design since it selects groups in which a variable is examined without random pre-selection processes, and it serves as a cluster sample as the individual participating athletic teams serve as individual clusters. A chi-square analysis has been used to analyze the data of the results of this study. Based on existing previous research, the hypothesis of this study claims that teams consisting primarily of individuals motivated by the task at hand (task-motivated) perform higher than those with large numbers of individuals motivated by outperforming their peers (ego-motivated), and analysis of the results of this study supports this hypothesis.

THE EFFECTS OF GOAL DISPOSITION ON HIGH SCHOOL ATHLETIC TEAM SUCCESS

Jesma Evans
Chapin High School

The purpose of this project is to analyze the connection between athlete goal disposition on the individual level and overall athletic success as a team. There is little prior research examining the effects of the goal disposition of individuals in a particular athletic team on overall team success, and thus the aim of this research project is to explore this gap in previous research. With the varsity high school athletic teams serving as selected groups and with goal disposition serving as the examined variable, this study uses a quasi-experimental design since it selects groups in which a variable is examined without random pre-selection processes, and it serves as a cluster sample as the individual participating athletic teams serve as individual clusters. A chi-square analysis has been used to analyze the data of the results of this study. Based on existing previous research, the hypothesis of this study claims that teams consisting primarily of individuals motivated by the task at hand (task-motivated) perform higher than those with large numbers of individuals motivated by outperforming their peers (ego-motivated), and analysis of the results of this study supports this hypothesis.

TO WHAT EXTENT DO THE LEVELS OF AMBIENT OZONE VARY THOUGHOUT DIFFERENT INDOOR SETTINGS WITHIN A SCHOOL FACILITY?

Mary Evans
Chapin High School

This report analyzes the different levels of indoor ozone throughout various indoor settings in a South Carolina High School. Indoor ozone is one of the most common indoor air pollutants, especially in schools and offices due to a greater number of residents in the building compared to the indoor square footage. This data will be collected using an Ozone Detector by Forensis, which is a device that detects the presence of ozone and the amount (in ppm or parts-per-million). The method of this study is ANOVA (Analysis of Variance), which is a statistical method that divides the data into different components to gain possible information between the independent and dependent variables.

THE EFFECT OF MINDFULNESS APPS ON THE AMOUNT OF TIME SPENT OFF-TASK ON THE PHONE

Tanner Evans
Spring Valley High School

Mindfulness apps are programs available on electronic devices that are meant to help relax one's mental state. While mindfulness apps are useful, their main issue is that, disregarding claims made by the various creators of the app, there is relatively little proof to guarantee the effectiveness of the apps. This experiment analyzed how mindfulness apps affect the time an individual spends on non-work-related programs on his/her phone throughout the work day. This process involved the study of 30 participants and the time spent off-task on their phones for one week without a mindfulness app, then doing the same after a mindfulness app session the following week. Based on the data, mindfulness apps were shown to have a significant impact on the participants' ability to focus, displaying an average of 23.1 minutes less on off-task programs after using Calm. The majority of individuals showed a decrease in off-task phone usage, with general day-to-day usage also decreasing by a significant margin. Participants, on average, spent about half an hour less time off-task on their phones after using Calm, a mindfulness app. The maximum amount of time spent off-task on a phone decreased by almost half an hour as well. These results indicate that mindfulness apps are likely to improve the user's ability to focus. Productivity

increases whenever an individual is able to avoid becoming distracted and can focus. If evidence of the effectiveness of mindfulness apps is displayed, then a larger number of individuals may incorporate the apps into their lives.

ENDOTHELIAL CELL DERIVED EXTRACELLULAR VESICLES AS NOVEL BIOMARKERS FOR ACUTE RESPIRATORY DISTRESS SYNDROME

Kevin Fan

Academic Magnet High School

Sepsis is defined as life-threatening organ dysfunction caused by a dysregulated host response to infection. Acute respiratory distress syndrome (ARDS) is a secondary disease that may follow sepsis and is characterized by inflammation, increased vascular permeability, and endothelial cell dysfunction, and patients with severe cases of COVID-19 commonly develop ARDS. Currently, there are no approved pharmacological treatments or reliable biomarkers for ARDS. Extracellular vesicles (EVs) are membranous microvesicles secreted from the endosomal compartments or plasma membranes of cells. 22 healthy controls and 85 ICU-administered sepsis patients enrolled in this study, 21 of whom developed ARDS. Since endothelial cell damage is a hallmark of ARDS, endothelial-cell-specific EVs were isolated from the blood plasma of these patients using biotinylated CD31 and CD146 antibodies and streptavidin resin. Measurements of caspase-1, mitochondrial DNA (mtDNA), and microRNA-126 (miR-126) levels in these cells subsequently followed. We chose caspase-1 and mtDNA for their significance in pyroptosis and miR-126 for its importance in maintaining cellular homeostasis. Our data demonstrated that caspase-1 activity significantly increased in ARDS patients compared to sepsis non-ARDS patients and healthy controls, and miR-126-3p levels significantly decreased among ARDS patients, while miR-126-5p levels did not differ among the three groups. Furthermore, mtDNA levels were lower among ARDS patients compared to both non-ARDS sepsis patients and healthy controls, which constitutes a novel finding. These findings demonstrate that EC EVs could be used as a biomarker for early ARDS diagnosis and that caspase-1 and mtDNA may contribute to ARDS development as well.

THE ETHICS OF BOXING: LINKS BETWEEN HEAD TRAUMA AND NEUROCOGNITIVE IMPAIRMENTS

Cierra Felder

The Center for Advanced Technical Studies

The boxing arena has been plagued with controversy surrounding the health of its athletes. Similar to how CTE became widely recognized in American Football. Injury has remained the direct result of boxing yet an accident in all other sports. Head trauma in boxing is unavoidable, however, the boxing community will be safer when the risk has been decreased. 90% of boxing participants have had some degree of head trauma and between 15%-40% of ex-boxers have shown symptoms of CBI. It takes years, even decades for symptoms of neurological damage to come to the forefront. If more people are aware of the ethical concerns of boxing then they'll be willing to adhere more to safety precautions. This study focused on surveying participants from boxing gyms that allowed sparring and asked for their input of the use of safety equipment, concussions, and ethical concerns. This method was used to receive strictly participant opinion. It is expected that the dependent variable will lean in a positive direction, open to changes in the sport for athlete wellbeing and health. The goal of this project is to encourage athletes to disrupt the connection between head trauma and neurological diseases by assessing their willingness to essentially change the game.

IDENTIFYING AND ANALYZING GENOME SEQUENCES OF POTENTIAL BIOSYNTHETIC GENE CLUSTERS (BGCs) FROM TEN DIFFERENT STRAINS OF STREPTOMYCES TO PRODUCE A NOVEL ANTIBIOTIC

Tiffany Felix, Ananya Hota, Arija Makela-Harms, and Kaylin-Mahal Smith
SC Governor's School for Science & Mathematics

Microbial organisms are known for generating secondary metabolites such as antibiotics. Due to the rise in the number of antibiotic-resistant pathogenic bacteria, there is a need for identifying secondary metabolites for drug development. One way to identify a novel drug is to study microbial Biosynthetic Gene Clusters (BGCs). A BGC is a group of genes that code for enzymatic pathways that create specialized metabolites, which provide the microbe specific evolutionary advantages. The goal of this research is to perform a computer analysis to analyze, compare, and identify various BGCs and their enzyme domains of ten specific Streptomyces species with known BGCs to identify novel domains in each species. The genome sequence of each strain was obtained from the NCBI website and was then uploaded onto AntiSmash software program which mines the sequences of the ten strains to identify BGCs. This analysis compares the BGCs of these species with known BGCs and the various enzyme domains in each one of them. These mined BGCs were then compared using Cytoscape program which collected the known BGCs from MIBiG software, and then integrated this information into spatially arranged, potential molecular pathways. The preliminary results indicate that each strain of Streptomyces had the enzyme domain to generate terpene intermediate, but chemical analysis could not be done due to pandemic constraints. The identified BGCs may be useful for drug development but further chemical analysis using liquid chromatography (LC) and mass spectrometry (MS) is needed to determine the potential of the unknown BGCs.

THE EFFECT OF MITIGATION METHODS ON THE PHOSPHORUS AND NITROGEN LEVELS OF RUNOFF

Christopher Ferguson
Spring Valley High School

The Effect of Mitigation Methods on the Phosphorus and Nitrogen Levels of

Runoff: Currently, runoff rich in nitrogen and phosphorus is harming the Gulf of Mexico's aquatic ecosystems. As such, the purpose of this project was to establish a cost-effective method of reducing the nitrogen and phosphorus levels in runoff by examining steep inclines and grass hedges. It was hypothesized that both of these methods would be significantly effective in detoxification. Four slopes were created for experimentation: 61.0° slope without grass, 61.0° slope with grass, 48.6° slope without grass and 48.6° slope without grass. It was hypothesized that the 61.0° slope with grass would be optimal. Each day, the plants atop the slopes were watered, causing their runoff to flow into their respective reservoirs. Samples were then collected from each reservoir and tested for nitrate, nitrite and phosphorus content. Ultimately, the hypothesis was not supported. Though the 61.0° inclines were more effective at detoxifying runoff than the 48.6° slopes, the same could not be said for grass hedges, which only seemed to increase the toxicity of runoff. Two Two-way ANOVAS, one for nitrate [$F(1, 44) = 23.32, p < 0.001 < \alpha = 0.05$] and another the nitrite [$F(1, 44) = 23.32, p < 0.001 < \alpha = 0.05$], reveal the results to be statistically significant.

CREATING ENVIRONMENTALLY FRIENDLY SOAPS FROM WASTE BIODIESEL GLYCERIN

Javier Fernandez

The Center for Advanced Technical Studies

The purpose of this study was to develop a bar of soap created from naturally sourced ingredients and biodiesel glycerin. The end goal of this project is to provide a bar of soap that is healthy for all skin types while avoiding using harsh chemicals like benzaldehyde, benzyl acetate, sodium laurel sulfate (SLS) and ethanol, which are found in commercial soaps. In the proof of concept phase of this project, bar soaps created with different oils (olive oil, coconut oil, etc) were made to determine the best blend of ingredients to incorporate with biodiesel glycerin. Various tests were performed to determine the pH and how curing time affects the quality. Future tests will be done to determine the effectiveness of the soap and the longevity. I expect this experiment to have an outcome of having a long lasting and properly saponified bar of soap that is made with biodiesel glycerin, natural oils and fats.

THE EFFECT OF DIFFERING LEVELS OF ZOPHOBAS MORIO INFESTATION ON BETA VULGARIS GROWTH

Isabella Fettig

Spring Valley High School

Pest infestations are a major problem in areas of the world that contain farm land. Beta vulgaris, beets, and Zophobas morio, superworms, are one type of plant and pest that are seen in the midwestern region of the United States. It was hypothesized that the damage done is centered around the roots and/or leaves of that plant. This hypothesis was tested by growing plants and adding different numbers of Zophobas morio for each of the four trials. However, exactly what kind of damage is caused by certain pests is unclear. The damage done by Zophobas morio in this study centered around the leaves and base of the stem. It was found through a one way ANOVA that there was significant data ($p=0.0058$) that led to a rejection of the null hypothesis. Because of this, a Tukey test was then performed to find the significance between each group. The results showed that differing levels of infestation significantly affected mortality rates of the plants that were being grown.

THE EFFICIENCY OF A SOLAR POWERED CAR

Edward-Jaydon Findley and Joshua Burton

The Center for Advanced Technical Studies

During the experimentation of the project, the group has found out that if you make slight adjustments to the wheel bearings, axle, and a number of solar panels the wooden car could travel at a greater velocity and travel a greater distance. We also discovered that by changing out the solar panels we were able to achieve a greater power output than the original design. While conducting the experiments we noticed the lack of fluidity of the wheels in the base model so the group decided that when we create our own model to add lubricant to the wheels to help the wheels move freely. We also discovered that the solar panel that came in the box with the other parts was pretty weak, so we exchanged it for a solar panel we bought online. After switching them out, we were able to see a distinct difference in power. When we created our own model we decided to make the chassis out of birchwood so it could be easily pliable while still holding its strength. We also increased the wheel diameter to increase the distance the car can travel without having to increase the power of the car.

LEARNING IN MADAGASCAR HISSING COCKROACHES

Georgina Fitzmaurice

SC Governor's School for Science & Mathematics

The purpose of this research was to display learning in hissing cockroaches and to see if ideas such as behaviorism, like habituation and classical conditioning, are the same in a wide variety of animals. To effectively use comparative psychology and eventually figure out why humans learn and behave certain ways. In the experiment, eight cockroaches were collected randomly and set on a heating pad, then moved to the experimental apparatus, the stimulus (scent extract of peppermint or orange) was presented, and then the subject was picked up and observed to see its response (hiss and movement). Each trial was 30 minutes apart with eight trials per subject and one preference test (both scents placed in each end of container and reactions recorded for five minutes). In the experiment, habituation has occurred during the US (unconditioned stimulus of them hissing) and post time period which is good, but the bad part is that they didn't do much else and learning has not occurred. In conclusion, all the experiments conducted show that Madagascar Hissing Cockroaches are unable to show learning. Although we do not know why this is, our next step would be to see what exactly it takes to get the hissing to learn for future comparative psychology research.

EFFECT OF TECHNOLOGY-ASSISTED OFFICIATING IN SPORTS COMPARED TO HUMAN OFFICIATING

Wesley Fletcher

Spring Valley High School

Controversy has long existed around officiating in sports, due to the frequent error made by referees. Early developments of technology-based officiating have been utilized in an attempt to fix this issue. The purpose of the study is to determine how significant referee error is, specifically in the National Football League. It was hypothesized that there will be significant difference in the accuracy of NFL referees given different crowd sizes due to the COVID-19 pandemic. Samples of 30 games from each of the 2019 and 2020 NFL seasons were taken to identify how important each type of penalty is, calculated by expected points. Expected point values were gathered from Pro Football Reference. To determine the accuracy of referee decisions, NFL Game Pass was used to watch and analyze pass interference calls from each year, due to its importance as a penalty. It was found that the most critical penalty in 2019 was defensive pass interference, which affected the game by 2.05 points per penalty. The most commonly called penalty in 2020 was overwhelmingly false start, most likely due to random sampling variation. A review of 22 pass interference calls from each of the 2019 and 2020 seasons found that 19 were called correctly in 2019, and only 16 in 2020. The null hypothesis, stating that these proportions are equal, was not rejected, with a p-value of 0.131 at a significance level of 0.05. The study hypothesis was not supported. The small sample size of penalties may have created error in the data, and the sample size would be increased, as well as more types of penalties being included, if this study was redone.

SNUGBUG; AN INNOVATION TO IMPROVE THE COMFORTABILITY OF PREMATURE INFANTS IN THE NICU

Savannah Folding

The Center for Advanced Technical Studies

This innovation was created for premature infants who spent time in the neonatal intensive care unit. Being in the NICU can be very overwhelming for the infant, so it is important that they have a sense of comfort. It makes the jobs of NICU nurses and parents of the infant, easier. Being born prematurely from failure thrive is the motivation behind this project. This issue can affect the infant's whole life and alter

ways of living, which makes it very significant. The goal of this innovation is to cause an internal change within the infant to promote peace and tranquility for the infant while in a chaotic environment. Building this innovation has taught time management skills as well as sparking creativity. The materials needed include cotton material, an isotonic pillow, heating and cooling controls, a vibration pad, and most importantly, a sewing machine. These materials are used in hopes of creating a calming environment for infants in the NICU. This innovation was evaluated by NICU charge nurse, Dr. Jessica Ravenell of Baptist Hospital in Columbia, South Carolina. She gave critiques, suggestions, and concerns on how this innovation could work. She was vital for the development of this innovation. She believed it had the potential to be great, therefore the evaluation goals were successful. There is another design being created that is similar to the original design but has the same goals and values. The SnugBug was created to improve the comfortability of premature infants in the neonatal intensive care unit.

TESTING FOOTBALL HELMETS' ABILITY TO ABSORB SHOCK TO DECREASE CONCUSSIONS AND PREVENT CTE IN ATHLETES

Nikki Frattaroli and Nina Frattaroli
The Center for Advanced Technical Studies

The goal of this research is to determine which helmet is the most effective by observing how each absorbs shock. The hope is that the results will lead high schools to implement the helmet proven the safest, and reduce the risk of CTE. The hypothesis states: if the Schutt, Riddell, and Vicis helmets are tested using shock absorption, then the Vicis helmet would be the most effective due to its enhanced structure. This study is similar to the NFL Helmet Testing such that the methods are similar where a drop test was performed at different heights: 24, 48, and 72 inches. However, temperature is also considered where the same drop test will be performed at a constant 48 inches at temperatures of 32oF, room temperature, and 100oF. The dependent and independent variables are the shock indicators stimulated and the different heights and temperatures, respectively. The current finds proved the Vicis helmet to be most effective in height in that the upward force was only stimulated at 25g's for most trials. The Riddell is second because more directional forces were stimulated at 25g's. The Schutt is last because 100g's was stimulated at 48 and 72 inches. Due to the lack of indicators stimulated for Vicis, this helmet performed more efficiently. In the near future, the expected results for the temperature data are predicted to be the same as the height data. Overall through testing, the data will suggest which helmet should be implemented to athletes to protect them from head trauma.

DISCRETE FIDGET BRACELETS: JEWELRY DESIGNED TO HELP FOCUS AND CALM ANXIETY

Delaney Freeman
The Center for Advanced Technical Studies

The Discrete Fidget Bracelets are designed to help people with ADHD, Anxiety, and other fidgeting related disorders to focus and calm down. This is important because it is not obvious and is not distracting. The bracelets will impact people who struggle with having the need to fidget in order to focus. The motivation is a friend with epilepsy, she carries around a blanket with different textures on it to help her stay calm after episodes. She feels embarrassed to carry around a big blanket everywhere and tried fidget bracelets that felt embarrassing too. It is important because many public schools ban fidget bracelets since they are seen as distracting to other students and many require hand-eye coordination. These bracelets will be discrete and as well as not requiring hand-eye coordination to use them. These bracelets will be allowed in schools and will not be seen as a distraction to these schools. Two designs of bracelets have been made, one being a scrunchie with an elastic band inside made of a velvet fabric. These have magnets inside of

them that users can play with. Another design created was a strip of magnets on an elastic string that can be wrapped around itself and worn in different ways. A survey was released to learn about people's personal fidgeting habits. The results showed that many people mess with anything they can around them - especially bracelets, necklaces, etc. The plan is to make more designs to reach a wider audience. These discrete fidget bracelets will help students and other users stay focused and calm their anxiety in public and at school.

WATER FILTRATION

Sullivan Funk and Dylan Williams

The Center for Advanced Technical Studies

Our engineering goal was to design an efficient water filter that suits the needs of people who travel into the wilderness, take camping trips in general, or even just for at-home use in third-world countries. Our plan was to make a bio stove that both distills and produces biochar. Once the water is distilled it will filter through the biochar reactor to remove any remaining volatile organic compound contaminants. The stove design utilizes a gasification stop configuration. The design produces its own filter material. We had to be able to succeed for a group of two individuals (recommended amount per day) by Healthline.com. The filter's success was very dependent on the water tests coming back negative for contaminants. We will know the water quality is safe to drink based on the water tester kit that we used.

CAN HOME-MADE BIOCHAR EFFECTIVELY FILTER WATER

Sullivan Funk

The Center for Advanced Technical Studies

This project's objective is to find if homemade biochar is effective at filtering water. The research compares homemade biochar against commercial activated charcoal as well as commercial biochar. The build of this project consists of a 3.5 gallon bucket to house the active ingredients and a sieve to accelerate the filtration process. The active ingredients are the different types of charcoal/biochar, sand, and filtration gravel. Success is determined by the cleanliness of the water measured using a water testing kit. Current results suggest that biochar is effective at removing artificial coloring from water. In areas of the world clean water is scarce, a biochar filter can easily be made therefore helping these areas. The findings of the project are ongoing and will continue to grow.

STUDY OF AN ETHENE HYDROGENATION REACTION ON A NICKEL OXOCLUSTER CATALYST USING DENSITY FUNCTIONAL THEORY

Justin Furgala

SC Governor's School for Science & Mathematics

A recent abundance of shale gas has shifted efforts back to converting natural gases to liquids for fuel and chemical use. However, this time consuming process cannot be done without the help of catalysts. The primary objective of this research is to find a more energy efficient approach by using Density Functional Theory (DFT) calculations. We believe that by using a small metal oxocluster, we can find the best metals for the extraction process in a fast and efficient way. To conduct this research we used Density Functional Theory, which is an approximate quantum mechanical method to obtain the energies of a molecular system. Using the Clemson supercomputer, we obtained the Gibbs Free Energy values for the singlet and triplet states of my compound. After the calculations had finished we found that the triplet state had a

higher energy barrier than the singlet state at every reaction. When comparing the small and large cluster, there were only three instances where there was a discrepancy of 50 KJ/mol or more. This gives evidence that the two clusters are linked in some way. This possible correlation will help us continue the research and determine if the models are actually connected, meaning that the cluster with less atoms will make similar predictions in much less time than the larger cluster. This will help us decide which metal acts as the best catalyst in the natural gas extraction process, ultimately leading to a more efficient system.

WHICH TUBE IS THE BEST FOR USE IN SOLAR THERMAL WATER HEATING

Geraldo Gambaloza

The Center for Advanced Technical Studies

This research is about what kind of tube is the best for solar thermal. The metal tube will conduct more heat than the rubber type. Use the same material that used to the other tube to see if what kind of tube is better. Exposing both tubes to the sun with exact time and measuring the water temperature. The equation for heat transfer is $Q = m \cdot c \cdot \Delta T$. Q is for heat transferred, m is for the mass, C is for specific heat, and ΔT is for delta temperature. People who have trouble getting hot water. The conclusions of this study so far indicate that both tubes will do great, but there is a tube that will step up.

EXPLORING HOW TO MERGE AN ASPIRATION THROMBECTOMY DEVICE AND A ROTATIONAL ATHERECTOMY DEVICE FOR EFFICACIOUS INDIVIDUAL OR JOINT REMOVAL OF THROMBI AND PLAQUE THROUGH IN-VITRO TESTING

Shyam Ganesh babu

Spring Valley High School

Endovascular occlusive diseases are among the leading causes of death around the world. Specifically, thrombosis is responsible for 1 in 4 people dying worldwide. Atherosclerosis is the underlying cause of about 50% of all deaths in westernized society. The purpose of this research was to improve on existing atherectomy and thrombectomy technology by producing a device that can conduct an atherectomy or thrombectomy independently or simultaneously. The goal of this research was to design, construct, and test an efficacious and safe joint rotational atherectomy and aspiration thrombectomy device. The device was designed using 3D-models and constructed using balsa wood, metal tubes, DC-motors, 3D-printed parts, wires, batteries, and surgical tubes. To test the device, a mock aspiration thrombectomy and rotational atherectomy were performed in a model blood vessel using model blood clots and plaque, respectively. The joint device was successful and increased the lumen diameter of blood vessels obstructed with blood clots or plaque. The mass of the blood clot present within the model blood vessel decreased, on average, from 206.66 grams to 0.00 grams, meaning 100% of the blood vessels were cleared. The plaque lumen diameter increased, on average, by 346.67% by the end of each procedure. It was concluded that such a joint device can effectively remove blood clots and plaque from blood vessels simultaneously or independently from relatively large blood vessels and is applicable in medical institutions.

COST BENEFIT ANALYSIS OF SOLAR PHOTOVOLTAIC PORTABLE POWER BANKS

Griffin Ganis

The Center for Advanced Technical Studies

Is it possible to build a more cost effective solar power bank than those currently on the market. Yes, more cost effective solar power banks than those on the market currently is possible to be built. To get results, first get charge times from the solar power banks on the market. Build solar power banks using materials that keep the cost down. Then, test the charge times of the solar power banks. Results so far, include the charge times of the solar power banks on the market. From the data collected from those trials improvement in charge times can be done by the solar power banks built. Concluding off of data collected that the solar power banks built can in fact have better results. The data collected leaves a lot of room for improvement on charge times from the market solar power banks tested.

GENERATING TRAINING DATA FOR CONVOLUTIONAL NEURAL NETWORKS TO AUTONOMOUSLY NAVIGATE UNDERWATER STRUCTURES

Samuel Garcia, Son Nguyen, and Amelia Stensland

SC Governor's School for Science & Mathematics

Manual exploration of underwater shipwrecks is dangerous, time consuming, and expensive. Using the Convolutional Neural Networks (CNN), the USC Field Robotics Laboratory established the viability of using a Neural Network to train the Aqua2 robot to automatically navigate through underwater structures. However, the limits of such an algorithm is that the dependent on data used to train the algorithm; because of the size of the dataset and the complexity of the task, an accuracy rate of only 80% could be achieved. However, this can be remedied by increasing the amount of data to train the CNN. Using video footage of the Aqua's manual exploration of the Stavronikita Shipwreck alongside a defined decision matrix, a human generated training dataset was created by student researchers; using frames the videos as the inputs and the indicated direction by the user as the output, training data for the CNN was generated. It is hypothesized that this larger and more well-defined dataset would yield a greater accuracy rate, with an ideal rate of 85% or greater. If this accuracy rate is achieved, then field testing of the Aqua2 robot can be conducted. Additionally, the research team will develop a newer version of Convolutional Neural Network in later stages of research. Thus far, the research has shown that the autonomous mapping of 3-D underwater environments by a robot is possible, though the practical viability of such methods still needs to be investigated though field testing.

EVALUATING INHIBITORY EFFECTS OF ANTI-SIGLEC-8 TREATMENT ON SIGLEC-8 EXPRESSING JURKAT CELLS

Haleigh Gartner

SC Governor's School for Science & Mathematics

The Siglec-8 receptor naturally exists on only two types of cells: mast cells and eosinophils. Siglec-8 identifies allergens and causes the cell to degranulate. Allakos has worked on creating a treatment for this, an antibody targeting Siglec-8, called 2E2. We want to further study the inner workings of Siglec-8, therefore, having an easily accessible cell line with functional Siglec-8 on it would be extremely useful. My project was to see if Siglec-8 would be functional on Jurkat cells. We first transfected Jurkat cells with varying amounts of Siglec-8 DNA plasmid and determined an appropriate concentration. Next, we attempted to activate wild type Jurkats using a variety of anti-CD3 stimuli, including CD3/28 beads and soluble CD3 both alone and crosslinked with secondary. Then, we attempted to internalize Siglec-8

transfected Jurkats using 2E2 treatment. Finally, we attempted to stimulate Siglec-8 transfected Jurkats using the stimuli above and inhibit activation with 2E2. We found that Jurkats respond to Siglec-8 transfection successfully, soluble CD3 alone induces the greatest activation, and Jurkats have moderate internalization of Siglec-8. However, no inhibition of activation via Siglec-8 was seen in transfected Jurkats using the anti-Siglec-8 antibody. Further steps in this research would be to obtain a clonal Jurkat population and to further optimize Jurkat activation.

MECHANICAL AID FOR THE ELDERLY
Joseph Gentry and Tristan Thompson
The Center for Advanced Technical Studies

As it is with many people, we drop things; as we are in a constant battle with gravity. No problem for the most part, however, some people cannot say the same. Many people worldwide have an incredibly hard time picking objects off the ground without either hurting, endangering, or even incapacitating themselves in attempts to retrieve an object on the ground. Usually, those who are older. We are going to combat this. Our product is a grabber, which we have optimized and automated so that it can be easily used by the elderly. This product combines many different concepts. The grabber mechanism itself is a suction-like device that is operated by a vacuum pump, the vacuum pump removes air from ground coffee in a balloon. Causing it to harden around the object that is being retrieved. As for the arm we have devised a string and reel system that retracts, like a true human arm and makes the object easily retrievable as it comes to the user. This is operated by a rotational servo motor, which reels in the string thus bringing the arm up as it breaks with a hinge. Our product attaches to a walker or wheelchair so that it is always there for them in case they drop something. Overall this design has been constructed specifically so that anyone who may have trouble retrieving a dropped item off the ground can do so easily, and efficiently without endangering themselves.

A MICROWAVE SPECTRAL ANALYSIS OF TRANS-2-PENTENAL
Emily Geraghty and Elic Weeks
SC Governor's School for Science & Mathematics

We measured the microwave spectrum of trans-2 pentenal to identify the constants that defined the shape of the molecule. We measured the spectrum from 8,000 MHz to 18,000 MHz using a total of 10,000 averages. Using our spectrum and comparing it to the theoretical spectrum, which was generated by Gaussian 03W software, we started assigning lines, a process where we took the theoretical lines, and compared them to the gathered data. We found the following constants: $A = 11512.80(50)$ MHz, $B = 1530.71560(78)$ MHz, and $C = 1374.26930(77)$ MHz. We also found the distortion constants which will be discussed in the presentation. The A, B, and C rotational constants are related to the shape of the molecule while the distortion constants are related to how “stretchy” the molecule is.

THE IMPACT OF COURSE LOAD DIFFICULTY ON THE STRESS LEVELS OF HIGH SCHOOL STUDENTS

Kylie Gilbert
Chapin High School

Over the past two decades, the topic of mental health in correlation to higher achieving students in specialized academic programs, such as International Baccalaureate and CollegeBoard's Advanced Placement program, in comparison to general education students has been studied in detail. However, little research has been conducted regarding the effects of an overall individual course load difficulty on student stress levels. This study investigated this gap as it conducted research dealing with the question: "To what extent does course load difficulty impact the stress levels of high school students?" The study collected quantitative data over a period of seven weeks through the use of surveys completed by high school juniors and seniors, between the ages of 16 years-old and 18 years-old, with varying degrees of course load difficulty. Afterwards, a linear regression t-test was used to analyze the collected data. The results indicated that students with partaking in more difficult courses often experience greater levels of stress compared to students with lower levels of course load difficulty. In conclusion, further research should be conducted with regards to the consequences of higher levels of course load difficulty — increased workload, sleep deprivation and burnout— that might result in increased stress levels.

DIG DEEPER: HOW CHEMICALS IN COMMON PESTICIDES ACT ON THE SOIL FAUNA IN RELATION TO ABUNDANCE AND DIVERSITY

Mary Abigail Gorospe
SC Governor's School for Science & Mathematics

Soil fauna are essential to the breakdown of plant and animal remains and restoring the nutrients to the soil, which contributes to the structure of the soil. The diversity and abundance of the soil fauna is affected by several elements such as thatch, how often the lawns are mowed, pesticides and fertilizers, the types of trees and grass grown there, and whether or not there is a garden kept. Soil samples were taken from two different lawns that are kept in the same manner, one treated with pesticides while one was not. The fauna was collected from the samples and separated by species. After all of the organisms are separated, each was then placed under the microscope for further examination. We were comparing and contrasting the total abundance of the two collections and the diversity of the fauna collected. With results that are currently inconclusive when a statistical t-test was conducted, this research needs more trials, samples, and improved methodology. In the future, this research can be used to create pesticides and fertilizers that are more sustainable for the environment and the organisms living within. With new pesticides and fertilizers, we can then keep the fauna healthy while maintaining the healthy grass and trees as wanted. This research is just the beginning of building a healthier and more sustainable way to achieve the same results of appearance of lawns.

THE EFFECT OF VARIOUS AQUATIC PLANTS ON THE PURIFICATION OF HYDROCARBON POLLUTED WASTEWATER

Vijay Gottipaty
Spring Valley High School

Hydrocarbon pollution has become an increasing problem over recent years and has had devastating effects on both terrestrial and aquatic ecosystems (Wolverton, 2013). As a means of solution for this rising issue, water purification methods have been developed to reduce this pollution. The purpose of this experiment was to use various types of aquatic plants such as Duckweed, Water Hyacinth, and Water

Lilies to purify water polluted with hydrocarbons. The hypothesis was that the Water Hyacinth would have been able to purify the polluted water in 24 hours. This was hypothesized due to previous data which showed that the Water Hyacinth was able to purify different pollutants more effectively than other aquatic plants. For this experiment, four, eight quart plastic containers were filled with five liters of pond water of which one milliliter of gasoline was added to each container. Afterwards, each plant was prepared for their individual optimal growing conditions and placed in the containers. The control group received no plant. The plants were allowed 24 hours to purify the water where the concentration of the gasoline was recorded before and after experimentation. A One Way Anova Test was used to determine a statistical significance between the data. A calculated F value of 175.427 showed to be larger than the F critical value of 2.76, which deemed that there was a statistical significance in the data. A further determination with a post-hoc Tukey test showed that the significant difference lied within the Water Hyacinth group.

VERTICALLY INTEGRATED BED FRAME
Kameron Green and Joshua Carlson
The Center for Advanced Technical Studies

The problem of our project is that people are needing to access items under their bed. The elderly are not as mobile or as strong as younger adults to be able to get down or even lift a bed to get a valuable item or something in general that is dropped under or placed under the bed. Taking into consideration the weight of a bed and back strain possibly caused, we are designing a vertically adjustable bed frame for people around the world who are constantly needing to easily access items under their beds.

POLITICAL SOCIALIZATION IN TEENAGERS: TO WHAT EXTENT DO SOCIALIZATION AGENTS INFLUENCE
THE POLITICAL DISPOSITIONS OF ADOLESCENTS AGED 14-18?

Luci Green
Chapin High School

Political socialization, the process by which individuals become acquainted with politics and form their own political values and beliefs, is primarily based on the information provided by socializing agents (e.g., friends, family members, public figures). This study seeks to explore the extent to which these influences may shape the beliefs of adolescents, considering the rapidly evolving state of political affairs and means of socialization over time. It was hypothesized that there would be a strong association between the political dispositions of the individual and those of their primary sociopolitical influences; in other words, an individual would be more likely to share similar political beliefs with close familiars. A survey was distributed to high schools within a southeastern United States school district via a voluntary cluster sample, in which students self-reported their own political beliefs as well as those of their sociopolitical influences. With 153 collected responses, there seems to be a fairly strong association between the beliefs of influencers and an individual. Additionally, close peers within an adolescent's social circle seem to be the most prominent influence on students' political opinion. Contrary to what was hypothesized, however, the heterogeneous nature of one's political environment indicates that many listed social factors are not so crucially influential, based on a considerable amount of "mixed" or "moderate" responses. Further research in this field may be conducted to more thoroughly explore political socialization and the development of political ideologies in adolescents.

THE EFFECT OF PESTICIDES AND HERBICIDES ON THE GROWTH OF SPINACIA OLERACEA FROM THE PRODUCTION OF ALLELOCHEMICALS

Nidhi Guntupalli
Spring Valley High School

This study investigates the effect of pesticides and herbicides on the production of allelochemicals. Allelochemicals can be both toxic and beneficial to its surrounding environment. The toxicity of the allelochemicals can damage the plant closest to it, by affecting inner processes of the nearby plant. It was hypothesized that the BioAdvanced pesticide trial would decrease the allelochemical production in the duckweed the most, causing the height of the spinach plants to grow the most compared to the control group, the group with no pesticide or herbicide added. The production of allelochemicals was inferred by measuring the height of spinach plants that grow along with duckweed, a plant that releases toxic allelochemicals. Using two hydroponic kits, the corresponding pesticide/herbicides were added to the water, along with nutrient solution in each trial. A one-way ANOVA test was conducted and resulted in $[F(3, 44) = 22.98, p < 0.05]$. A post-hoc tukey test was later performed after the ANOVA test presented a significant difference. The tukey test showed that there was a significant difference between the groups. The results did not support the hypothesis, because it showed that RoundUp group had a greater mean, meaning that the spinach plants were taller. This displayed that the allelochemical production decreased with the RoundUp group. The only significant differences were found between the control group and RoundUp, RoundUp and BioAdvanced, and RoundUp and Sevin Dust. The results of this study can further improve the understanding of how allelopathy can affect non-allelopathic plants.

NEURAL NETWORK REINFORCEMENT LEARNING FOR SIMPLE GAME PLAYING

Nitin Gupta
SC Governor's School for Science & Mathematics

The purpose of our research was to learn the basics of neural networks and network-based reinforcement learning. Furthermore, to exercise this learning, we played with some simple image classification tasks and trained AI that played simple games. The understanding of this topic is very important in this day and age as everything around us, from social media to automobiles, is getting automated and this is achieved through machine learning. Our research methods consisted of learning about neural networks and convolutional neural networks. We also learned some basic linear algebra and calculus which helped us understand the gradient descent method of training networks. Using this knowledge, we were able to learn about Markov Decision Processes and State Value Functions under the bigger picture of machine learning. Using this research, we were able to make an AI that could beat the game of Pong from the Atari console. We were also able to solve simple Grid World environments. We did approach the idea of beating another game called "QWOP", and also solving other, more sophisticated, Grid World examples, but due to the time constraints, we were not able to fully conduct research in that area. These aforementioned results serve as a basic understanding of the concept of machine learning and while we do have a long way to go before understanding the machine learning involved in making a self-driving car, this research proves as a great stepping stone for anyone to reach that milestone in the future.

DEVELOPING A MOBILE FLOOD WARNING APPLICATION FOR THE CHARLESTON, SC REGION

Raviteja Guruvelli and Jacob Nichols
SC Governor's School for Science & Mathematics

We are experiencing the oncoming effects of global warming, and this is especially prevalent in coastal cities where frequent flooding of the city's roads and property are flooded by rising tidal levels. This problem is no stranger to Charleston, SC where flooded roads and areas pose a hazard for drivers and pedestrians. Funded by the South Carolina Sea Grant Consortium, this project's goal is to develop a map application that shows current and predicted street flooding levels in the Charleston area, so that the public, first responders, and municipalities may use it to prevent hazardous encounters and safely navigate the county during tidal flooding. The project focuses on mining, cleaning, and analyzing data for use on cellular phone app from multiple sources of tide and precipitation data, using data science and engineering processes. Considerations included data from the National Oceanic and Atmospheric Administration, the National Weather Service, crowdsourcing websites, and proprietary agencies. Data were chosen based on factors such as accuracy, resolution, and refresh frequency. After collection, the data is reorganized for use in an ArcGIS environment—software allowing for the creation of interactive maps. Python scripts using Pandas were integrated within layers of an ArcGIS WebApp, and all of this allows for the user, through the graphical user interface, to view current and future flood level information from storm surges, tropical cyclones, and other weather phenomena. The app is still under development but hopes to achieve an independent platform that can be downloadable by users in the future.

COLOR, LIGHT, AND SOUND THERAPY FOR ALZHEIMER'S PATIENTS

Emma Gutshall
The Center for Advanced Technical Studies

This engineering project was meant for Alzheimer patients that have plaque build up in the brain. Her motivations generated from seeing her friend's family struggle with the death of a loved one who had Alzheimer's. Alzheimer's also runs in her family's medical history on her mother's side. The experiment that was used was led by Dr. Li-Huei Tsai and was conducted on rats with the same key symptoms as Alzheimer's patients. She used a 40 hertz light and sound that Dr. Tsai used. Balsa wood was used for the frame, adjustable straps for support, translucent color sheets to give off the color of choice, and foam for comfort. Since she couldn't test her product on patients her goal was to make a comfortable headset that had the possibility to achieve the same goal as Dr. Tsai, decreasing the amount of plaque in a patient's brain. When testing her prototype on her classmates and family she found that some areas were more uncomfortable than others but everyone had an issue with the bridge of their nose. She also changed the shape of the frame to fit the volunteer's heads better. She found that the curve of the frame covers any view of the outside so the user has less distractions. This project has shown an alternative and a more comfortable option to use on Alzheimer patients to reverse the effects of the disease.

VISCOELASTIC BIOLOGICAL FLUIDS EXAMINED THROUGH MICRORHEOLOGY

James Ham
SC Governor's School for Science & Mathematics

The idea of this research project is to gather data on viscoelastic biological fluids as to better understand their properties. Because the sample size of the fluids is often quite small, the examinations must be done on a microscopic level. Prior to the research, videos were recorded that displayed the tracking of microscopic probes inside these fluids, but the color markers indicating the probes were not always

accurate. They would blink in and out of existence or mistake the halo around the probe for a probe itself. The main objective was to better organize and document the path of the probes. This was done using MATLAB. First, an ideal signal-to-noise ratio (SNR) was identified that would serve as an appropriate cutoff for what could be considered a probe. However, it was more complex than just that. The SNR of each video was plotted onto a chart in order to get a better idea of what the cutoff SNR should be. The main result was a table that contained all of the accurate particle trajectories so that they could be better used for microrheology analysis. Further analysis towards the behavior of these fluids could be useful information in the study of artificial organs, an example being the pumping of blood by an artificial heart.

THE MYCOREMEDIATION OF *ESCHERICHIA COLI* BY *PLEUROTUS OSTREATUS*, *STROPHARIA RUGOSOANNULATA*, AND *TRAMETES VERSICOLOR* IN CONTAMINATED WATER

Madison Han
Spring Valley High School

Escherichia coli contamination is a major health concern that can cause adverse health effects like fever and gastrointestinal illness. White-rot fungi produce exoenzymes that degrade pollutants, including *E. coli*, in a process called mycoremediation. The degradation abilities of *Pleurotus ostreatus*, *Stropharia rugosoannulata*, and *Trametes versicolor* have been examined in previous literature, but no studies have compared their abilities to remediate *E. coli*-contaminated water. The purpose of this study was to directly compare the abilities of these fungi to degrade *E. coli* in water. It was hypothesized that white-rot fungi would decrease *E. coli* concentration in water, and *T. versicolor* would remove more *E. coli* than *P. ostreatus* and *S. rugosoannulata*. After culturing fungi with wheat straw, *E. coli*-inoculated water was added to each sample. Initial and final concentrations (CFU/mL) of *E. coli* were determined following serial dilutions. *Trametes versicolor* treatments resulted in a 52.51% decrease in *E. coli* concentration, while *P. ostreatus* and *S. rugosoannulata* treatments resulted in a 12.90% increase and a 114.21% increase in *E. coli* concentration, respectively. A one-way ANOVA found that results were statistically significant ($F(38103.22, 5147.34) = 7.40, p < 0.001$), and a post-hoc Scheffé test was conducted to compare the fungus species. This post-hoc test found significant differences between *T. versicolor* vs. *S. rugosoannulata*, *T. versicolor* vs. control, and *P. ostreatus* vs. control. The results of this experiment suggest that *T. versicolor* can remediate *E. coli*-contaminated water more efficiently than *P. ostreatus* and *S. rugosoannulata*.

AN INEXPENSIVE WATER FILTRATION SYSTEM FOR REMOVING ARSENIC FROM TUBE WELL WATER AND IMPROVING HEALTH IN RURAL POPULATIONS

Ishraq Haque
Academic Magnet High School

Approximately 200 million people worldwide are affected by arsenic-contaminated water for reasons such as drinking tube well groundwater. Last year, the author created a novel and inexpensive One Step Red Soil Filtration (OSRSF) system for villages in Bangladesh. The goal of this current study was to investigate the long-term biological effects of utilizing the OSRSF with a slight modification of the container for a more efficient system. After one-year usage, hair and nail arsenic levels of villagers significantly decreased. The percentage of immune cell survival was also improved by using the OSRSF. This result was verified in the laboratory by using the cell viability assay to check how arsenic trioxide and sodium arsenite affect survival for two B-cell lines. Then, an immunofluorescence staining assay revealed how mitochondrial stress was attenuated due to a decrease in the cell death marker Bax caused by the filtration system. Western blot analysis showed caspase-3 protein expression decreased, causing a reduction in immune cell death.

Overall, this study presents how an economical filtration system can improve human health and provide clean water for low-income populations.

HISTORICAL ARCHAEOLOGICAL DATING OF A NINETEENTH-CENTURY AFRICAN-AMERICAN HOME

Emily Anne Harris

SC Governor's School for Science & Mathematics

After South Carolina Department of Natural Resources (SCDNR) archaeologists excavated a duplex home on the Fort Frederick Heritage Preserve property, thousands of dirt-covered artifacts were recovered. This study will identify and date these artifacts to verify when this house was occupied and who its residents were. This process began by cleaning the artifacts with a simple toothbrush and water basin, and then leaving them to dry. They were then sorted into categories by type, including ceramics, glass, and nails. From there, individual artifacts were identified by using online databases such as Digital Archaeological Archives of Comparative Slavery (DAACS). Once a sherd, for example, had been recognized as one particular type of ceramic, the range of dates for its popularity and/or manufacture could be found on these databases. While some artifacts were dated to the late 1700s and early 1800s, other artifacts' production did not begin until approximately 1840. For this reason, it is estimated that the house was inhabited between the years of 1840 to 1860. In order to get more accurate findings, it would be necessary to date all of the artifacts from the home, not just a small range from one plot, which contained some of the first artifacts to be identified from the property since their excavation. However, this date range verifies historical records including pictures and journal entries that mention small homes occupied by enslaved persons on the Old Fort Plantation.

FIELD SAFETY MONITOR

Christopher Heaps, Jacob Kessel, and Reyn Slater

The Center for Advanced Technical Studies

False spotting event cancellations cost major sporting facilities 10-15 million dollars in 2017, the way major facilities determine whether to cancel events is outdated and underperforms. The Field Safety Monitor is a new way to determine the cancellation of sporting events to better the experience for players and save the facilities millions. The idea started out as a modified weather radar system, meant to be placed up high where it could monitor changing weather patterns. However, due to other already existing products, the Field Safety Monitor was moved to the ground, where it could monitor field moisture and coefficient of friction. Our plan at this point for it was to put the monitor underground on a soccer field, but we changed to the structure to be a moving robot, for economical and practical purposes. The robot will determine the playability of a field using an automated system to measure soil moisture, soil compactibility, and surface friction using custom sensors; furthermore the ability to determine these three variables through the use of custom sensors allows for a wider variety of data to determine the true safety of the field in different weather conditions. The automation of this robot also allows for the ability to determine the true outcome without any physical human involvement which saves an abundance of time and removes the bias people may have on the cancellation of an event.

IDENTIFICATION OF CANDIDATE APTAMERS TO FACILITATE SARS-COV-2 DETECTION

Maura Hilbourn, Tianna Kidd, and Ankita Menon

SC Governor's School for Science & Mathematics

Over one million people have died from a coronavirus infection, so it is critical to generate an effective vaccine. Antibody testing and aptamer testing are the most popular methods for this. Aptamer testing is cost and time efficient, so aptamers were used for this research. The goal is to identify candidate aptamers with a secondary structure that would bind to Sars-Cov-2. The research was completed using several online applications (NCBI GenBank, Lab Notebook, PSPAD, Strawberry Perl, Pymol Software, Vienna RNA Package, RCSB Protein Databank, HDOCK Server), and Excel sheets. Between each step, the potential aptamer sequences were documented in Excel. First, the viral sequence was downloaded from NCBI and potential aptamers sequences were created through Strawberry Perl. Next, the DNA sequences were converted into RNA sequences since Sars-Cov-2's genome is comprised of RNA and therefore needs an RNA aptamer. Vienna RNA Package provided the free energy levels of each potential aptamer sequence in addition to their RNA sequences. The data was sorted based upon which aptamers would most likely bind to Sars-Cov-2. Next, the primary structure had to be changed into secondary structure, so the spike protein sequences were downloaded from RCSB and docked by the HDOCK server. About 250 candidate aptamers were identified. They will be developed in a lab and will be tested to see if they bind to Sars-Cov-2, and can be used for its detection. The aptamer that pairs best with the virus will then be determined from this list.

TO WHAT EXTENT IS THERE A CORRELATION BETWEEN THE GREEN-SPACE TO INDOOR-SPACE RATIO AND ACADEMIC PERFORMANCE IN SOUTH CAROLINA DISTRICT FIVE HIGH SCHOOLS?

Joseph Hill

Chapin High School

The role of schools is to properly equip students with skills needed to pursue careers and potentially higher education. In order to this to the best of their ability schools must provide an environment that best suits the needs of students. It has been proven that spending time in green-spaces can help people by reducing stress, increasing productivity, and promoting social cohesion. Perhaps green-spaces being incorporated into schools to be used by students can increase academic performance and better prepare students for life in their career and or pursuing higher education. In addition to directly increasing the productivity of students, increased access to greenspace could ease stress and anxiety among students which could also improve the students performance and wellbeing. Incorporating green-spaces can be applied to schools in order to achieve the best learning environment for students. This is done by this study by gathering the total area of schools and the area of the green-spaces accessible to students, comparing these two areas, and comparing this ratio to the academic performance of the students. This must be done to ensure schools are providing the absolute best environment to suit their students needs.

THE CONDITIONS IN WHICH TOTAL VOLATILE ORGANIC COMPOUNDS PRODUCED BY LIBRARIES IS DELETERIOUS TO HUMAN HEALTH

Sona Hill-Liles

Chapin High School

Volatile organic compounds are produced by many different objects including paper. In books these VOCs are produced as the paper, glue, and ink breaks down. VOCs are considered markers for degradation in books. Some such VOCs are acetic acid and furfural. Both of these chemicals ,however, are known for

being quite dangerous in certain concentrations. No research has been done to determine if the concentration of VOCs in libraries are large enough to cause person, it still may be high enough to affect people with asthma and other respiratory issues, and allergies. My research question is “what are the conditions in which volatile organic compounds produced by books can become deleterious to humans?”. I hypothesize that the TVOC levels in the libraries will not exceed “fair” on the indoor air quality index. Those that do reach this level will have the least controlled conditions. Libraries generally keep the indoor conditions of their libraries very regulated. Many studies found that VOCs increase the degradation of books, so many libraries keep their library conditions controlled to reduce the chances of the books degrading. the adverse side effects. If the concentrations are low enough to not be dangerous to the normal

OPTIMIZING THE COMPUTATIONAL PARAMETERS OF FERRITE COMPOUNDS

Zachary Hoover

SC Governor's School for Science & Mathematics

The compounds nickel ferrite (NiFe_2O_4), cobalt ferrite (CoFe_2O_4), manganese ferrite (MnFe_2O_4), and zinc ferrite (ZnFe_2O_4) may have magnetic properties that could surpass current biomedical technology. Currently, nickel ferrite nanoparticles are used in a process called magnetically modulated energy delivery (or MagMED for short). MagMED delivers energy to diseased areas through magnetization. It has seen success in the past, but is limited due to a lack of resources and inefficiency of dosage. Our research group's goal was to see if other compounds could be used in place of the nickel ferrite currently used. For the ferrite compounds to be used safely and successfully, they must be stable. The magnetic moment measures the magnetic strength of the compound. The higher the magnetic moment and lower energy, the more stable the compound is. To see how we could make stable compounds, we ran theoretical calculations through a system and changed the mixing flags. Mixing flags change how the ions in compounds are distributed and structures. This directly affects the energy and magnetic moment of the compound. The only mixing flag we were able to change within the amount of time given was the LMIXMAX flag. We were able to discover that changing this parameter has little to no effect on the magnetic moment or the energy of the compound.

IMPACT OF TOPOGRAPHY ON ATTRACTION BETWEEN 3D PRINTED MAGNETS

Aiden Houghton

Spring Valley High School

Many different researchers have shown that it is possible to make a working magnet with 3D printing technology, but few have bothered to take things further than that. This experiment aimed to discover if there is a correlation between the topography of the surfaces on which bonded magnets meet and how well they stick together. It was hypothesized that no impact would be found in changing the shape of the surface where two 3D-printed magnets meet. Although 8 different pairs of magnets were planned and a rig designed to test them, an error in a slice prevented the first set of them from being printed. This failed first print would not magnetize, and prints afterwards also failed to magnetize, so the original 8 pairs were never printed. However, during the printing process odd observations were made that may imply some magnetic interference or phenomena during the printing process. These behaviors include odd patterns forming out of iron powder on the resin tank; which supposedly meant that unmagnetized powder got stuck to the build platform near the screws. There was also an odd matching hole on the prints, one of which had a line of iron powder going through it after the resin tank was refilled mid-print, but not before. Although the causes for these events are not known, this experiment has shown contrary evidence to past

experiments which manage to print magnetized objects using Fe₃O₄ powder, implying that not just any Stereolithography (SLA) printer can print magnets with it, while also unearthing some potential odd magnetic behaviors active during the printing process.

THE EFFECT OF THE COMBINED USE OF GARLIC EXTRACT AND SODIUM SALICYLATE ON THE INHIBITION AND ERADICATION OF *STAPHYLOCOCCUS EPIDERMIDIS* BIOFILMS GROWN ON TITANIUM

Angel Huang

Spring Valley High School

Implant associated infections (IAIs) place a burden on the healthcare system as well as affected patients, and a common pathogen involved is *Staphylococcus epidermidis*, which can attach to implant surfaces and produce biofilm. The purpose of this study was to analyze the effects of aqueous garlic extract (AGE) and sodium salicylate (SOD SAL) on the inhibition and eradication of *S. epidermidis* biofilms grown on titanium as a potential remedy for IAIs. It was hypothesized that a combination of SOD SAL and AGE would inhibit the most biofilm growth and eradicate the most pre-grown biofilm. For the inhibition assay, bacterial suspensions were incubated with titanium discs and one of three treatments. In the eradication assay, bacteria was cultured with titanium, then treated with different treatments. The absorbance measured in optical density (OD) of each sample after treatment was taken using a spectrophotometer. AGE inhibited >40% of biofilm growth, while AGE and a combination of AGE and SOD SAL eradicated 17% of bacteria. An ANOVA was conducted for both assays; at $\alpha = 0.05$, $p < 0.001$ for both. AGE had significantly the lowest OD in the inhibition assay, and there was no statistical difference between each treatment in the eradication assay. It was concluded that AGE is better at inhibiting biofilm growth, but each treatment showed generally the same efficacy in killing pre-grown biofilm. Based on this, AGE could be used as an alternative substance to treat and prevent IAIs.

PARTIAL CONVOLUTIONS FOR EFFICIENT AUTOREGRESSIVE SUPER-RESOLUTION

Zachary Huang

Spring Valley High School

Super-resolution, the task of upscaling images, has many applications, especially in fields such as microscopy and satellite imaging. While deep learning-based approaches to super-resolution have evolved significantly in recent years, not much research has been conducted on efficiency. In addition, state-of-the-art research in image generation has shown that autoregressive models can achieve great results in many image tasks, including super-resolution. The autoregressive property of these models can be imitated using partial convolutional layers, which also happen to be computationally efficient. As such, it was hypothesized that partial convolutions could be utilized for efficient and high-quality super-resolution. Using the PyTorch deep learning framework, super-resolution models were constructed; one model used partial convolutional layers while the other used standard convolutional layers. The performance of these models were measured using both a perceptual loss to measure quality and a consistency score to determine plausibility. After training and testing on super-resolution using the DIV2K image dataset with a 4x upscaling factor (32x32 to 128x128), statistical analysis revealed that the use of partial convolutions did not significantly affect the perceptual score $t(39) = 0.463$, $p = 0.322$. However, the partial convolutions did cause a statistically significant increase in the consistency score $t(39) = 4.538$, $p < 0.0001$. In addition, both models had a memory footprint of about less than two megabytes. Thus, the use of partial convolutional layers were able to improve the plausibility of efficient super-resolution models, but not their perceptual quality.

NEURAL NETWORK REINFORCEMENT LEARNING FOR SIMPLE GAME PLAYING

Christian Ihekweazu

SC Governor's School for Science & Mathematics

Reinforcement learning and machine learning are crucial aspects of the ever-growing technology field; it allows us to train a computer to learn and conceptualize information in ways it could have never done before. The purpose of our research was to learn the basics and concepts behind reinforcement learning so that we could create neural networks and programs to automate simple games. Throughout our research, each person had different tasks which ranged from things like a write-up on a specific concept to writing code to complete a task and then reporting back to the group during the next meeting. Throughout the process, we also utilized pre-established resources in our research as well, so that we could better understand some of the logic and reasoning behind why certain things behave in a certain way. By the end of our research, we were able to create a program that was able to play a virtual game of ping-pong by itself. Using this information in the future we will be able to create programs to play more advanced games and potentially dive into other fields that deal with reinforcement learning.

DOES SOIL COMPOSITION INFLUENCE HOUSE TEMPERATURE IN GEOTHERMAL SYSTEMS?

Steven Jackson

The Center for Advanced Technical Studies

Does Soil Composition Influence House Temperature in Geothermal? I hypothesize that the material with the most dense composition will cause the highest temperature in the house. In order to successfully conduct an experiment, I will need to undergo certain methods to obtain this goal. This includes being able to install a small geothermal system on my small scale house. The results that I got in my proof of concept design was that clay caused the highest temperature increase, and sand caused the lowest temperature increase in the house, and the soil was roughly in between those two. Possible reasoning behind this is that clay is the most dense material, which could be why it had a higher temperature than any other material. My hypothesis was supported by the data since the densest material (the clay) caused the highest temperature increase. This information is valuable to people who may be interested in purchasing a geothermal system, since this information could inform them if their specific type of soil will maximize the potential of a geothermal system. A future study that I could conduct would be how different sized houses influence the temperature of geothermal.

THE EFFECT OF USING JUICES CONTAINING FURANOCOUMARINS ON THE GROWTH OF ESCHERICHIA COLI DURING SOLAR WATER DISINFECTION (SODIS)

Amaya Johnson

Spring Valley High School

Contaminated water has long been decided as harmful when considering humans' health. As a result, various research has been conducted on how to reduce negative effects by naturally inhibiting the growth of harmful bacteria through the use of solar radiation with a process known as solar water disinfection (SODIS). However, even with the research that has been done to help identify furanocoumarins as effective partners to the SODIS process, few studies have compared the effects of pairing different compounds from this group with SODIS. The purpose of this study was to compare the effects of using different furanocoumarin compounds in addition with SODIS in order to investigate how to best improve this process. The hypothesis was that the addition of these recognized photoreactive compounds to the

SODIS process would enhance its ability to kill bacteria such as *Escherichia coli*. During the experiment, the effectiveness of the groups was tested by placing *E. coli* in water bottles associated with each combination and quantified by the amount of *E. coli* growth witnessed in colony forming units. The results from this experiment were inconclusive regarding which SODIS combination was the most effective, as statistically significant differences were not found between SODIS combinations by ANOVA testing. However, it is anticipated that with further research and modified methods, the most effective combination could likely be found. This potential discovery would further progress research in searching for ways to improve SODIS's efficiency.

FEMALE ATHLETIC PARTICIPATION AND PERCEPTION OF TITLE IX

Aislyn Jowers
Chapin High School

Title IX is perceived differently for people across the country, and this research aims to look at female high school students' perception of this law. Female athletic participation has varied since Title IX's passing in 1972, and now in the 2020-21 school year, this law could be seen as ineffective almost 50 years later. A survey will be conducted in a high school outside of Columbia, SC. Anyone who is a student in this specific high school can take the survey to create comparable data from males to females and athletes to non-athletes. This survey will ask questions about participation in sports, if the student being surveyed has heard of Title IX, and if so, what they know about it. They are also asked if they perceive Title IX to be effective in high schools, but the results could be varied if they do not know what this law is, this is why perception is significant. Participants vs. non-participants could have an influence on perception. A Chi-Square Test will be used for the data analysis comparing perception and participation due to correlational research methods. Students' answers will be graded on a rubric that was created to compare numerical data. This research aims to find a correlation between perception and participation and the effectiveness of Title IX since it was enacted in 1972 and intended primarily for colleges and universities. The conclusion reached by the results is that Title IX can be effective if students know what the law is.

THE AUDITORY FOREIGN LANGUAGE EFFECT ON MORAL DECISIONS

Cindy Ju
Chapin High School

The use of a foreign language has been observed to increase deliberative thinking, favoring utilitarian decisions when making decisions involving moral dilemmas. Previous investigations of the foreign language effect have been heavily limited to written stimuli, and very few have observed simultaneous bilinguals. In the current study, the impact of the auditory foreign language effect on moral decision-making in simultaneous English/Mandarin bilinguals is investigated using a participant group with ages ranging from 14-20. A survey containing audio recordings of 7 moral dilemmas was presented entirely in Mandarin or in English, and after listening to the dilemma participants were instructed to indicate whether the specified action was appropriate or not. The results showed a lack of decision-making differences between the two language groups which may be attributed to the high level of cultural immersion of the participants. The findings also suggest limitations to the foreign language effect attributed to high proficiency in listening for both languages.

VIRTUAL VEHICLE AUTOMATION
Anish Kanthamneni
SC Governor's School for Science & Mathematics

The purpose of my research project was to see if it is possible to use Python to drive a vehicle in a driving simulator. This is a fairly new field that interested me due to how much safer it could make our roads if applied to real cars. My main source during the duration of this project was Sentdex, a Youtuber guiding us in a tutorial on how to drive a scooter in Grand Theft Auto 5 using python. I, however, didn't have GTA, so I had to adjust the code to suit my needs and fit the simulator I was using (Top Seep Driving 3). When creating the code, I used grab-screen, a method in python, to obtain the image and used send keys to allow the program to input commands (W, A, S, and D) into the simulator. The end result was a program that was able to "see" the computer screen and send input to the vehicle. Python was able to make the car stay within the lanes; however, it had some trouble when the road had a 90-degree turn. It was supposed to turn and get inside the lanes of the other road, but it would occasionally fail to turn properly. These results, if improved, could aid the self-driving car industry. There are many benefits to automated cars including safety and convenience. Automated driving could prevent the 1.25 million deaths annually from car accidents and 20-50 million injuries.

SARS-COV-2: A STUDY OF THE DISPERSION CHARACTERISTICS OF AEROSOL PARTICLES USING ULTRAFAST
CARBON NANOTUBE SENSORS IN A SIMULATED INDOOR ENVIRONMENT

Shriya Kapoor
Spring Valley High School

The SARS-CoV-2 virus (COVID-19) pandemic has exposed the lack of preparedness of many advanced countries and their methodology to bring it under control. Understanding the trajectory and spread pattern of virus carrying airborne respiratory aerosol droplets with quantifiable data can solidify or negate the guidelines for social distancing, and disease control and spread. Carbon nanotubes (CNT) sensors, CSM-eSTEP cough stimulator, optical particle sizer, and a particle image velocimetry (PIV) were used to: a) quantify velocity of exhaled air from cough under normal physiological condition, b) evaluate and quantify transport of aerosol particles from a simulated cough and c) dispersion characteristics of aerosol droplets within the six feet to validate guidelines set by CDC. This experimental trial validated that a cough (teenager and adult) air flow pressure is equivalent to 30-50 PSI compressed air flow from an orifice. The cough air flow trajectory was found to be detectable and quantifiable by sensors as far as 1.3 meters away from source. Further experimentation revealed a statistically high number (10 cm away, $F(2,87)=4.76$, $p<0.012$, and 1.8 m away, $F(2,87)=4.18$, $p<0.018$) of aerosols particles detected beyond the social distance guideline set by CDC. Lastly, the PIV and velocity vectors reveal the disorderly spread of the aerosol particles thus requiring thorough sanitization in addition to social distancing guidelines. In the future, different indoor criteria of humidity, temperature, and HVAC air flow will be set to understand virus laden aerosol velocity vectors.

DIFFERENCE IN INVERTEBRATE COUNTS IN SOIL SAMPLES TAKEN FROM GOLF COURSE AND UNTREATED LAND

Emma Keiser

SC Governor's School for Science & Mathematics

The purpose of this research project was to compare the number of invertebrates found in soil samples taken from untreated land and a golf course. These invertebrates are essential to the overall health of the upper soil layers. The goal of this project was to assess whether treatments used on a golf course impact the number of these invertebrates in the soil. A golf course was chosen due to shared similarities with other large, grassy lawns. Soil samples were taken from each location and placed in a berlese funnel underneath a 60 watt light for 4 days. The invertebrates found were then counted and sorted by taxon. The difference between the counts of individual taxon in each sample were found, and a statistical t-test using the total differences from all taxons was performed. It was found that the difference in total invertebrate counts between the two locations was statistically different from zero. However, when the differences in individual taxons were analyzed, it was found that the difference was not statistically different from zero. This indicates that overall there is a difference between the two areas, but not on an individual taxon scale. While this study showed results that indicated large, grassy areas have less invertebrates, this research project was conducted on a smaller scale, meaning that the data collected was insufficient to be an indicator of any large trends.

THE EFFECT OF LEAF LITTER AND SOIL PH ON SOIL'S POTASSIUM AND PHOSPHORUS AMOUNT

Heiyaani Kerai

Spring Valley High School

Potassium and phosphorus are major building blocks regarding plant growth, healthy living, and lifespan. Conditions such as leaf litter and soil pH can affect potassium and phosphorus levels in the soil. Potassium and phosphorus levels can have a major impact on vegetation and proper plant growth. The purpose of this research study was to explore how leaf litter and different pH levels in soil can affect the amount of potassium and phosphorus nutrient levels in soil. It was hypothesized that the closer the soil's pH level was to 6 and if the soil contained leaf litter, the more stable the potassium and phosphorus levels in the soil would be at keeping the soil more nutritious and most efficient for plants. For experimentation, 5 egg carton trays were used with 30 slots each. Each of the 5 trays had different pH levels of 4- 8. 15 slots for each tray had grass grown with leaf litter and the other 15 were grown without leaf litter. The potassium and phosphorus levels will be measured every other day for 9 days using a nutrient test kit. Four one way ANOVA tables were conducted at 0.05. The four tests revealed p-values that were greater than the alpha 0.05, these results were statistically insignificant. Nevertheless, the soil that was watered with a pH level of 5 with leaf litter was the most efficient at keeping the soil nutritious and better suited for plants.

THE DIFFERENCES IN AGEIST ATTITUDES BETWEEN HIGH SCHOOL STUDENTS AT SPRING VALLEY HIGH SCHOOL VERSUS THEIR PARENTS

Vikram Kneece

Spring Valley High School

The purpose of this project was to research the differences in ageist attitudes between high school students and older age groups. In order to do this the Fraboni Scale of Ageism was used, which is a scale that asks questions in a Strongly Agree to Strongly Disagree manner in order to give a quantitative score to ageist attitudes. These questions were added to a google form and sent to parents and students from

Spring Valley High School. All participants who took the survey were asked to identify themselves within four different age groups: 13-29, 30-40, 41-55, and 56+ years old. After all 92 responses were collected the final scores were analyzed using a One-Way ANOVA test. It was found that there was a significant difference between the groups, with the 13-29 year old age group found to have higher scores on the Fraboni Scale of Ageism than the three other age groups.

THE RELATIONSHIP BETWEEN SOCIAL MEDIA MISINFORMATION AND THE RESPONSE TO TWEETS ABOUT TOPICAL ISSUES

Justin Kong
Spring Valley High School

Misinformation of major issues has been attributed to illogical perspectives on social media platforms such as Twitter. Although present for many decades, misinformation on Twitter is considered contagion, the imitation of mob behavior. Therefore, the purpose of this study was to understand the prevalence of misinformation on frequently discussed issues such as gun control and the vaccination of children. By comparing quantitative statistics for misinformation and correction-based tweets on these topics, it was hypothesized that there would be more likes and retweets for tweets with correction-based responses, than tweets containing misinformation about gun control and the vaccination of children. Using the search filter function on Twitter, specific hashtags such as “#Pro2A” were assigned based on the type of tweet. Further search criteria included the date and the average total number of likes and retweets (the general response) of tweets. Tweets were collected for both misinformation and correction-based samples of each topic. The general response of misinformation tweets for gun control and the vaccination of children ($M = 168.9$, $M = 16.3$) were approximately one-third (36.2%) and entirely (95.3%) less, respectively, than the corresponding correction-based tweets ($M = 264.4$, $M = 288.9$). The results indicated that there was a significant difference between misinformation tweets and correction-based tweets for both topics, $z(29) = 1.645$, $p > 0.05$. This trend was supported with previous research literature, however, was applied to more recent topics within the study. These findings may provide valuable information for developing solutions to counter social media misinformation.

EXPLORATION OF PHOTOREALISTIC FACE RENDERING IN A LIGHT STAGE

Kyle Koon
SC Governor's School for Science & Mathematics

Facial geometry and reflectance data must be captured to produce realistic computer-generated renderings of the human face. The goal of this project was to affordably acquire this necessary facial data by programming a series of cameras and lights in a light stage to take images on command under varying lighting. The data from these images would be used to create a photorealistic rendering of the subject's face with the use of consumer-level equipment. Arduino microcontrollers, .txt files, and Python were used to serially send user-defined lighting data to Digital Multiplex (DMX) controlled lights. The Maya 3D rendering software and Python were used to virtually model the spherical structure of the light stage along with 364 lights and a human face. Python was used to create a user interface that allowed a user to design custom lighting setups, visualize them with virtual lights in Maya, and then test them on the physical lights. The different lighting patterns were visible on the downloaded face model within Maya; however, the results would be more accurate if the face model was supplied with reflectance data. Reflectance data would be used to adjust the face model to replicate how that person's face reflects light based on its geometry. Although the camera control software was not created, upon its eventual

completion and connection with the lighting software, images and reflectance data should be able to be captured and sent to the control computer, and then processed to create the face model.

TEMPORARY FISH TRANSPORT TECHNOLOGY USING TUBES

Charles Koverman

The Center for Advanced Technical Studies

How can temporary fish transport systems, be used in the construction of both hydroelectric dams and normal dams. The main goal of this project is to see, if a temporary and easily movable fish transport system can be made. In order to be a success, it must be able to move fish from one point to another, with a height difference(lift). Going through the process of designing the assembly that will lift those fish from pont a to b, is the main focus and takes the most amount of time. It requires getting a pump that will create a pressure difference across the tubes, so that the fish is pulled/pump from one end to the other. In order to test and improve the design and have some quantitative data, both flow rate and pressure difference readings are collected. In the last test, a flow rate of .123 liters/ second and a pressure difference of 376 Pa. In future testings, the goal is to raise both of these metrics. The goal is efficiency, so the higher these metrics can get the more effective the design can be deemed. Along with these metrics, some qualitative observations should be made. It is for the transport of fish, so by using some sweedish fish to run through the tubes, to see if any modifcations of the tubes themselves should be made. The future of this project is going to be focused on the continual improvement of the pump assembly.

THE RISING POPULATION OF SURROUNDING CITIES IMPACT ON LAKE MURRAY'S WATER QUALITY

John Krompecher

Chapin High School

The population of the surrounding cities of Lake Murray have increased dramatically over the past decade. Chapin has increased from 1,445 people to 1,940, Lexington has increased from 262,391 to 320,601, and Irmo has increased from 11,097 to 12,215(United States Census Bureau,2020). These statistics come from the federal agency, the United States Census Bureau(USCB). Though an increase in population has brought more economic opportunities and prosperity, we must ask the question: How is this impacting our ecosystem? More specifically, how is this impacting our Lake? Typically when we see cities boom in population ,similar to the ones surrounding Lake Murray, there is an increase in pollution on the major ecosystems in said city. Chicago is the best example, in 1837 the population was an estimated 4,000, today it is 2.7 million. Though Chicago is now renowned for its industry and economy, it also is ranked 18th in pollution, this statistic comes courtesy of the American Lung Association(American Lung Association, 2019). Though Lake Murray hasn't experienced a Chicago level population boom, we have seen a massive increase in population among the various surrounding cities. Due to multiple examples of cities experiencing a population boom and then soon after a pollution boom, it is important to monitor the water quality of Lake Murray during this time of increased industry and population.

DETERMINING THE EFFECTIVENESS OF ADDING FIBERGLASS TO AMBIGEL COMPOSITE BASED ON THERMAL CONDUCTIVITY

Anish Kulkarni
Spring Valley High School

With the increasing uses of lightweight porous materials such as aerogels and ambigels in different fields of work, many methods to create an aerogel versatile in many areas have been researched. The purpose of this experiment was to determine if there is a correlation between adding fiberglass to ambigels in order to determine if a change in thermal conductivity when compared to a regular ambigel (without fiberglass) exists. The hypothesis was that the regular ambigel would have the lowest thermal conductivity when compared to the 2.5% and 5% ambigels because ambigels have lower thermal conductivity than fiberglass, so adding more fiberglass should strengthen the mechanical structure of the aerogel and not the thermal conductivity. The ambigels were created by mixing two solutions containing tetramethyle orthosilicate, methanol, and ammonium hydroxide. These formed a gel when they were combined. This was the hydrogel that had been produced after the solutions had formed a gel. The final procedure was to perform a solvent diffusion with acetone and hexane and wait for 24 hours for the acetone to evaporate from the hydrogel, forming the ambigel. The regular ambigel resulted in having the highest thermal conductivity with an average of $43.7 \text{ W/m}^{\circ}\text{K}$, while the 2.5% ambigel had a thermal conductivity of $22.35 \text{ W/m}^{\circ}\text{K}$. This meant that the hypothesis was not supported because the regular ambigel had the highest thermal conductivity, meaning that it was the worst insulator. The 2.5% ambigel, because of its lower thermal conductivity, was the best insulator.

WEIGHTS WITHOUT SPACE

Daniel Kunkle and Miles Turner
The Center for Advanced Technical Studies

Our problem that we are working to solve is saving space while having a weight bench at home. Our design is a wall mount conversion kit for weight benches of all shapes and sizes. The access to all the same weight bench options with our added product will allow more people to have viable access to a home gym during use and save floor space when not in use. Thereby allowing more people to stay fit and healthy in a world trending towards virtual and home based workouts.

THE EFFECT OF PH ON IDEONELLA SAKAIENSIS' ABILITY TO DEGRADE POLYETHYLENE TEREPHTHALATE (PET)

Ryan Leadbitter
Spring Valley High School

Polyethylene terephthalate (PET) plastic is a major source of pollution, especially in marine environments ("Marine plastic pollution," 2020). A recently isolated bacteria known as *Ideonella sakaiensis* uses the enzyme PETase to hydrolyze polyethylene terephthalate. *Ideonella sakaiensis* uses PET as a carbon energy source and converts the polymer into carbon dioxide and water. It was hypothesized that *Ideonella sakaiensis* would degrade PET more effectively at a basic pH within its optimal pH range of 5.5-9. Two broth solutions of differing pH levels were prepared for the *Ideonella sakaiensis* and agar plates were poured into Petri dishes to cultivate the bacteria. Small, sterile PET samples were also added to the Petri dishes to be degraded by the bacteria. More efficient PET hydrolysis would be indicated by a negative change in the mass of the PET samples used. However, the mass of the PET samples showed an increase in mass. A z-test was run to determine if there was a significant difference between the mass changes

between the two pH groups. The results of this z-test failed to reject the null hypothesis that the pH of the environment would not affect the ability of *Ideonella sakaiensis* to degrade polyethylene terephthalate.

THE EFFECTS OF HEAT STRESS ON POLLEN VIABILITY IN PEANUT GENOTYPES

Christopher LeBarron, Mary Lee, Elizabeth Middleton, and Kaylex Wilcox
SC Governor's School for Science & Mathematics

Consistently rising temperatures are a major environmental factor that threatens the yield of one of South Carolina's top cash crops, *Arachis hypogaea*, or the peanut, because peanuts are heat susceptible during the reproductive phase. Our main goal of this research was to identify the peanut genotypes that have the highest probability of reproducing under increasing annual temperatures. Under greenhouse conditions, samples from six genotypes (Bailey, Wynne, Georgia 12Y, SPT 06-07, Tifguard, Phillips) were grown under either ambient (31/22°C) or heat stress temperatures (41/27°C). Once the peanut plants flowered, pollen was collected and stained with triphenyl tetrazolium chloride to indicate pollen viability. The pollen was observed under a microscope and recorded as viable, semi-viable, and nonviable, based on the shade of the stained grains. Pollen viability was calculated as the ratio of viable pollen grains to the total number of pollen grains. While the pollen viability for each genotype decreased, four genotypes, SPT 06-07, Tifguard, Georgia 12Y, and Phillips, had higher percentages of viable pollen and thus higher probabilities of reproduction. Despite Bailey having the highest percent of viable pollen in ambient temperatures, it produced significantly less pollen when subjected to heat stress. The four peanut genotypes that yielded a high percentage of pollen viability may result in a higher overall crop yield of the peanut plant considering increasing summer temperatures. These results will promote the implementation of more resilient peanut genotypes in agricultural practices, which would maintain peanut production and profits should temperatures continue to rise.

FACTORS OF STRESS IN STUDENT ATHLETES AND THE IMPACT COACHES HAVE ON CREATING THE FACTORS

Delaney Lewis
The Center for Advanced Technical Studies

The purpose of this engineered project was to help identify whether pressure injuries are worsening by the coloration that appears through the exterior of the dressing. Different colors would alert the attendants of the healing levels and whether the wound fluid is alkaline or acidic. This product would not only benefit immobilized patients in long term care facilities/nursing homes, but also the nursing staff by giving them an indicator to check on and eliminate further development of the wound. With time, the incidence of pressure ulcers has increased as well as resulting lawsuits. Therefore, the use of these dressings would lower the worst possible circumstances and allow the nurses to know whether it is healing or if it needs additional maintenance. Though this has yet to be completed, in order to evaluate this, different indicators that resemble the pH levels found within the wound fluid will be dropped among the interior of the prototype and the results will show through the transparent film. Despite the fact that this can not be tested among real patients, the implementation of a survey that gathers nurses opinions on the product will further this project overall.

TRANSPARENT FILM DRESSINGS WITH PH INDICATORS IN ORDER TO MONITOR PROGRESSION IN PRESSURE ULCERS

Kinsley Lewis

The Center for Advanced Technical Studies

The purpose of this engineered project was to help identify whether pressure injuries are worsening by the coloration that appears through the exterior of the dressing. Different colors would alert the attendants of the healing levels and whether the wound fluid is alkaline or acidic. This product would not only benefit immobilized patients in long term care facilities/nursing homes, but also the nursing staff by giving them an indicator to check on and eliminate further development of the wound. With time, the incidence of pressure ulcers has increased as well as resulting lawsuits. Therefore, the use of these dressings would lower the worst possible circumstances and allow the nurses to know whether it is healing or if it needs additional maintenance. Though this has yet to be completed, in order to evaluate this, different indicators that resemble the pH levels found within the wound fluid will be dropped among the interior of the prototype and the results will show through the transparent film. Despite the fact that this can not be tested among real patients, the implementation of a survey that gathers nurses opinions on the product will further this project overall.

PARTIALLY SPEAKER-DEPENDENT AUTOMATIC SPEECH RECOGNITION USING DEEP NEURAL NETWORKS

Christopher Li

Spring Valley High School

As people continue to streamline everyday life with technology, the use of speech recognition has been made available in smartphones, speakers, cars, and more. The process of converting audio to text is known as automatic speech recognition (ASR), and current research is focused on improving robustness to speaker variability and background noises. One way to do so is speaker adaptation, which uses a small dataset of speech from one speaker to boost the program's accuracy on the chosen speaker. Due to the literature gap around an accuracy improvement goal for speaker adaptation, this research project aimed to set this goal by directly training ASR programs on the target speaker. It was hypothesized that training the model on data from a specific speaker would improve the model's accuracy when transcribing different speech from the same speaker. Using the Kaldi Toolkit and TIMIT Speech Corpus, unadapted and adapted hybrid models were trained. Using phone error rate (PER) as a metric for accuracy, it was found that training the model on the target speaker improved mean target speaker accuracy by an absolute PER of 7.4% and mean overall accuracy by 0.5%. Inferential statistics with t-tests revealed that both the increase in target speaker accuracy $t(47.52) = 19.90$, $p < 0.001$ and the increase in overall accuracy $t(57.97) = 3.33$, $p = 0.0015$ were significant. As a result, this experiment presents a successful partially speaker-dependent system that can be used as a goal for novel speaker adaptation approaches.

THE MICROWAVE SPECTRUM OF 2,6-DIFLUOROPHENOL

Ziwei Liu and Shamitha Nandi

SC Governor's School for Science & Mathematics

The rotational spectrum of 2,6-difluorophenol was measured through microwave spectroscopy. In microwave spectroscopy, a molecule's rotational transition gets excited due to its absorption of microwaves. Then, the molecule relaxes and emits the radiation back. This process helps in having a better understanding of the molecular shape. The procedure begins by measuring the frequencies ranging from 8000-18000 MHz using a Fourier-transform microwave spectrometer. A total of 10,000 averages were

obtained. The theoretical rotational spectrum of the molecule was calculated using Gaussian software. The theoretical rotational constants were the following: $A = 2344.0833$ MHz, $B = 1753.4626$ MHz, and $C = 1003.1035$ MHz. The experimental rotational spectrum was determined by using a software where lines were assigned to fit the theoretical transitions to the experimental ones. In conclusion, the experimental rotational constants were the following: $A = 2345.3196(27)$ MHz, $B = 1760.9802(33)$ MHz, and $C = 1005.8164(13)$ with an overall RMS error of 0.035 MHz.

THE EFFECT OF HIGH SCHOOL SPORTS PARTICIPATION ON ACADEMIC SUCCESS

Jay Locker
Chapin High School

This study is designed to explore the possible correlation between a student's GPA and their participation in high school sports at Chapin High School in Chapin, South Carolina. The data will be collected through a survey asking the students their grades and how long they study and practice each week. The expected data will show a positive correlation between participating in a high school sport and the student's GPA.

USING DATA DRIVEN TECHNIQUES TO PREDICT CARBON FIBER STRENGTH

Nathaniel Lott
SC Governor's School for Science & Mathematics

For my research project I used Python and artificial data to better predict carbon strength and find ways to improve upon it. This topic was researched because problems in carbon fiber manufacturing can lead to various issues in the strength of carbon fiber strands. Collecting enough data to analyze these errors and varying strengths would require millions of fibers and would have to be tested in a method that would take a large amount of time. With that being said, it could save a lot of time and resources to use the artificial data produced through the Weibull model to predict what the carbon strength will be for the finished product. When working towards a way to create and analyze the data, we used the Weibull model to form an equation and data structure to calculate the different ranges of failure at different lengths. The Weibull distribution is an indicator of the variability of strength of materials resulting from a distribution of flaw sizes. With this information I created a Python code designed to take multiple values of F (failure probability) and determine what sigma value would be needed to fit that equation. Unfortunately the code still has some issues to work out but does perform the task it was designed to do. Overall, the result of the code and data acquired is a major impact on the improvement upon carbon fiber strength and manufacturing as well as a more developed system of machine learning to create more artificial data.

THE EFFECT OF POLYVINYL CHLORIDE ON THE HEART RATE OF DAPHNIA MAGNA

Sreya Maddipati
Spring Valley High School

Polyvinyl chloride or PVC is an extremely abundant microplastic that is used in various commodities from packaging, to pipes, and to household appliances like bags and credit cards. Most of these items are portable or could easily be disposed of, but they could end up polluting the environment. Almost 80% of the world's pollution is caused by plastic, and one major cause for pollution in freshwater ecosystems are plastics as well. PVC is one of the most widespread and used microplastics, but it is also one of the main pollutants in freshwater environments. It was hypothesized that if *Daphnia magna* were introduced to

increasing amounts of polyvinyl chloride, their heart rates would increase as the organisms got more agitated by the new addition. In order to test this theory, 5 containers of about 30 *Daphnia magna* each were introduced to increasing amounts of PVC, with the first container being a control container. The other four containers were given pieces of a 1/2 x 12 inch PVC pipe that were cut into 1 inch, 2 inch, 3 inch, and 4 inch sections. The mass of each section also increased from 3.2g, 6.5g, 9.5g, to 12.6g. According to the one-way ANOVA test, the results of the experiment were statistically significant, with $F(4,102) = 156.491$. The median of each set of the variables increased as the amount of PVC introduced increased. The mean of the data set decreased as it went on; however, that was due to the *Daphnia magna* that did not survive and had heartbeats of 0 bpm. These altered the data. The medians from control to the highest amount introduced were an average of 179.5 bpm, 210 bpm, 237 bpm, 247 bpm, and 260 bpm. This shows that as more polyvinyl chloride was introduced to the *Daphnia magna*, they were more and more agitated with some even perishing.

MIDDLE AND HIGH SCHOOL STUDENTS VAPING OPINIONS BEFORE AND AFTER PRESENTATION

Ashley Majewski

The Center for Advanced Technical Studies

The purpose of this experiment was to see if students change their opinions on vaping before and after they watch a presentation about the dangers of vaping and the effects it has on your health. The target audience of this was middle and high schoolers and it will hopefully impact them so that they will be educated about vaping and its effects since they are the biggest target audience for vape companies. The motivation behind this was that many middle and high schoolers continue to vape, and especially with COVID it will have a negative impact on their lungs. People aged 15-17 are 16 times more likely to vape than 25-34 year olds. The goal of this was to see if people change their likelihood of vaping before and after the presentation and to see if they gained any more knowledge on vaping based on survey questions that assess their knowledge on their topic. The survey has the same questions on the pre and post and answers will be compared. So far, the results are very scattered but overall, many people say that vaping does not appeal to them and this will not vape after watching the presentation. This is important because it will combat teens becoming addicted to nicotine and stop a generation from forming an addiction.

USING SOLAR PHOTOVOLTAIC ENERGY TO POWER A PORTABLE BLUETOOTH SPEAKER DEVICE

Jackson Massalon

The Center for Advanced Technical Studies

Over the past couple years, sustainable energy devices have become more advanced and accessible, but sometimes unable to compete with the more mainstream appliances. In this project I am hoping to close the gap between these two different types of appliances. I will be creating a speaker powered by solar PV cells that can compete with the most mainstream speakers. In order to have a chance to compare to the best selling speakers today, I am focusing on making this speaker very portable, have a reliable battery life, and deliver great sound quality. I plan on eventually 3d printing the main body of the speaker in order to maximize portability. Since I am creating a custom body, I am also wiring each prototype speaker myself. So far I have been able to test different pre-made panels to decide which ones would work best for my project. In these tests I found that four- 0.5 volt/200 milliamp solar panels are the best ones for my project. Now I am working on wiring my speaker and assembling the first prototype shell made from a board of laser-cut wood. After receiving the rest of the electronics, my first prototype will be finished soon.

THE EFFECT OF THE COVID-19 CRISIS ON THE EMOTIONAL INTELLIGENCE OF HIGH SCHOOL STUDENTS

Elizabeth McCallum
Spring Valley High School

The COVID-19 crisis has recently put a large strain on the mental health of youth in the United States. The purpose of this study was to analyze the effect of the COVID-19 crisis on the Emotional Intelligence of high school students. It was hypothesized that the average Emotional Intelligence of high school students would decrease after the onset of the COVID-19 crisis. Students at Spring Valley and Blythewood High School were asked to complete a questionnaire both in November of 2019 (before the onset of COVID-19 in South Carolina) and in December of 2020 (9 months after the onset of COVID-19 in South Carolina). The survey contained the Schutte Emotional Intelligence scale, and the averages of Emotional Intelligence from 2019 and 2020 were calculated. The average Emotional Intelligence from November 2019 was 121.8 and the average Emotional Intelligence from December 2020 was 117.7. To compare these averages, a T-test was conducted. With a p value of 0.055 and an alpha value of 0.05, there was not sufficient evidence to reject the null hypothesis. Therefore, the hypothesis that the Emotional Intelligence of high school students would decrease after the onset of the COVID-19 Crisis was not supported. This suggests that Emotional Intelligence can continue to be used as a tool to promote resilience and better mental health throughout the extent of the COVID-19 Crisis.

CORRELATION BETWEEN EMOTIONAL FACTORS AND WORD RECOGNITION

Kat McConnell
SC Governor's School for Science & Mathematics

How quickly you recognize a word you are reading is called processing speed, which is subjective, meaning it changes depending on the person reading the word. Valence is how positive or negative a stimulus is; it is also subjective, and is measured on a scale of 9 in this experiment, where 1 is very negative, and 9 is very positive. Many studies have been conducted to see if valence affects processing speed, but there is still not a concrete conclusion. This experiment aimed to discover whether valence influences processing speed or not. A database was created to measure different factors of words, including their valence and the time that it took a pre-selected group of people to recognize them. This database was put into R Studio to create a correlation matrix. The matrix displayed the correlation coefficients between all of the factors to determine whether they are related. This matrix showed that there was a very slight negative correlation between valence and processing speed. It was incredibly small, though, so it was not enough to draw a solid conclusion. This superficially aligns with the Automatic Vigilance Theory, which concludes that words with negative valence take longer to recognize. Despite the fact that the results slightly follow this theory, the correlation is too weak to infer that it is anything other than chance or interference from other factors.

COOLING SOLAR PANELS TO PREVENT EFFICIENCY LOSS AT HIGH TEMPERATURES

Gavin McLaurin
The Center for Advanced Technical Studies

This study's purpose is to reduce temperatures of solar panels in order to reduce thermal drift and make solar panels more efficient. Solar panels were tested under a lamp that produces high heat, increasing the temperature of the tested solar panels to about 35 degrees Celsius. Two different prototypes were tested on the solar panel: a design with heatsinks attached to the bottom of the panel with a fan blowing air

underneath the panel, and a design with a pump-based system that pumped water through a pipe with holes that passed over the top of the panel, allowing for water to flow over the surface of the panel. When compared to the solar panel with no modification, both modifications showed an increase in DC voltage production - increasing voltage production from 90% of the maximum voltage to near 100% of the maximum. Developing a full-scale method of reducing the temperature of solar panels will greatly benefit the voltage production, making solar panels more efficient.

PART OF WEARING A MASK IS WASHING A MASK: HERE'S THE BEST WAY

Ari McNeal

The Center for Advanced Technical Studies

The purpose of this project was to determine the best way to clean a face mask that we now use daily. It did educate those on keeping their masks clean, who didn't already. The target audience of this was young adults and adults and it did provide guidance on which way would be most efficient to clean masks. Masks are now used daily and should be cleaned daily. My motivation behind this project is to show people how masks should be cleaned to provide the best use during this pandemic. It is key that people do everything to stay clean and healthy during this pandemic. By cleaning masks and getting rid of bacteria, it makes everyone safer. The goal is to get more people to be efficient, clean their masks, to prevent further sickness and spreading germs. The purpose of this project is to determine the best way to clean a face mask that we now use daily. COVID-19 is the biggest topic in the world right now, since masks have become the "new normal". Making sure people take every measure to stay clean, will help the virus spread itself. The survey and data claims that many only wash their masks weekly or monthly. Masks collect over 50% of germs that come through your nose and mouth a day. When not taken care of germs can be spread easily, just by talking or taking off your mask. This research will educate people that masks should be washed daily to ensure safety.

SIP SAFE: ANALYZING DEHYDRATION IN STUDENTS DUE TO MASKS

Anna Grace Mensch

The Center for Advanced Technical Studies

COVID-19 created a new normal for society, bringing changes in every aspect of one's life, including how much one eats or drinks. Wearing masks and social distancing protocols have limited students' ability to hydrate as usual. The purpose of this study is to examine hydration status between those students having to obey mask policies in schools versus those learning from home. The hypothesis is if the hydration status of students is measured using three different hydration indicators over the course of a virtual day versus a face to face day, there will be a correlation between poorer hydration status and face to face school days because of the mask and COVID policies implemented in schools. A group of twenty high school students operating on a hybrid school schedule were gathered and their change in percent body water, urine color, and thirst level in the afternoon minus the morning on virtual and face to face days was measured. Although the correlation calculations have not been completed, the data has been reviewed and is expected to support the hypothesis. However, this could change depending on if the data is statistically significant or not. Since it is well known that masks are paramount to keeping students safe, an engineering project has been designed to solve the problem the research defines, by creating a safer way for students to hydrate during a pandemic. The goal of the research and engineering is to help students stay safely hydrated during the remaining duration of the pandemic.

THE EFFECT OF PERSUASIVE SOCIAL MEDIA ON ADOLESCENTS' PERSPECTIVE OF THE MINIMUM WAGE IN THE UNITED STATES

Matthew Miller
Spring Valley High School

Experiments with the Elaboration Likelihood Model have shown the effectiveness of peripheral cues. However, the effectiveness of peripheral cues has yet to be examined in the context of the social media platform Instagram. Therefore, the purpose of this study was to examine the elaboration likelihood model in the context of Instagram. It was hypothesized that the group that experiences peripheral-route persuasion through social media posts would be the most positively influenced in favor of raising the minimum wage. The hypothesis could be attributed to research showing biased posts are often more persuasive than objective posts, especially with younger demographics. The survey was conducted using three different groups: No Persuasion, Central, and Peripheral. Each group represented a different part of the Elaboration Likelihood model and was shown a different set of images. Before and after being shown the images, the participants were asked questions gauging their opinions on the minimum wage. The participants were high school students ranging from 14-18 years old who attended Spring Valley High School. The central route was the most consistently effective with two the sub-groups (clarified in results) having $t(54)=2.73$, $p=0.0043$ and $t(54)=2.93$, $p=0.0025$. The peripheral route was more effective than no persuasion as it had one significant subgroup while no persuasion had no significant sub-groups. The results of this study indicated that people are less influenced by biased social media than thought to be true, which did not support the hypothesis.

THE EFFECT OF ENVIRONMENTAL NOISE FACTORS ON THE CONCENTRATION OF E-LEARNING STUDENTS DURING THE CORONAVIRUS PANDEMIC

Alexander Mills
Spring Valley High School

The purpose of this project was to study the effects of various environmental noise factors within one's work environment during the Covid-19 crisis to test the focus during school. It was hypothesized that if the participants have various noise factors within their work environment, instead of one loud and continuous noise, then it would decrease the comfort level and their ability to focus in school or e-learning. The participants were asked a series of questions using a google survey. These questions were aimed to find out the number of environmental factors and the participants level of focus while being exposed to these environmental factors. The level of focus was tested by a likert scale ranging from 1 to 5. After experimentation was complete, the data was put into a spreadsheet and then analyzed. An independent t-test was conducted on the level of comfort before COVID-19 school conditions and during COVID-19 school conditions. The data showed that there was a difference between the two means in the comfort levels. With a p-value of 0.00141 which is less than the critical value of 0.01, the results are statistically significant. Means shows that the hypothesis was supported in showing that the different environmental noise factors have a negative impact on a students comfort and their ability to focus.

DEVELOPMENT OF ANTIBIOTIC TO COMBAT ISONIAZID-RESISTANT MYCOBACTERIUM TUBERCULOSIS

Ethan Mills
SC Governor's School for Science & Mathematics

The disease Tuberculosis, caused by the highly successful Mycobacterium tuberculosis, has plagued humanity for thousands of years. With the advent of modern medicine, it has become possible to treat

the disease, however it is notoriously hard to cure and requires a combination of many antibiotics. Isoniazid, in combination with other drugs, is the first line of treatment for patients suffering from Tuberculosis, however the increasingly common isoniazid-resistant strains of *Mycobacterium tuberculosis* have greatly reduced the effectiveness of the drug. Due to the dire need of a new drug to combat these drug-resistant strains of the bacteria, I sought out to develop a derivative of Isoniazid that would be able to work as an effective antibacterial drug against the bacteria. Using molecular modeling, docking, and visualization programs, I was able to develop 20 derivatives that had slightly altered molecular structures and calculate their binding energy with the enzyme they inhibit, 2-trans-enoyl-ACP reductase. Using this data, I compared the binding energy and conformation of the derivatives with an isoniazid-resistant mutant of the enzyme. This data revealed that by increasing the length of the isoniazid compound by adding extra carbons, the derivatives were able to bind at a more favorable energy on both enzymes. Although future work will need to be done to determine the true effects of the derivatives, the results suggest that by slightly altering the isoniazid compound, a new antibiotic can be derived that is able to target isoniazid-resistant *Mycobacterium tuberculosis*, greatly improving our current treatment of patients with Tuberculosis.

ELECTROMAGNETIC MOTOR SYSTEMS TO DEVELOP ALTERNATIVES TO CURRENT MAGLEV INFRASTRUCTURE AND TRANSPORTATION

Apurva Mitta
Spring Valley High School

MAGLEVs use permanent magnets cooled at cryogenic temperatures, as well as coils throughout the track, for a process of repulsion and levitation that pushes the train above the track. Through magnetism and elimination of friction, these trains can reach speeds greater than 300 mph without the need of a constant power supply—the trains' properties themselves regulate motion. However, issues worldwide have limited their prevalence due to the cost of infrastructure, political and social support, and possible mechanical failure. The purpose of this study was to explore alternatives to the current infrastructure and method of transportation of the standard MAGLEV train. A comparative analysis was conducted between DC motor systems and an AC motor system to determine velocity as a variable for efficiency. The DC Motors were physically simulated on a tangible prototype and MAGLEV Track, and an AC Motor was modeled with optimum parameters on Autodesk Inventor for simulation on the CAD-modeled prototype through COMSOL Multiphysics. Two one-way ANOVAs were conducted to analyze the statistical significance of the times of running and velocities of the motors. It was revealed that the AC Motor had the highest velocity; the times of running were significant, as $F(2,12) = 120917.86$, $p < .001$, and the velocities were significant, as $F(2,12) = 511.29$, $p < .001$. Tukey tests for Post-Hoc analysis also confirmed statistical significance. Overall, the results of this experiment can provide insight into possible designs for future MAGLEVs to maximize implementation throughout areas in need of such change.

UNDERSTANDING CRYSTAL GROWTH MECHANISMS VIA MODEL-BASED ANALYSIS AND ATOMIC IMAGE SIMULATION

José Montés
SC Governor's School for Science & Mathematics

The goal of the project was to investigate the nature of crystals and use software to simulate images of their structures. It is important to better understand crystals since many materials are crystalline in nature, such as metal, stone, and glass materials, all of which are regularly used to manufacture consumer goods and various technologies. Studying crystals facilitates the development of better technologies and consumer products. These simulated images would be used to better understand how crystal structures work on a molecular level. With guidance from advisors from Clemson, the project focused on modeling

the structures of diamond, titanium, and Iron (III) Oxide using Dr. Probe and VESTA, two types of crystallography software. In the process of research, several images of diamond crystals, Iron (III) Oxide crystals, and titanium crystals were created, each with variations to account for differences and irregularities in their growth. As expected, the simulations produced images that closely match the images found by those collected by electron microscopes. Crystal growth was also modeled, and as crystal structures are repetitions of a basic system of atoms and molecules known as the unit cell, only a few repetitions of the unit cell were needed for a crystal nanoparticle to develop, which fits with the current scientific understanding of crystals. In using crystallography technologies, new renewable energy technologies can be created for batteries and solar panels, and new materials can be created for industrial uses in manufacturing.

PLAN MEDICATION MODERATION

Zachary Moore, Alexander Nelson, and Lucas Phillips
The Center for Advanced Technical Studies

The problem that we aimed to solve was the fact that elderly people struggle to open and distribute their medication. Additionally, elderly people struggle to read the directions on the medication they're taking, this could lead them to take the wrong dosage or they could end up taking the wrong medication altogether. While prior attempts have been aimed at aiding in the opening and reading of prescription medications, it has resulted in a multitude of tools that, while very useful, ultimately do not help in every aspect. The Jokari rubber grip with attached magnifying glass helps the opening of the bottle but does not help to keep time when medication is needed. Another one of these devices is the Hero automatic pill dispenser, which separates and distributes the medicine when needed, but cannot open the medication to be sorted. There are many devices like these that while they can solve our problem together, they can't do it separately. The expectation is that the device will complete all the aforementioned problems in one machine/solution by reading the medication, sorting it, and dispensing the medication at the correct times.

DETERMINING THE REACTION MECHANISM FOR AQUEOUS-PHASE REFORMING WITH A CATALYTIC PLATINUM CLUSTER OVER AN ALUMINA SUPPORT

Elena Morgan and Shamitha Nandi
SC Governor's School for Science & Mathematics

Aqueous Phase Reforming (APR) is a chemical process that transforms oxygenated hydrocarbons, like sugars or alcohols, into hydrogen and light alkanes. Hydrogen has become increasingly popular as an energy source. However, most hydrogen is produced from fossil fuels. The use of APR in biorefinery presents a more sustainable and environmentally friendly way to produce hydrogen. For this project, we used computational models to study the APR reactions with a catalytic platinum cluster over an alpha alumina support. We focused on three main goals: (1) the development of a platinum-8 (Pt-8) model, (2) the lattice optimization of a triclinic bulk alpha alumina support, and (3) the identification of potential binding sites for the adsorbates COH and CHO on a Pt-4 cluster. The first and third goals involved adding either a platinum atom or the adsorbate to the Pt-4 cluster (four platinum atoms bonded together). Several locations were tested to find the structure with the lowest energy configuration. We identified the most favorable structures and confirmed previous studies that found the alpha alumina support interacts with the adsorbate. Future work needs to be performed to investigate the impact of this interaction. For the lattice optimization goal, we compared the energies and volumes of different lattice parameters to identify the optimum parameters for the support. Overall, this research will contribute to

the development of more accurate models of APR reactions and provide insight into the interfacial sites for catalysis, which will help improve the APR process in the future.

THE EFFECT OF THE CONDITIONS AND TREATMENT OF AN AREA ON THE SPECIES ABUNDANCE AND RICHNESS OF SOIL FAUNA

Sophia Morrison

SC Governor's School for Science & Mathematics

Soil fauna aids in the breakdown of dead plant and animal matter. Moisture and leaf litter amount increase the abundance of soil fauna. High levels of human activity decrease abundance of soil fauna. The effect of temperature on soil fauna varies with species. The purpose of this research was to determine if the conditions and treatment of an area affects the species abundance and richness of soil fauna. We analyzed the variety and quantity of soil fauna from two different locations. Location A is a suburban yard with regular physical and chemical maintenance, high levels of foot traffic, and low levels of leaf litter. Location B is a rural yard with no maintenance, low levels of foot traffic, and high levels of leaf litter. We took samples from both locations and placed them into a Berlese funnel to slowly dry them and to force the fauna to migrate through the mesh and into alcohol. This fauna was isolated, identified, and separated into order under a stereomicroscope. The specimens were counted and recorded. Recorded data was analyzed using a T-test. Our results did not show a difference in variety or quantity of the soil fauna between the two locations. This is most likely because of the small sample size. However, the difference in soil composition was not taken into account. Future research should take soil compositions into consideration in location selection.

PREDICTING MECHANICAL PROPERTIES OF NANOCOMPOSITES USING CLEMSON'S SUPERCOMPUTER

Natalie Mueller

SC Governor's School for Science & Mathematics

There is a great need for lighter, tougher, stronger, and more flexible materials to build new technology. New materials could be used to construct lighter aircraft and vehicular parts, food storage containers that hold food for longer, and for medical procedures. These materials already exist in nature but we looked at how to create them synthetically. This research looked at how to build these materials on a nanoscale or atomic level. Particularly, this research observed Young's Modulus. This was achieved by using computer simulation done by Clemson's Supercomputer. We used computer simulations to test our composites as opposed to physical testing due to it being cheaper and less time consuming. Once more testing is done, physical versions of each material can be made to test further. We looked at different configurations of graphene and polymer to see which would resist deformation the most. Due to our limited testing, we were unable to draw definitive conclusions on how these composites would react under stress. Since this research is fairly new, more testing is required to understand how to replicate biomaterials.

THE HEALING HUG: A SENSORY TOOL TO COMBAT THE NEGATIVE HEALTH EFFECTS OF SOCIAL ISOLATION

Mackenzie Murphy

The Center for Advanced Technical Studies

The purpose of this project is to design and create a product that will help alleviate the negative health effects of social isolation. During the COVID-19 pandemic, social isolation has reached an all time high as many people have chosen to stay home due to their region's stay at home orders or out of an abundance of caution in regards to the transmission of the virus. Studies have determined that isolation and loneliness are associated with significant health issues. The target audience for this product are elderly shut-ins, nursing home patients, or people who live alone at home, all of which are lacking a proper amount of social and physical contact. Studies have shown that hugs release oxytocin, a hormone that stimulates dopamine release and decreases stress and anxiety. The goal of this project is to create a tool that can effectively take advantage of these benefits using a combination of deep touch therapy and weighted blanket technology to simulate a real human hug. The prototype is made with three layers; the first is made up of weighted pockets that add up to around 14 pounds, the second is a layer of stuffing to make the product more comfortable, and the third is a washable minky fleece layer that can be unzipped and removed. The prototype is still in its final stages of construction and has not yet been evaluated, but students who have held the completed inner layers have reported feeling calmer, so the results are promising.

THE EFFECT OF PLASTIC AND PAPER TEA BAGS ON THE MORTALITY AND HEART RATE OF DAPHNIA MAGNA

Madeline Nealey

Spring Valley High School

The purpose of this study was to figure out whether plastic or paper tea bags are more harmful to *Daphnia magna* in order to know which direction future research should go in making more eco-friendly tea bags. It was hypothesized that plastic tea bags would result in greater mortality and lower heart rates of *D. magna* than the paper tea bags because, not only have microplastics been shown to negatively impact aquatic life, but they can also release chemicals that are harmful to organisms (Yang et al., 2011). Two brands of plastic tea bags, Lipton and Twinings, and two brands of paper tea bags, Numi and Tazo, were steeped in hot water. *D. magna* were cultured in this water after it cooled, and mortality and heart rate was recorded. The results concluded that plastic tea bags were more harmful than one paper tea bag (Numi) but not the other (Tazo), partially supporting the hypothesis. Heart rate also decreased with each tea bag; they decreased faster with the plastic tea bags. A two-way ANOVA test resulted in a significant difference of heart rates with the tea bags, $F(4, 40) = 70.11$, $p < 0.001$; over time, $F(3, 40) = 175.41$, $p < 0.001$; and the interaction, $F(12, 40) = 15.82$, $p < 0.001$. A post-hoc Tukey test resulted in a significant difference between means. Therefore, the null hypothesis was rejected, meaning plastic and paper tea bags impact *D. magna* heart rate and mortality.

THE EFFECT OF WEIGHTED CLASSES ON THE ANXIETY OF SPRING VALLEY HIGH SCHOOL STUDENTS IN AN ONLINE ENVIRONMENT

Tim Nguyen
Spring Valley High School

In a year where COVID-19 persists throughout the entire world, the typical structure of how students learn has changed dramatically. One of these changes is the switch from in-person learning to virtual learning. The research has been conducted in order to understand how junior students at Spring Valley High School have reacted to this change through stress and anxiety. The participants have been chosen based on which English class they go to: English 3 CP, English 3 Honors, and AP Language students. It has been hypothesized that the larger the weight is for the class, the more anxiety the person will have from the switch from in-person to virtual learning. In order to determine this, a google form was sent out to various classes after a midterm exam to evaluate their stress after them. Their score was determined by the prompts at the third section of the questionnaire, where the higher the score, the more anxious that person was during the exam and virtual learning as a whole. However, in the end, not enough participants did the questionnaire and thus the hypothesis was inconclusive and the t-test was not significant.

COVID-19 AND ITS IMPACT ON INFECTIOUS DISEASE RATES IN SOUTH CAROLINA

Anders Orr
SC Governor's School for Science & Mathematics

This research was an observational study where two samples of patients from Dr. Sally Burgess, from Piedmont Pediatrics, were compared. The two groups of patients were from two separate years, 2019 and 2020. The main question was if COVID-19 had any effect on the rate of doctor visits or positive test results. Ratios of positive test results to the total number of patients were compared for each year. A preliminary investigation of the data indicated that the positive test result ratio for 2020 was higher than that of 2019's ratio. Under the assumption that our given sample constitutes a simple random sample from the entire population of similar patients within South Carolina, the claim was tested using a difference in proportions statistical test. It was found that the 2020 proportion of results were indeed higher than the 2019 proportion at the $\alpha = 0.10$ level of significance. There are various proposed theories for this difference, including that individuals with mild to no symptoms were less likely to visit a doctor than individuals with more intensive symptoms.

DOG FUR MATTING

Samuel Pacific and William Petruzzi
The Center for Advanced Technical Studies

Research has shown that dogs tend to get lots of mats when they have long hair and curly hair. This leads to infection, fleas, and pain in the dogs. You need to brush the mat out because if you don't you can hurt the dog. Fleas and ticks can hide in the matts and you would not know. You need a brush that can get them out in a short time, and use a small amount of force. Also, matts have to be shaved off by a dog groomer and the average cost can be from 60\$ to 90\$ every time. Our design will be compared to a commercially available mat brush. It will be modular in design, allowing for different heads to be tested. Our success criterion will be the removal of similarly size matts in less time with less force than the control brush. The way we've measured the data is by using a force transducer.

THE EFFECT OF AYURVEDIC PLANT EXTRACTS-- *MUCUNA PRURIENS* AND *BRASSICA OLERACEA*--ON THE
DELAY OF MOTOR SYMPTOMS IN PINK1
DROSOPHILA MELANOGASTER: A MODEL OF PARKINSON'S DISEASE

Sanjana Parise
Spring Valley High School

Parkinson's Disease (PD) is a neurodegenerative disease that is characterized by loss of dopaminergic neurons of the Substantia nigra, negatively affecting motor control and causing symptoms such as dyskinesia, or uncontrollable, involuntary muscle movement. The purpose of this study was to act as a PD model to explore a safe, affordable, and accessible method of treatment for such symptoms. It was hypothesized that when *Mucuna pruriens* (Mpe) and *Brassica oleracea* (*B. oleracea*) extracts are administered to PINK1 *Drosophila*, *Brassica oleracea* would delay the loss of motor ability in the PINK1 flies the longest because it contains sulforaphane which activates the Nrf2 pathway, promoting antioxidant activity and countering oxidative stress. To quantify the climbing ability of the PINK1 *Drosophila*, which display PD-like symptoms, a climbing assay was conducted on the treatment groups, where the flies were administered either 32mg/100g Mpe or *B. oleracea*, and the control group, which was administered nothing. After running an ANOVA and t-test on the results of this experiment, it was determined that only Mpe had a significant effect on the climbing ability of PINK1 *Drosophila*. Because the t-test displayed a p-value of 0.003761, which is less than 0.05, the difference between the Mpe treatment group and the control group was significant. However the *B. oleracea* had a p-value of 0.348447, which is greater than 0.05, meaning that the difference was not statistically significant. Therefore, Mpe most effectively delayed the loss of climbing ability in PINK1 *Drosophila*, meaning it can potentially be used to treat the motor symptoms of PD.

THE EFFECT OF COMPETITIVE YOUTH SOCCER ATHLETES (U13-19) RETURNING TO COMPETITION
CONSIDERING COVID-19 PROTOCOLS IN REGARDS TO THE PLAYER'S PHYSICAL HEALTH AND STRESS
LEVELS

Christopher Park
Spring Valley High School

This study revolves around the circumstances of the COVID-19 pandemic on the competitive youth soccer athletes in the state of South Carolina. The purpose of this study was to identify levels of physical health and mental stress in competitive youth athletes before and during the implementation of COVID-19 protocols. It was hypothesized that the player's physical health and stress levels would decrease due to returning to play with COVID-19 protocols because of the large quarantine time frame. It was also predicted that the athlete's physical health would decrease due to the inability to train as a team in an outdoor environment. The survey requested responses regarding their name, age, team name, followed by several questions that focused on their current and past physical health and stress levels, opinions directed on the current public health precautions, and the league's implementation of their protocols for the current and future season(s). The questions focused on current and past health levels, analyzed through a Mann U Whitney Test, which analyzes two independent groups when the dependent variable is ordinal. The results concluded that the sampled participants were more distressed and felt physically unsafe during the return to play phase with the pandemic's protocols adverse to the playing conditions before the outbreak. As a result, the hypothesis was partially supported as the sampled athletes supported the claim that their physical health decreased, with a p-value less than 0.05, marking the result as significant, rejecting the null hypothesis. The stress levels were increased due to the protocols, with a p-value of less than 0.05, marking the result as significant, rejecting the null hypothesis.

DECIPHERING CRYPTOGENIC STROKES WITH ATTENTION TO SYSTOLIC VALUES, CRP, LEVELS, AND MEDICATIONS

Aryan Parmar

The Center for Advanced Technical Studies

This research is intended for patients who have suffered from a cryptogenic stroke. It will benefit them and the medical professionals they are working with to understand the cause of their stroke. Knowing the medical cause of the stroke is crucial for preventing, treating, and diagnosing strokes. I was motivated by my father's stroke, which does not have an identifiable cause after four years. The problem is significant as more than 30-40% of ischemic strokes are labeled as cryptogenic. I hypothesize that by studying patient data, specifically hyperventilation systolic right middle cerebral artery blood flow velocity (SYST MCAR HV), I will identify diseases that may have caused the stroke. My research is unique as a study on hyperventilation systolic values and directly finding out possible diseases has not been conducted before. The problem I will solve with my project includes diagnosing cryptogenic strokes. My methods include sorting and organizing data in excel and Orange Data and comparing values of one patient to others. A similar previous study by M. Liu predicted the etiologic subtype of a mild stroke. Variables include systolic and diastolic values. I have found that SYST MCAR HV values for a particular patient are statistically significantly higher than others. C-reactive protein levels are also high, the coupling of these factors likely led to a stroke. The hypothesis was supported as the systolic values were 15.07 for the patient, while the average was 53.00. My research's significance is systolic pressure being reduced led to a stroke.

THE ALLELOPATHIC EFFECTS OF EUCALYPTUS, SUNFLOWER, SPEARMINT, AND BARLEY STRAW NATURAL EXTRACTS ON THE GROWTH INHIBITION OF MICROCYSTIS AERUGINOSA

Meghan Pasala

Spring Valley High School

Harmful algal blooms in freshwater ecosystems can introduce toxins into the environment that can have negative effects on aquatic organisms and cause health complications within humans. Instead of using chemical algicides that can further harm the environment, this study investigates environmentally friendly algicides by comparing the allelopathic effects of eucalyptus, sunflower, spearmint, and barley straw species on the growth inhibition of *Microcystis aeruginosa*, a common harmful algal bloom species. It was hypothesized that the barley straw extract would result in the highest growth inhibition because of its previously identified allelopathic effects. *Microcystis aeruginosa* and culture medium, followed by each of the natural extracts, were added to their respective plastic cups and left at room temperature. Absorbance values for each algal sample were recorded at 430 nm using a spectrophotometer before extracts were added. Absorbance values were also recorded three days and ten days after the addition of extracts. The data showed that the barley straw treatment group had the highest negative mean change in absorbance values during experimentation, indicating the most growth inhibition, which supported the hypothesis. A two-way ANOVA test, followed by a Tukey test, revealed significant data; $F(4,290) = 49.60$, $p < 0.001$ and $F(1,290) = 190.30$, $p < 0.001$. The results showed that allelochemicals within the barley straw extract had the greatest inhibitory effects, followed by eucalyptus, spearmint, and sunflower. These findings suggest that future studies should continue to focus on the allelopathic properties of polyphenols and alkaloids with other plant species.

HOW DIFFERENT TYPES OF SOIL THAT CONTAIN CLOSTRIDIUM BUTYRICUM WILL AFFECT THE POWER OUTPUT OF A MICROBIAL FUEL CELL

Jay Patel
Spring Valley High School

With the increasing need for energy, an energy crisis is inevitable. Microbial fuel cells are a promising technology that can potentially avoid this crisis. Microbial fuel cells (MFCs) are fuel cells that collect electrons from bacteria in order to produce electricity (Logan, 2006). However, the expansion of MFC technology is slow due to many limitations such as its low power output and the lack of understanding of microbial fuel cells and bacteria's relationship with them (Xu, 2015). The purpose of this experiment was to see which soil will produce the greatest amount of electricity. In this experiment, the effect of topsoil, compost soil, and silt soil on the power output of the microbial fuel cells (watts) was tested. *Clostridium butyricum* grew inside of the soils and the power output of the MFCs was recorded daily. It was hypothesized that the microbial fuel cell would have a higher power output in the compost soil because the *Clostridium butyricum* will produce more energy due to the soil's optimal pH (6-8), ability to retain nutrients and water, and its abundance of macro/micronutrients, minerals, and vitamins. The results supported the hypothesis, as the compost soil had the highest power output compared to the silt and topsoil. By changing the soil that MFCs inhabit to compost soil, MFC technology can evolve at a rapid pace. With the help of microbial fuel cells, large amounts of electricity can be produced without hurting the environment in any shape or form (Ochoa, 2016).

THE EFFECT OF NODULATION AND NITROGEN APPLICATION ON SOYBEAN GROWTH

Phillip Perea
SC Governor's School for Science & Mathematics

Nodulating soybeans can fix atmospheric nitrogen into a bioavailable form through a mutualistic relationship with a special bacterium housed in their root nodules. However, under stressed conditions, some soybeans lose their ability to nodulate and thus are unable to facilitate N-fixing bacteria. The goal of this project is to test the effect of different nitrogen application levels on the soybean growth of nodulated and non-nodulated soybeans. In our field experiment, we planted two different types of soybeans (Williams 82) and (Nod -) designed to test nitrogen application on nodulated and non-nodulated soybeans, respectively. The (Nod-) soybeans we used were genetically modified and represented a stressful year that causes nodulation failure in the soybean's roots. This is attributed to poor water access and nutrients in the soil. The nodulating soybeans represent a regular year for the farmers and were used as a control to see the effects of nitrogen application on nodulating soybeans. After the addition of nitrogen fertilizer, we measured the height, greenness, and canopy fraction of the soybeans using a handheld Green Seeker and with a drone. In conclusion the application of additional nitrogen (Low- 80 lbs./acre, Med - 160 lbs./acre, and High - 240 lbs./acre) at the flowering stage benefited (Nod -) soybean plants. However, we also found that the (Williams 82) soybeans did not properly form root nodules due to outside factors, nullifying our control. This research will be used to develop a test that will tell farmers the optimal amounts of nitrogen fertilizer to put on stressed soybean fields. Further studies are required to clarify the potential beneficial impacts of N addition.

THE CORRELATION BETWEEN POLITICAL AFFILIATION AND COVID-19 PRECAUTIONS

Dalton Perry
Chapin High School

Over the past year, the COVID-19 pandemic has taken the world by storm. In America alone, 484,000 casualties from the coronavirus and 27.6 million confirmed cases have been confirmed since the initial outbreak. Simultaneously happening within America, political tensions and upheaval has been at an all time high. One topic of debate throughout America today is the precautions that should be taken with regards to the novel coronavirus, but more specifically, the difference in political parties' views on the virus. Explained by the Pew Research Center survey mentioned multiple times throughout this paper, there are stark differences between the left and right view on precautionary measures that should be taken with regards to COVID-19 (2020). However, many high school students are not included in these political polls. This study will investigate the correlation between political affiliation and the precautions taken with regards to COVID-19, thus addressing the gap that surveys such as the one done by Pew Research Center creates. To investigate this gap, a survey was conducted with questions pertaining to one's political affiliation and a multitude of questions pertaining to precautions that they have taken or other people should take to help slow down the spread of COVID-19. This will help show the correlation between political affiliation and precautions taken with regards to COVID-19. From the results of the survey, the correlational test, there is a strong, positive correlation, between left leaning individuals and a compliance with COVID-19 precautions.

RISING GLOBAL PANDEMIC: A REUSABLE, SAFE, AND MORE COMFORTABLE FACE MASK

Harrison Pham
The Center for Advanced Technical Studies

With the current COVID-19 pandemic, reducing transmissions is essential to benefit the whole population. Face masks are mandated in order to encourage safety during these crises, yet current masks on the market are found to be rudimentary, causing irritation, discomfort, and fogginess in glasses. This project offers a revised design including features such as adjustable straps going around the back of the head and a lip to catch breath, preventing its upward escape to fog glasses. Improved user comfort is significant for increasing mask usage and thereby decreasing transmission rates. The goals of this product are to increase comfort, breathability, and ameliorate issues found in previous designs. Repeated experimentation and critical analysis were the methods of choice to find faults in the designs of face masks on the market as well as prototypes developed within this project, addressing issues with slight alterations. Several methods to test mask filtration have been presented in past studies, though few account for sneezing velocity which would be prevalent given the current disease's transmission through respiratory droplets. In this study, a centrifuge will be used to simulate sneezing velocity, and particle pass-through will be analyzed via microscopy. Surveys will be conducted to show levels of comfort, breathability, and style comparatively to masks on the market to determine the effectiveness of this product. The results of each are expected to show positive results of increased levels of user comfort and safety and will serve as a baseline for validation and the further improvement of future developments.

THE EFFECT OF DIFFERENT PROTESTING METHODS ON POLICY CHANGES

Caleb Phillips
Spring Valley High School

Protests are a common way people express their beliefs against what a larger group is doing, and these protests can be conducted in multiple ways. The three main types are petitioning/marching, boycotting, and rioting. Petitioning/marching takes the least amount of effort and is the most peaceful, boycotting takes medium effort and is peaceful, but more indirect, while rioting is the most violent and most direct method of protesting and proving a point. The main issue with protests is that people use various different methods, but many of them fail to make an impact. The purpose of determining which protesting method is most effective would be to allow a protestor to choose the most effective method for bringing change. Research and experimentation found that the most effective protesting method is petitioning/marching. This supports the initial hypothesis that petitioning/marching would be the most effective protest type. Rioting was found to be the second most effective and was still significantly less effective than petitioning/marching. Boycotting was the least effective and was only slightly less effective than rioting. These results show that peaceful protests should be the primary protesting method for people. It should also be acknowledged that boycotting is hardly as effective as petitioning. The lack of specific experimentation used could lead to more specific experimentation in more specific categories in the future. Future researchers could find more specific categories under the petitioning/marching category, or determine how quantity of people affects effectiveness.

ORGANIZATIONAL EFFICIENCY THROUGH GOALS, COMMUNICATION, AND RESPONSIBILITIES: A CASE STUDY OF A LEAN NON-PROFIT ENTITY

Luke Phillips
SC Governor's School for Science & Mathematics

This study involves an organizational behavior analysis case study to determine factors improving organizational efficiency in one small non-profit entity. The mission of this entity, SC Economics, is to improve K-12 economics and financial literacy in the state of South Carolina. Over a six-week period, the author conducted one-on-one interviews with each staff member and observed everyday operational activity. It was determined that the organization operated at a high level of efficiency, being effective at meeting goals given available resources. SC Economics was able to reach this level of efficiency by having a common goal, well-structured and clear communication, and distinct and clearly defined responsibilities.

EMPIRICAL STUDY OF EARLY ELECTION RESULTS

Julien Pitrois
SC Governor's School for Science & Mathematics

Election night is a very exciting night with people gathering around to see the news projecting the winners. Using election results from each polling place in Australia's elections from 2004 to 2019 this study investigated how news agencies can predict winners without all the votes being tallied. Using the coding language Python, an algorithm was created to check what number of polling places is needed in a district to predict the winner of the district's house seat with a success rate of 950000 out of 1000000 trials. The algorithm entailed taking a random selection of 1 to the total number of polling places in the district polling places from a list and comparing the aggregate results to the actual winner of the seat. This data proved that there is a correlation between the percent of polling places and the margin of victory. There are several districts where the results can be predicted within one polling place, but only when the results

are extremely one sided. When there is an extremely close race, almost all polling places are needed to predict a winner. When 50% of polling places have reported, the winner can be projected if the results are 52-48 or greater, but it is too close to call if the margin of victory is smaller than this margin. Similarly if 10% of polling places are reporting and results margin is 57-43 or greater, the election can be called.

EXPLORING THE EFFECT OF METAL CHELATING PROPERTIES OF HYLOCEREUS UNDATUS, ARTOCARPUS
HETEROPHYLLUS, AND RUBUS IDAEUS ON THE MORTALITY RATE OF CAENORHABDITIS ELEGANS:
POTENTIAL ACE INHIBITORS

Evelyn Plakal
Spring Valley High School

Based on the World Health Organization in 2019, over one billion people worldwide have hypertension (WHO, 2019). Currently, angiotensin-converting enzyme inhibitors like captopril are used to lower blood pressure. However, these medicines produce side effects and are not fully natural. A potential method of lowering ACE levels, protecting against oxidative stress, removing heavy metals, and increasing lifespan was proposed using *Hylocereus undatus*, *Rubus idaeus*, and *Artocarpus heterophyllus*. It was hypothesized that if the metal chelating properties, ACE inhibitory properties, and the lifespan of the N2 *C. elegans* were tested using *Hylocereus undatus*, *Artocarpus heterophyllus*, and *Rubus idaeus*, then the *Hylocereus undatus* would produce the highest metal chelation activity, ACE inhibition activity, and the longest lifespan for the N2 *C. elegans* due to the high amount of phytochemicals and the health benefits of the fruit (Cheah et al., 2016). The fruit extracts were created using a 50-50 ethanol water solution. For the metal chelation test, a spectrophotometer was used to measure the absorbance of the mixture of ferrozine, FeSO₄ and the extracts at 562 nm. For the ACE inhibition test, a spectrophotometer was used to measure the absorbance of the mixture of FAPGG substrate, rabbit lung ACE, captopril, and the extracts at 340 nm. The days each individual worm lived was counted until all the worms perished. Three one-way ANOVA tests were performed for the three different methods. Statistically significant results ($F(3,116) = 129.48835$, $p < 0.00001$; $F(3,116) = 21.7582$, $p < 0.00001$; $F(3,116) = 5.83881$, $p = 0.00946$) were found overall between the groups. The *Hylocereus undatus* extract produced the highest metal chelating activity, the highest ACE inhibition activity, and had the longest lifespan for the *C. elegans*, supporting the hypothesis. Although, there was an insignificant difference between the *Rubus idaeus* and *Hylocereus undatus*. This study opens up the possibility of using natural substances especially *Hylocereus undatus* and *Rubus idaeus* as ACE inhibitors, metal chelating agents, and a source to potentially increase the human life expectancy in a long-term situation.

THE EFFECT OF NOISE-REDUCING ACOUSTIC PANELS ON THE NOISE LEVELS AND OVERALL SAFETY OF
INFANT SLEEP MACHINES

Pranav Poola
Spring Valley High School

Infant sleep machines (ISMs) are devices used to help infants fall asleep faster and stay asleep for longer amounts of time, yet they can often be too loud for infantile ears, which could potentially be dangerous. This research aimed to minimize the risks of infant sleep machines without reducing the effectiveness of the infant sleep machines themselves through the use of acoustic panels. Based on previous studies, it was hypothesized that the acoustic panels would reduce the noise levels of the ISM to less than recommended limits of 50 dB-A. A specific corner of a designated room was prepared with a crib with a sound level meter placed inside and a table housing the ISM all to simulate a sleeping infant being exposed to the white noise from the ISM. After 30 trials were conducted without any soundproofing, another 30

trials were conducted after acoustic panels were placed on the walls behind the crib in order to reduce the noise levels of the ISM. Significant differences were found between the two groups, with the t-statistic of 30.9688 being much higher than the critical value of 1.697, and the p-value being less than 0.001, all with an alpha of 0.05. Finally, it was found that acoustic panels did reduce the noise levels to below less than 50 dB-A, which means the hypothesis was supported. This shows that acoustic panels have a significant effect on noise reduction for infants and are a safe, inexpensive option for parents.

PET EPILEPSY DETECTION

Katelyn Potts and Ashley Trumbull
The Center for Advanced Technical Studies

Between 1 and 5% of dogs have seizures. Animal seizures are dangerous because the pet can hurt themselves during a seizure if their owner does not protect them. The present experiment explored how to detect epilepsy in dogs, and when to notify their owners of an oncoming seizure. A dog harness was designed with a heart rate monitor, thermometer, and a muscle spasm detector. The original qualification for a seizure includes a dog that weighs under 30 lbs having a heart rate outside of 120-160 bpm, or a dog that weighs over 30 lbs having a heart rate outside of 60-120 bpm. The heart rate was also compared with temperature and muscle spasms. A temperature outside of 100-102.5 degrees Fahrenheit is another sign of a seizure. The harness was given to a dog previously diagnosed with epilepsy in hopes to detect a present seizure and alert its owner over the phone. The experiment was a success when a positive result on the harness matched with a visible seizure. If a seizure occurred and the harness did not detect it, or if a seizure did not occur and the harness produced a false positive, then the design was reconfigured with new parameters on the monitors to match the dog's lifestyle. This device is useful because it notifies the owner when their pet undergoes a seizure, so the owner can move the dog to a safe location and prevent the pet from hurting itself.

THE ULTRA-LOW THERMAL CONDUCTIVITY OF THE THERMOELECTRIC MATERIALS GETE AND SNSE

Oliver Rancu
SC Governor's School for Science & Mathematics

This study examined the reasons behind the ultra-low thermal conductivity of two materials, SnSe and GeTe. The efficiency of thermoelectric materials is given by the dimensionless figure of merit ZT , defined with thermal conductivity in the denominator; the ideal thermoelectric material therefore has a low thermal conductivity. Specifically, the flow of heat in a lattice can be represented by the interactions of phonons, or quantized lattice vibrations. Using temperature-dependent Raman Spectroscopy, the peak phonon frequency shifts of 4 modes in a lattice of SnSe and 2 modes in GeTe were examined. This shift was attributed to a combination of quasi-harmonic volume expansion and anharmonicity. Anharmonicity was dictated by so-called 3-phonon and 4-phonon processes, whereby in the simplest case, a phonon decays into 2 and 3 other phonons, respectively. Experimental data of the frequency shifts as a function of temperature were fitted using code developed in MatLab and previously derived equations, and the fitting parameters showed the relative strengths of the processes in their contributions to the frequency shifts. The 3-phonon processes dominated the shift in the modes for SnSe, but the fits for GeTe demonstrated either a mix in their relative contributions or complete domination by 4-phonon processes. These findings give a better understanding of the poor thermal conductivity in these materials in an effort to better understand the ideal thermoelectric materials. Research will continue to examine more materials to further our understanding of thermoelectric materials and their properties.

HYDRILLA POPULATIONS OVER TIME IN THE SOUTHEASTERN UNITED STATES AND CORRELATIONS WITH TYPE OF MANAGEMENT STRATEGY

Alyssa Raynor
Chapin High School

Since its introduction in the 1960s, the invasive aquatic plant *Hydrilla verticillata* has been a nuisance to much of the Southeastern United States. It has consistently ranked at the top of the Federal Noxious Weed List, outcompeted native species, and has indirectly contributed to the death of dozens of bald eagles and thousands of coots per year. There have been several management plans throughout the years to manage *hydrilla*, and these plans can be categorized into chemical, biological, physical, and manual. In order to assess which strategies have been the most effective over time and to see which management type had the most significant correlation to changes in population on *hydrilla* secondary data was collected. More specifically, forty lakes between 10,000 and 20,000 acres in size across six states in the Southeastern United States between 2007-2019 were chosen for this study. From there, management plans were utilized and acres of *hydrilla* per year was collected from publicly available records from state sponsored management organizations. Additionally, drought data was collected as well so that *hydrilla* in order to account for the potential confounding variable of weather conditions as these have been recognized to have impacted *hydrilla* populations. In the end, it was determined that the use of mixed-management methods to control *hydrilla* correlated with the greatest decreases in *hydrilla* populations.

THE EFFECT OF MULTIPLE RENEWABLE ENERGIES ON AMERICA

Hunter Reddick
Chapin High School

This study is being used to find the best possible renewable energy source for the U.S. based upon the job creation, habitat destruction, land usage, cost, and ownership. I will be using previous studies to hopefully connect research, and I will also be using a survey that will ask people what renewable energy do they find to be most effective. My expectations for the conclusion of the study is that I will find that solar energy will be the overall most effective renewable energy for the U.S.

THE EFFECT OF MUSIC LISTENING, MUSIC INSTRUCTION, AND MUSIC FREESTYLE ON THE OVERALL ANXIETY OF AMERICAN ADOLESCENTS

Parker Reyes
Spring Valley High School

Music has been used since the beginning of mankind for helping improve mood. This research project focuses on the music therapy and the three most prominently used forms of music therapy, music instruction, music freestyle, and music listening. These forms of music therapy are commonly used among therapists but the best for lowering anxiety is not known. It was hypothesized that the music freestyle group would have the lowest overall anxiety as they were allowed to choose what they believed to be best in order to help themselves. It is commonly thought among the music therapy community that each form of music therapy is positive for different people and different circumstances. In order to find the best form of music therapy in order to lower overall anxiety in adolescents, one divided adolescents in random groups. After this, the participants completed the State Trait Anxiety Inventory (STAI) test and then underwent 15 minutes of their randomly given form of music therapy. With scores being 0-60, with 60 being no anxiety and 0 being extreme anxiety, scores were recorded before and after music therapy to record change. The hypothesis was unsupported. At $p < 0.05$, the p-value came to be 0.9711. This

concluded that the data was insignificant. With this being said, the mean values showed one that scores rose by about 10 points in each group. This showed that each form does work and is positive but that the different forms are good for different people and different circumstances.

THE EFFECTS OF CERTAIN SUGARS AND THEIR RESPECTIVE AMOUNTS ON RUNNING PERFORMANCE OF TEENS AGED FROM 14-18.

Davis Ricks
Chapin High School

This study is designed to evaluate different sugars based upon running performance and the question I am trying to answer is "To what extent is there a threshold between the amount and types of sugar consumed and running performance in ages 14-18?". This research is important because although there are many energy supplements for runners, most are not age specific. I am attempting to create a draft for a supplement that will assist teenagers aged from 14-18 because studies show that this is the age of athletic takeoff (where most people start to progress in their athletic lives). Although most of the supplements are helpful to athletes, creating age-specific substances will not only help them, but bring insight to the world of nutrition and health. To determine the most prime ingredients for the age specific substance, I will use table sugar, honey, and maple syrup. The experimentation process will include a control group and an experimental group. The control group receives no sugar and the experimental group receives different types of sugar and different levels of each sugar. I am trying to find which sugar is best for runners aged 14-18 before a race for running performance. I am also trying to find which levels of each sugar is best for these runners.

USING CUBESATS TO DETECT OCEAN DEBRIS

Madeline Robertson
SC Governor's School for Science & Mathematics

When plastic finds its way to the ocean, it quickly degrades into microplastics. These microplastics are difficult to clean up and are easily eaten by sea life. This project was to look into the feasibility of using cubesats to detect large pieces of plastic before they degrade, in order to assist clean up efforts. Previously, the same concept of plastic identification was applied using an airplane to sweep segments of the ocean. Over two sweeps of a segment of the Pacific Garbage Patch, 1600 items were detected, and 120 were positively identified as plastic. A cubesat could do the same job as the airplane, but with a much larger range and for a longer time. A model cubesat was constructed. To test the cubesat, three poster boards were set up and colored pieces of plastic were placed on them. A ten orbit cycle was simulated by moving the cubesat in a circle over the poster boards at a speed of one orbit per minute. The cubesat was able to take pictures of each poster board. From there, the image processing code was able to crop the poster board and identify the amount of plastic. It was determined that using a cubesat was viable to identify ocean waste, however, a more precise attitude determination module, a higher quality camera, and more solar panels would be needed.

SOIL ANALYSIS OF THE RARE RHODODENDRON EASTMANII (MAY-WHITE AZALEA)

Mattie Rumfelt

SC Governor's School for Science & Mathematics

Azaleas are a widespread species of plant and in 1999 a rare species of azalea, the *Rhododendron eastmanii* (May-white azalea), was discovered to be native and populated in South Carolina. While the species has been studied over the last twenty years, many characteristics of the May-white and its ecological niche are unknown, including its preferred soil type. Insight into the plant's unique properties can be obtained through a greater understanding of the physical and chemical characteristics of soils where May-whites flourish. In this study, we investigated the soil texture and pH best suited for the species. We acquired soil samples of May-white populations identified at seven sites across five counties in South Carolina. Even with a variety of textures and pH values found, our results indicate May-whites thrive in acidic, sandy loam soils, supporting previous theories about the habitat of *Rhododendron eastmanii*. A greater understanding of the range of conditions that support May-whites will help preserve this rare, endemic species and allow researchers to focus their monitoring on optimal sustainable habitats.

AUTOMATED FIBER PLACEMENT AND CONVOLUTION NEURAL NETWORKS

Benjamin Sale

SC Governor's School for Science & Mathematics

The Automated Fiber Placement process creates composite architectures that are used for a multitude of structures. The new way that the Automated Fiber Placement process is being used requires it to use different and more precise angles, as well as different widths of fibers. This research will try to determine which composite architecture is ideal for toughness and strength from this new process. To determine the ideal composite architecture, we used Convolution Neural Networks, a type of deep learning network mainly used for visual images. We created a program that would construct composite architectures from unit cells and show the properties of that composite architecture. Unfortunately, due to time constraints, the Convolution Neural Network program was not finished. Therefore, we could not find the best composite architecture. However, if we were to have finished the program, the findings would be theoretical and would have targeted two composite architectures. The first composite architecture we would have wanted to find would be the ideal composite architecture for toughness and strength. The second composite architecture we would have liked to determine would be the most practical one. The most practical composite architecture would be the one used in mass production, so it would need to be cheap enough for mass production but also strong and tough enough for structural integrity.

A STUDY OF THE ANTI-BACTERIAL PROPERTIES OF ARTIFICIALLY MADE SHARKSKIN-TYPE PATTERNS COMPARED TO FLAT 3D MATERIAL

Ian Saracila

Spring Valley High School

The purpose of this study was to see if using biomimicry of sharkskin's geometry to design and 3D print a similar type pattern would inhibit, or even stop, the growth of bacteria such as *E. coli*. Research was conducted by comparing the growth of *E. coli* on thirty 3D printed samples having sharkskin-type geometry to thirty flat/blank samples from the same material to determine if the pattern geometry had an impact on bacterial growth. *E. coli* was cultured and put on each of the samples for growth and spectrophotometric analysis. The test results showed that sharkskin-type samples had a lower optical

density mean absorbance (at 600 nm) of 0.0309, while the flat pieces had a mean absorbance of 0.0628, demonstrating that, overall, the sharkskin-type material had less bacterial growth as hypothesized.

THE SYNCHRONIZATION OF HEADING ANGLES USING PULSE COUPLED OSCILLATORS

Soumit Sarkar and Jackson Self

SC Governor's School for Science & Mathematics

Pulse coupled oscillators are devices that only transmit and receive binary pulses on a select frequency. They send data-less pulses at designated intervals to communicate with other units. This investigation was conducted to find a way of utilizing pulse coupled oscillators to synchronize heading angles on multiple raspberry pi robots connected to the same network. An algorithm was developed by testing multiple ways the heading angle would be changed. It was intended to run on fully equipped robots. However, due to restrictions from the pandemic it had to be tested in a simulation. The most efficient was one that based its changes on percentages of the difference between the heading angle and 360 degrees. Each simulated device executed the same script, and each responded to receiving a pulse in a way that would cause them to synchronize their simulated heading angles. Ultimately, each of the simulated “robots” were able to synchronize their heading angles, within a 40 second time interval. This technology will eventually be used for encrypted communication, hive-mind control, and cyber security.

TESTING VARIOUS ULTRAVIOLET LIGHT STERILIZER DESIGNS ON ESCHERICHIA COLI CULTURES TO OBSERVE VISIBLE CULTURE GROWTH

Adeep Sen

Spring Valley High School

The risk of widespread pandemic has grown as the world becomes more connected through the process of globalization. As people have to risk their health to maintain a livelihood, it is important that they are able to maintain security in knowing their possessions are safe. The purpose of this study was to offer a cheap, and reliable method of disinfection that anybody could construct with items available in most areas. The bacterial growth of Petri dishes was qualitatively measured after they were streaked with Escherichia coli and exposed to the UV light of two different sterilizer designs. The flashlight design was modeled after a flashlight with a convex lens at the end of a tube, while the box design had a UV light positioned within an aluminum foil wrapped box. It was hypothesized that of the two designs, the flashlight design would prove most effective at restricting bacterial growth. The data was sorted using bacterial growth described as unrestricted, restricted, and heavily restricted. The data supported the designs efficacy and the flashlight design appeared most effective, as the flashlight and box designs had only 2 and 5 samples in the unrestricted category, while the control group had 15. A chi square test of independence was performed to examine the relation between bacterial growth and sterilizer design. The relationship between these variables was significant, $\chi^2(4, N = 94) = 21.3728$, $p = .000267$. These findings may help people construct their own working sterilizer in the future if another pandemic situation arises.

DISTINGUISHING GRAVITATIONAL WAVE POLARIZATION THROUGHOUT BLUE STRAGGLER FORMATION

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Blue stragglers are main sequence stars that appear bluer and more luminous than stars at their corresponding main sequence turnoff points. They possess indefinite origins, with suppositions based on circumstantial evidence. It is assumed that these bodies are formed as the single product of binary star

collisions. Due to the intangibility of gravitational waves, these emissions receive inattention during interactional studies. However, understanding such properties would expand insight on associated formative distinctions. This research characterizes the linearly polarized components of a collision instigating blue stragglers. JavaScript code processed datasets from the NASA Open Data Portal. These contained such values during differing times for four simulated collisions. One trial was chosen to represent the studied interactivity due to conditional similarities. The 18,654 data points per trial were arbitrarily distributed; thus, the initial results of each study were implemented in graphs of polarization values vs time. R code used an autoregressive integrated moving average model to fulfill functional discrepancies. The Minitab software acquired the values from prior methods, creating plots for the principal simulation. Fourier transforms converted their domains to frequency and the graphs were divided by similar waveforms. For each region, cosinor regression models produced fit line equations. These would allow the prediction of polarization values during times of standard simulations. While physical studies of gravitational waves are onerous, their statistically-driven models can be computationally manipulated. The only required equipment is a laptop with inexpensive softwares. Hence, the process for acquiring developmental data would increase efficiency with certain envisaged frameworks.

MICRORHEOLOGICAL ANALYSIS OF COMPLEX BIOLOGICAL FLUIDS

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Physical properties and behaviors of biological fluids have remained relatively unexplored until recently. This study aims to introduce knowledge of these properties in viscoelastic (complex) fluids, as most biological fluids are, and how they respond to applied forces. Four mock-up complex fluids were used in place of real biological fluids, while still maintaining similar properties. Microrheology avoids the problems of larger scale rheology by reducing needed sample sizes, and providing a microscopic understanding of the material. Through fluorescence imaging, the motion of fluorescent particles inserted in mock-ups of biological fluids was observed and recorded. Algorithms were designed to track the motion of the particles throughout the frame, and to select which particles in each recording were most likely to be representative of the characteristics of its fluid. After clean data on the particles was obtained, analysis of their trajectories could begin in order to glean new information about the flow of these complex fluids. Using the Stokes-Einstein equation, evaluating the diffusion coefficient, and then the mean squared displacement (MSD) leads to discovering the mode of displacement of particles in each fluid. This can be either freely diffusing, transported, or bound and limited in movement. Further analysis is required to draw conclusions about specific properties of the biological fluids. Once more is known about biological fluids, advancements in medical technology can be made, such as improving the efficiency of artificial hearts pumping blood, as well in other biological fields.

THE EFFECT OF METAL TYPE AND MAKE ON DURABILITY IN GUITAR STRINGS

Aiden Sheftman

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Over the generations, guitars have had rapid changes to their design, tone, quality, and the material they are made of. Notably, guitar strings are the most changed aspect of the guitar. Standard strings today are made with either nickel or steel, which are also coated to improve the durability of the strings. These modifications also increased the price of strings by almost three times the original price. The purpose of this was to test different make of guitar strings on their durability. It was hypothesized that the wound,

coated, steel strings would be the most durable and have the highest tensile strength compared to the other two types of guitar strings. Each of the low E strings from each type of string were cut into 10 pieces of approximately 9.144 cm in length and then tested on the tensile strength machine. The amount of sheer breaking force was recorded for each string. Once all the strings were tested, the tensile force was then compared. The results showed that the wound uncoated nickel and steel strings had the highest tensile strength at 93.5 lb/ft of force, while the wound coated steel strings had the lowest at 63 lb/ft of force. These results support the claim that the more expensive strings are more consistent; however, they require less force to break, which suggests that the claims that the companies make about their strings are incorrect.

IMPROVING THE ABSORPTION OF ICOSAPENT ETHYL IN THE GASTROINTESTINAL SYSTEM

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As the leading cause of death in the U.S., pharmaceutical companies have developed and continue to develop preventative treatments for heart disease like Icosapent Ethyl, also known as Vascepa. Due to Vascepa's abnormally large dosage and limited information about its mechanism of action, the study examined how to improve the solubility of Vascepa in water using emulsifiers to improve absorption with the goal of reducing required dosage. Taurocholic acid, Glycocholic acid, and Polysorbate 80 were examined as emulsifiers to improve Vascepa. After docking each emulsifier to Vascepa using PyRx and examining their interaction using VMD, Taurocholic acid was selected as the best candidate. Models of Vascepa with 0-5 molecules of Taurocholic acid were simulated in water. The results were quantified by examining the average total energy of each simulation. The results showed that as more molecules of Taurocholic acid were added to Vascepa, its solubility increased. Vascepa alone had a total interaction energy with water of -27.75 kcal/mol and Vascepa with five molecules of Taurocholic acid had a total energy of -42.85 kcal/mol. While the numbers show an improvement, the 3D model of the simulations showed that Vascepa was still exposed to water when it should have been surrounded by Taurocholic acid molecules. This suggests that more research needs to be done in determining the optimum ratio of emulsifiers to Vascepa, the stability of emulsifiers with Vascepa, and the best emulsifier. Overall, the experiment was a success and has opened the door for further lifesaving research into heart disease treatment.

COMPARING THE EFFECTIVENESS OF ANGIOSPERM VERSUS GYMNOSPERM XYLEM ON *E. COLI* FILTRATION

YeJoon Shin

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The lack of access to clean drinking water is a growing problem in third-world countries where water can easily be contaminated with bacteria such as *E. coli*. The large majority of water filters today are either too expensive or inaccessible to be a viable option. Xylem filtration, however, costs significantly less and some have been shown to effectively filter various water contaminants, including bacteria. As such, the purpose of this study was to determine if pine (*Pinus*), the gymnosperm, or magnolia (*Magnolia grandiflora*) angiosperm xylem would filter more bacteria. It was hypothesized that if *E. coli* is filtered using the xylem from magnolia and pine trees, then the gymnosperm will allow fewer bacteria to pass through the filter because angiosperms have fewer filtration points in the xylem conduit and have less xylem tissue. Liquid *E. coli* broth culture was filtered through pine and magnolia branches, and the bacteria in the filtrate was measured with a spectrophotometer. The results showed that while both pine and

magnolia could filter out *E. coli* from the water, the pine samples consistently filtered more bacteria, $t(43)=3.47$, $p<.005$. These findings support previous studies that found gymnosperms surpass angiosperms in water filtration because of the structural differences in the xylem.

THE ADDITION OF MAGNETS TO IMPROVE THE INFERIOR VENA CAVA FILTER REMOVAL PROCEDURE

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The Center for Advanced Technical Studies

The addition of magnets within the Inferior Vena Cava Filter and its retrieval device prevents factors such as filter tilt or skewed anatomical planes from obstructing a safe and easy removal of the filter. The IVC filter is a device implemented within patients who cannot take anticoagulation medication but are still at risk for blood clots. Filters remain within the patient until outside and unrelated medical factors resolve and the filter can be removed. At the time of removal, unexpected obstructions can arise such as the filter being tilted at an angle within the Inferior Vena Cava, as well as skewed anatomical planes within the patient's vascular structures. These obstructions can make the alignment of the filter and its retrieval device very difficult and can make the entirety of the removal procedure very difficult as well as putting the patient's body through an unnecessary amount of stress under anesthesia. The addition of magnets onto the IVC filter and its retrieval device allows for the retrieval device to align with the superior portion of the filter so that the retrieval device can snag the filter with less effort and in a smaller amount of time. Although not yet completed, the expected results for this study will indicate that the addition of magnets onto the IVC filter and retrieval device will in fact improve the alignment of the filter and retrieval device; allowing for an easier removal in a more timely manner without obstructions such as skewed anatomical planes or filter tilt.

CORRELATION BETWEEN ANXIETY SYMPTOMS AND PERSONALITY TRAITS

Kate Soderlund

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Research has been conducted to assess the correlation between five personality factors and the strength of anxiety symptoms. This is particularly significant because adolescent anxiety can lead to future mental deterioration. The research that has been conducted implements the Big Five Personality Test and the Beck Anxiety Inventory (BAI). The five personality types, extraversion, neuroticism, openness, agreeableness, and conscientiousness, as well as the anxiety levels are self reported on a continuum by highschool students. The answers on the Big 5 Test range from "disagree" to "agree" with the statements while the BAI ranges from "not at all" to "severely" in terms of how intensely the symptoms are experienced. Based on the 129 responses from highschool students in a suburban school district in South Carolina, there is a weak correlation between the factors. This does not support the hypothesis that students with high levels of neuroticism and low levels of extraversion will experience higher levels of anxiety symptoms, as well as the hypothesis that there would be no correlation between agreeableness, conscientiousness, and openness with anxiety symptoms. The strength of these correlations was determined with the use of a Linear Regression T-Test for statistical analysis. While the correlation coefficients were weak, the direction of the linear pattern for neuroticism and extraversion matched the hypothesis. The p-value between extraversion and anxiety, 0.003, indicates the relationship is statistically significant, making its correlation less likely due purely to chance.

TO WHAT EXTENT DOES BODY STEREOTYPING AFFECT THE EUMENORRHEA MENSTRUAL CYCLES IN HIGH SCHOOL FEMALE ATHLETES?

Jasmyn Sorapuru
Chapin High School

The purpose of this research is to research and analyze the following question, "To what extent does body stereotyping affect the dysfunction of Eumenorrhea Menstrual cycles in female high school athletes?". I believe that the more the emphasis of the sport's body stereotype is place lean or thinness, the greater risk there will be of these female athletes developing a dysfunction in their menstrual cycle. I discovered I wanted to research this topic when I came across this article called Prevalence of the Female Athlete Triad Syndrome Among High School Athletes, by JF Nichols and MJ Rauh published in 2006. The study was conducted on female athletes to see if they exhibited any traits of the Female Athlete Triad syndrome. The triad syndrome occurs when the athlete develops an eating disorder(s) which later leads to a loss in bone mass and menstrual dysfunction. In the experiment they gave them a questionnaire named, "Eating Disorder Examination Questionnaire (EDE-Q)23" to determine their eating behavior (normal vs elevated EDE-Q score) and their menstrual status (eumenorrhea vs oligomenorrhea or amenorrhea). When I was researching I found that most of the experiments were done on Collegiate athletes vs High school athletes. I think that with these collegiate athletes I could find more stable results and information but staying within my age community will help benefit the ones around me and reach out to the younger age group. This project is meant to bring awareness to this topic so that women can understand the dangers of a dysfunction within their menstrual cycle.

THE EFFECT OF EPSOM SALINITY ON THE DECOMPOSITION OF SOIL ORGANIC MATTER

Freedom Spiva
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Organic matter decline occurs when there is not enough organic matter, which is caused by the lack of soil biodiversity or an increased rate in organic matter decomposition, and this results in the degradation of soils. The purpose of this research was to find a way to not just preserve or prevent soils from degrading, but rather restore degraded soils. The research was based on the effect of epsom salinity on the decomposition of organic matter. The hypothesis was that watering soils with epsom salt would have an impact on the amount of organic matter decomposed. In other words, it was hypothesized that there would be a significant difference between the means. The soil organic matter was put into two containers everyday and watered with either tap water, group 1, or water mixed with 0.75 ounces of epsom salt, group 2. The containers were watered on the first, third, and sixth day while being left out for one week. Each container was sampled three times and each sample was weighed to be 30 grams, then put into a melting furnace at 550 celsius for ninety minutes. Then each sample was weighed on an electronic scale again to find how much mass was lost. The average mass of the groups were similar with group 1 having an average mass of 4.32 grams, and group 2 having an average mass of 3.87 grams. This resulted in $p > .05$ which means epsoms salts do not affect organic matter decomposition.

EVALUATING THE EFFECTS OF HOMEWORK HAS ON THE MENTAL HEALTH OF STUDENT ATHLETES

Kate Stebbins
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It has come to the conclusion that some causes of anxiety levels in teens are unknown; a mystery to mankind. However, scientists have been able to find a few factors that could possibly be the leading causes of anxiety. These include but are not limited to: an individual's genetic makeup, the biochemistry of their brain, previous trauma, and adaptations they are faced with. If one sees triggers that may have been traumatizing to them in the past, it may also cause an individual to develop anxiety or severe stress, detrimental to the human body and brain (Lyness, 2014).

THE ABILITY OF OYSTER MUSHROOMS TO DEGRADE MOTOR OIL

Ava Stewart
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Oil spills occur when oil pipelines can rupture as a result of extreme weather conditions, such as flooding or hurricane. As pipelines rupture, the oil released can have catastrophic impacts on the environment, human health, and the economy. Oil spills can cause mass casualties of fish and birds, cause cancer in humans, and cost oil companies and governments billions of dollars. Current cleanup methods are ineffective and cause different problems to arise. Because of fungi's mycelial and regenerative root-like structure, their potential in bioremediation (mycoremediation) efforts have been recognized in recent years. In order to test this hypothesis, mushrooms will be grown and then exposed to motor oil in order to see if they are able to degrade it fully. This presence of motor oil will be tested using oil test strips. While this method is original, it is the best way to test this as a high school student with limited resources. After testing, most samples did not have a presence of motor oil, although a few did. This indicates that the mushrooms were capable of degrading motor oil, for the most part. As the initial concentration of oil went up, the less likely the mushrooms were to degrade the motor oil.

THE ASSESSMENT OF VALENCE AND AROUSAL THROUGH NARRATIVE

Savannah StremLOW, Caroline Strinsky, and Gracen Anne Thompson
SC Governor's School for Science & Mathematics

In psychology, affect refers to the positive or negative feelings experienced in reaction to stimuli, whereas hedonic valence is a characteristic used to describe its pleasantness or unpleasantness. These terms were used consistently throughout our part in the Aging Brain Cohort Study. This study was prompted by the changes in brain health as people reach advanced age. This has the potential to make them more susceptible to age-related problems such as Alzheimer's disease. Valence can be researched in a variety of controlled ways like audios, visuals, or narrative. Because valence is not a physical object, scientists are trying to understand how it operates biologically in our brains. Through experimental psychology we investigated the question of how valence is affected by narrative and how it is displayed in the brain. In this study, we divided 23 texts into segments, following grammatical rules as well as natural pauses. We then moved our newly divided segments, called offsets, into spreadsheets and recorded their start and end time for each speaker of each story. These timestamps are used to play each audio segment aloud for a group of senior research participants. Participants will undergo fMRI scans while listening to our offsets. We want to determine if there is a relationship between the active parts of their brains and the ratings of the texts in order to provide us a better understanding of the way an aging brain works.

THE CORRELATION BETWEEN THE SELF-ESTEEM OF FEMALE GYMNASTS AND FEEDBACK GIVEN BY THEIR COACHES

Allison Strenk
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Self-esteem begins developing at a very young age, between four and eleven, which is when many children begin to play sports. Focusing solely on gymnastics, athletes join between this age range, if not earlier, and begin getting criticized for how they complete each skill. This criticism that comes from the coaches can sometimes be harsh, and the purpose of this research is to determine whether there is a correlation between corrections that coaches give and the self-esteem level of young female gymnasts. This study found that there is a correlation between the self-esteem levels of gymnasts and the corrections that they are given inside of the gym. According to the data collected in this study, it is proven that self-esteem levels are higher in gymnasts that have been given positively phrased corrections for their skills. Overall, coaches of young athletes need to consider how their correction will sound before it is stated, and understand the fact that young athletes are typically very fragile.

OUTDOOR LIGHTING GENERATED BY WIND POWER: ACHIEVING THE LOWEST APPLICABLE WIND SPEED

Korinna Stroud
The Center for Advanced Technical Studies

Is there a cleaner way to potentially power holiday decorative lights? I believe there is a way since decorative outdoor lights are typically used during the winter months. During winter, temperatures tend to be cooler and with cooler temperatures there is typically more wind produced. This project aims to demonstrate that wind powered holiday lights would be an efficient form of clean energy. Initial studies using curved-tip wind turbine blades will be attempted first since those blades require a lower applicable wind speed, along with rounded edges all along the blades. In addition, the bigger the blade the more wind it captures. Having lots of space where wind can just go around the blade creates inefficiency in wind turbines. In the future, wind could be used to power more than just lights. It can be a form of clean energy for many more portable power devices located in the windiest portions of the country.

TO WHAT EXTENT DOES COMPETITIVE DANCE EFFECT EATING DISORDERS IN FEMALES AGES 14-18?

Caroline Sullivan
Chapin High School

Eating disorders are a mental illness that cause one to have low self-esteem and a negative body image. They are often accompanied by severe symptoms that can cause drastic weight loss or weight gain. Eating disorders have the highest mortality rate of all mental illnesses. Many athletes suffer from eating disorders, and dance is often found to have the highest percentage of athletes with an eating disorder. Dance has many factors that may be the reason for the high number of eating disorder cases, including emphasis on appearance, costumes, and coaches. From December 2020 to February 2021, data was collected from competitive dancers and non-dancers, all females ages 14-18. The scores on the EAT-26 test, a survey measuring symptoms of various eating disorders, were compared for each group. The EAT-26 survey uses a scale that goes from never to always and uses numerical values that correlate with the answer choices to receive a score. In order to assess the correlation between competitive dance and eating disorders the averages between the test group and control group were compared. The averages from both groups were close, with the test group having an average of 12.86 and the control group having

an average score of 10.53. These results show that there is small correlation between eating disorders and competitive dance.

THE EFFECT OF SALT IN FABRIC DYE ON THE NUMBER OF PLANARIAN MORTALITIES

Gowri Sunilkumar
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Textile fabric dye effluent is often disposed of in bodies of water and pollutes aquatic ecosystems, harming the wildlife. Many fabric dyes also contain salts that further harms the organisms. After identifying a quality of the dyes that harm organisms, the dyes can be improved to be more eco friendly. By observing how dye and salt affects planaria, the harm the products leave can be clearly seen. This research was aimed to observe the effects of salt and consumer fabric dyes on the number of mortalities of freshwater planaria, organisms used as a model to represent freshwater organisms. It was hypothesized that if planaria were put in dye solutions with added salt, the solution with Rit dye and added salt would yield the highest number of mortalities because of its incompatibility with strong oxidizing agents ("Safety Data Sheet," 2017). It is hypothesized that the salt and dye concentrations created after serial dilutions in this experiment were too weak to produce mortalities. Preliminary experiments were conducted but resulted in mortalities of all the planaria in a dye solution after 24 hours due to the concentrations being too strong. There is a possibility that a concentration between the preliminary experiment and serial dilutions where meaningful data can be obtained. The results demonstrate that concentrated dye solutions will lead to the mortalities of planaria, but a heavily diluted solution will not yield any mortalities. This data is anticipated to help find ways to reduce dye effluent in water to keep the wildlife healthy.

THE ACCURACY OF ARTIFICIAL INTELLIGENCE (AI) CHATBOTS IN TELEMEDICINE

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Partially due to the pandemic, artificial Intelligence (AI) chatbots in telemedicine are a recent advancement in the medical field and are pushing the medical community forward toward automated healthcare. The purpose of this research was to discover whether AI chatbots are effective in giving a patient an idea of what medical condition he/she might have before consulting a medical professional. The hypothesis was that of the four AI chatbots that were used--Symptomate, Ada, Isabel Symptom Checker, and K Health--K Health was the one that would be the most accurate. This prediction was made based on the user interface and the accessibility of the app. Chatbots were tested by first developing a set of medical symptoms after consulting with a medical professional. The predetermined medical symptoms were input into the AI chatbots which then gave a diagnosis. Out of thirty trials, the accuracy of the chatbots were as follows. Symptomate averaged 66% correct diagnoses, Isabel Symptom Checker averaged 86% correct diagnosis, K health and ADA scored with a mean of 80% accuracy. Since the F was less than F the null hypothesis failed to be rejected.

THE EFFECTS OF GREEN SEED OIL COATING ON THE INHIBITION OF WHITE-ROT FUNGAL GROWTH ON MAPLE WOOD

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Protective green coatings are advantageous because not only are they eco-friendly and sustainable, they also protect common surfaces such as wooden objects and construction sites. Many commercial coatings are based on acrylics that are harmful and derived from waning fossil fuels. In this study, three natural seed oils, tung, linseed and soybean, were used to investigate how oil compositions could inhibit fungal growth on maple wood, a commonly used surface. Given the variation in the number and type of unsaturated double bonds, it was hypothesized that the oil compositions would impact the fungal growth with tung oil being the most efficient inhibitor followed by linseed oil and soybean oil. The oils were placed under direct sunlight to form cured films on the maple surfaces. The oil-coated samples were then placed on agar petri dishes that were spread with White-rot fungi. The diameters of growth inhibition for each sample were measured over six days using an Agar diffusion assay. The results showed that all oil-based coatings inhibited the White-rot growth. As expected, tung oil was the most effective with linseed and soybean being less potent. The results from a two-way ANOVA with replication method showed that the seed oils had a significant effect ($F(3, 696) = 246.21$; $p < 0.001$), and a post-hoc Tukey test showed significant differences in pairwise comparisons between different oil coatings, with the exception of linseed-control. This new class of green coatings could be beneficial both economically and socially, given their high abundance, low cost, and environmental friendliness.

THE EFFECT OF METHYL PARABEN AND PROPYL PARABEN ON THE HEART RATE AND MORTALITY OF DAPHNIA MAGNA

Shreya Thiagu
Spring Valley High School

Parabens are a common ingredient in skincare and cosmetic products. They are used to preserve the product and prevent the growth of mold and bacteria. Parabens are known to mimic a hormone known as oestrogen. The increased presence of oestrogen has been linked to hormonal imbalances and birth defects in rats. The impacts that parabens have on humans to the fullest extent is unknown. There has not been enough research conducted to make a definitive statement. While parabens impact humans, they have also shown up in water ecosystems. The purpose of this study was to investigate the potential effects that parabens could have on aquatic organisms using *Daphnia magna* as the model organism. measuring the heart rate, mortality, and reproduction of the organisms, more information on the harmful effects of parabens will be uncovered. It was hypothesized that if thirty *Daphnia magna* were exposed to methyl paraben, propyl paraben, and a mixture of methyl and propyl paraben, the methyl paraben would result in the highest rates, the propyl paraben would have second highest, and the combination would result in the lowest heart rate, highest mortality, and lowest reproduction rates. Over a span of five days, male and female *Daphnia* were exposed to the different paraben solutions by introducing the treatment to their water source. The organisms were collected from their main bowl, and their heart rates were measured under a microscope. Then, the presence of new *D. magna* were recorded. All of the organisms were fed the same and stored in the same location with the only difference being the concentrations of parabens. Then, the organisms were disposed of by the addition of bleach. The hypothesis for the original experiment was supported with a p-value of <0.001 . A post hoc tukey test was run to determine where the significance lay.

COMPARISON OF JOB SEARCH ENGINES AND SPECIALIZED JOB BOARDS BASED ON INFORMATION QUALITY OF EMPLOYMENT OPPORTUNITIES

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Job searches are increasingly being conducted online in the modern day. There is a widespread amount of platforms that can be used for this. The purpose of this study was to determine whether job search engines or specialized job boards are the better choice when searching for a job on the internet. The COVID-19 pandemic has caused unpredicted challenges in many careers. Understanding which job search sites are the best to use is essential in overcoming these setbacks. The hypothesis was that job search engines would be preferable because listings come from many sources, implying that the listings would have to be chosen selectively. To perform this experiment, the Website Evaluation Criteria scale (Selim, 2012) was used. These criteria provide a method for assessing websites based on the information quality on the webpages. Three job search engines and three specialized job boards were analyzed. Ten job listings from each site were chosen to be evaluated by the criteria. Specialized job boards scored significantly higher on information quality than job search engines as shown by a z-test ($z=11.26$, $p<0.001$). Therefore, specialized job boards resulted in better information quality than job search engines based on this study. While these results did not support the hypothesis, the conclusion that specialized job boards resulted in better information quality than job search engines may provide valuable insights for job seekers.

EFFECTS OF FASTING ON CELLULAR HEALTH IN BROWN PLANARIA (DUGESIA TIGRINA PLATYHELMINTHES)

Abigail Thompson
Spring Valley High School

Fasting has been discovered to have the ability to extend the lifespan of different living forms. Fasting also helps to tackle age-related diseases like diabetes in humans. Therefore, fasting may have evolved billions of years ago to enhance survival and increase lifespan. Planarians have helped enhance the research on periods of food scarcity because of their full-body regeneration ability. They rely mostly on adult stem cells; neoblasts (Reddien, 2013). Planarians are members of the flatworm family (Platyhelminthes) and have adapted an outstanding stem cell system. Their stem cells divide continuously, resulting in a turnover of differentiated cells that lead to the animal's self-renewal within a short period. The purpose of this research is to determine if planarian full-body regeneration abilities are positively affected by introducing fasting into their diet. The hypothesis was that if brown planaria, *Dugesia tigrina* (Platyhelminthes), were placed on an intermittent fasting diet, their abilities of regeneration would improve because their mitochondrial functions would adapt to the stress factor. Two groups of planaria were exposed to different diets for three weeks, where the control group was fed a regular diet weekly and the research group was placed on an intermittent fasting diet where they were fed half as frequently as the latter. After the three week period of being assigned to their diets, the planaria were cut in half horizontally. Planarian regeneration abilities were measured through the evaluation of the length of the planaria in millimeters and visual deformities. Results found that statistical significance was present when comparing the data from both groups. There was a significant difference in the scores for the control ($M=56.8$, $SD=7.85$) and the intermittent ($M=67.9$, $SD=3.98$) conditions; $t(34)=7.62$, $p < .001$. This experiment found that planarian regeneration quality and ability can be improved through the use of a structural diet.

THE EFFECT OF Φ X174 BACTERIOPHAGES ON RESISTANCE OF PHAGES TO E. COLI K-12 BACTERIA

Sai Siddharth Thumsi
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Bacteriophages have gained interest as alternatives to antibiotics for mitigating bacterial infections. As the number of antibiotic-resistant bacteria increases, phage therapy is becoming more accepted but the efficacy is still contested due to the possibility of bacteria developing resistance to phages. The purpose of this study was to determine whether E. coli K-12 bacteria could develop resistance to Φ X174 bacteriophage when exposed to them. It was hypothesized that if the E. coli bacteria were exposed to the Φ X174 bacteriophages, bacterial resistance to the phages would develop due to the ability of bacteria to use horizontal gene transfer to exchange mutations. The research was conducted by first culturing bacteria from slant agar in Lennox LB agar on a petri dish. These bacteria were used to provide the preliminary sample for three groups (no exposure to bacteriophages and a lower and a higher concentration of bacteriophages), each with 18 samples.

Bacteriophages were exposed to the bacteria using the double-layer agar technique over a period of 22 hours. The surviving bacteria were then transferred two more times to petri dishes with their respective concentrations of bacteriophages. The results of the study were inconclusive due to the inability to distinguish, and thus quantify, individual colonies. Although quantitative data was not available, qualitative analyses found that bacterial colonies tend to be more distinct in the third stage of research in the samples with higher concentrations of bacteriophages, suggesting that the bacteria may have been unable to develop resistance to the phages fully.

THE EFFECT OF VARIOUS FLAVONOIDS ON THE LONGEVITY OF CAENORHABDITIS ELEGANS INFECTED BY A PATHOGEN

Simran Tippabhatla
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The immune system is the first line of defense against diseases. Keeping the immune system healthy and functioning correctly is an effective method in the prevention of neurodegenerative diseases. Nutrition plays a vital role in maintaining the immune system. Foods with high antioxidant activity and anti-inflammatory properties are the most important in this maintenance, as they prevent the inflammation of tissues and scavenge harmful molecules. Polyphenols, more specifically flavonoids, are molecules found in plants that contain high levels of antioxidants. Flavonoids are known to help healthy individuals prolong their lifespan and decrease their risk of disease. However, limited research has been done on the effect of flavonoids on the lifespans of individuals with pre-existing conditions. This experiment exposed *C. elegans* to three different flavonoids: Epigallocatechin gallate, Quercetin, and Naringenin. After being exposed to one of the three flavonoids, all four groups of *C. elegans* were infected by *Serratia marcescens*, an intestinal pathogen. The number of dead nematodes in each experimental group were observed for three days after infection. The experimental group with the least nematode deaths was the EGCG group, and the group with the most nematode deaths was the Quercetin group. A Two Way ANOVA test was conducted and the results found that there was a statistically significant difference in number of nematode deaths by the flavonoid used ($f(2)=3.93$, $p<0.05$) and the number of days after infection ($f(1)=9.66$, $p<0.0001$). A t-test was then conducted in order to find where the significance in the data was. The p-values of the t-test were not significant, meaning that the type of flavonoid used did not have a statistical significance on the number of nematode deaths. However, the number of days after infection did have a statistical significance on the number of nematode deaths. The data suggested that the flavonoids were effective in preventing nematode deaths.

THE EFFECT OF LINUM USITATISSIMUM, CURCUMA LONGA, AND GINKGO BILOBA ON THE AMYLOID-BETA TOXICITY IN CL2006 CAENORHABDITIS ELEGANS

Bhavani Tupple
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Complementary alternative medicine is a growing system of medicine treatment that has been increasingly incorporated into people's daily's lives to help in the treatment or prevention of diseases. The current research was aimed to determine the effectiveness of three specific extracts on their ability to alter the toxicity of amyloid-beta plaque in *Caenorhabditis elegans* that express Alzheimer's disease (a neurodegenerative disease caused by the buildup of amyloid-beta plaque). The expression of amyloid-beta plaque is phenotypically expressed through paralysis. It was hypothesized that if *C. elegans* were exposed to extracts such as flaxseed, curcumin, and ginkgo, then the use of ginkgo would exhibit the most paralysis-resistance in adult *C. elegans*. An experiment was designed in which three plates of *C. elegans* were exposed to extracts for two weeks. In the end of the experiment, the plates were kept in an incubator kept to 27.5 degrees Celsius and live photos of the *C. elegans* were taken every two hours for data collection. Curcumin extract, as seen in the results, exhibited the highest scoring of live *C. elegans*. To further analyze the data, a two-way ANOVA test was run to display the differences in means between the independent variables. A post-hoc test known as the Tukey-Kramer test was used to determine the differences in statistical significance between the independent variables and control once the null hypothesis was rejected by the ANOVA test. In both statistical analyses, curcumin presented the highest absolute mean difference, partially supporting the hypothesis that extracts have the ability to alter characteristics of AD.

TO WHAT EXTENT DOES SLEEP DEPRIVATION AFFECT ACADEMIC ACHIEVMENT AMONGST HIGH SCHOOL STUDENTS

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This study examines the relationship between sleep deprivation and academic performance. The data will be collected through the use of a survey provided to highschool students asking them for their current grade, current course enrollment, and average amount of sleep. I predict that students who get more sleep will have higher grades and therefore be in higher classes.

TESTING A MULTIFUNCTIONAL INTERLOCK MATERIAL THROUGH COMSOL MULTIPHYSICS

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Over the last couple of decades, there has been great interest and progress in the design of several artificially engineered composite materials called metamaterials. They can manipulate acoustic waves in a unique way not present in natural materials, making them more suitable for various practical scientific applications. When metamaterials are shaped in periodic structures, they exhibit features such as wave focusing, acoustic transparency, superlensing, and negative refraction. In this study, a new interlock structure made out of PMMA and silicon rubber was tested and as well as a more elongated exciter. The metamaterial structure explored in this paper applies to many scientific areas, including biomedical ultrasonic imaging, cloaking, and aerospace functions. This was accomplished using Comsol Multiphysics V4.3 software which is a simulation program. Preliminary studies were done, including finding natural frequencies through eigenfrequency and mesh sensitivity. In the eigenfrequency study, a dispersion curve

was constructed, which revealed band gaps from ~190 kHz to ~240 kHz and from ~300 kHz to ~350 kHz and a linear behavior below ~100 kHz. This indicates the possibility of acoustic transparency and vibrations, which is promising. Before these characteristics could be tested through frequency domain, a mesh sensitivity study was done to achieve accurate results. The settings were calculated to be 1.32 mm for PMMA and 0.02 for silicon rubber. Computational power was too limited to apply the settings so this particular study ended there.

THE EFFECT OF DIFFERENT DANCE SHOES ON THE AMOUNT OF GROUND REACTION FORCE IN SINGLE FOOT LANDINGS IN DANCE

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The purpose of this study was to investigate the use of padding in different dance shoes to cushion the initial shock force for athletes, when completing a landing. Dance shoes manipulated in this experiment included ballet flat shoe, heeled jazz shoes, dance tennis shoes, and a control group that represents bare feet, or no shoe, shown by a bare weight. It was hypothesized that if dance tennis shoes were used in a landing simulation using a pile driver mechanism representing the impact of the landing, then the amount of ground force reaction would be less than the other shoes because the extra cushion would absorb some of the shock. Beginning with the control group that included the 1032 g weight, each shoe was dropped from a height of 44 cm, to simulate a simple one-foot landing that is common in dance. From an ANOVA test with a 95% confidence interval, there was sufficient evidence to fail to reject the null hypothesis $F(3,116) = 22.6869$ $p < 0.001$. A post-hoc tukey test determined that the dance tennis shoe group was significantly different from the other groups. This means that the dance tennis shoes made a statistically substantial difference in absorbing the shock by lowering the amount of ground reaction force through absorption in the padding of the shoe.

THE EFFECT OF TRIPLE SUPERPHOSPHATE FERTILIZER ON MALE AND FEMALE DAPHNIA MAGNA HEART RATE AND MORTALITY

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The amount of eutrophication occurring as a result of chemical water pollution is rapidly increasing in numerous aquatic environments. Although a necessary Nitrogen, Phosphorus, and Potassium (NPK) balance is needed for plant growth and development, excessive fertilizer use has led to increased algal growth and disruption of aquatic ecosystems following runoff. To determine whether the introduction of phosphate-based fertilizer into an aquatic ecosystem could vary in its effect on male inhabitants versus female inhabitants, the effect of phosphate fertilizer on male and female *Daphnia magna* heart rate and mortality was investigated. *Daphnia magna* were placed in solutions of phosphate fertilizer at varying concentrations over a span of four days and their heart rate was collected prior to and after exposure to the fertilizer. Previous research to establish lethality of concentrations found that at $\alpha = 0.05$, exposure to increasing levels of phosphorus correspond to a lower heart rate, $F(2,47) = 105.98$, $p < 0.05$ with significant differences between unexposed *Daphnia* and groups of 0.05 M and 0.075 M phosphorus. Considering the implications of these concentrations, this study observed concentrations of 0.025 M, 0.050 M, and 0.075 M phosphorus.

THE ADDITON OF AN ANTIMICROBIAL LINING TO THE DENTAL CROWN TO PREVENT BACTERIA GROWTH

Caleb Wing

The Center for Advanced Technical Studies

The addition of copper into a dental crown will eliminate the threat of bacteria. Bacteria breaking the seal of the dental crown and contaminating/compromising the crown can cause crown failure. The problem with this is the large amount of money that would have to be spent to correct the compromised crown and the worst case scenario the tooth could break off and require an implant to fix the issue. With the addition of an antimicrobial metal(copper) the bacteria that causes the decay of the tooth will be unable to affect the tooth after being killed off by the copper. While still allowing the beneficial bacteria to live in the mouth without harm. The crown would have an inside layer of copper shielding the tooth from the bacteria. The crown will be tested to see if the antimicrobial properties are effective enough. This project's results can positively impact the dental community and help significantly reduce crown failure.

THE EFFECT OF PROJECTILE AND BLUNT FORCE ON HANDMADE SHIELDS MADE OF DIFFERENT MATERIALS

Eamon Wood

Spring Valley High School

Last summer, Americans watched as what should have been peaceful protests turned violent as protesters and police clashed. Sometimes these encounters caused deadly injuries due to rubber bullets and tear gas canisters. The purpose of this study was to determine which shield's plastic core is the strongest in order to better protect people during potentially violent protests. The hypothesis was that the shield with the 10 mm corrugated plastic core would sustain the least amount of damage because it was thicker than the other two cores and had more surface area for the force to spread across. Three kinds of shield samples were built, with a core of either 6 mm corrugated plastic, 10 mm corrugated plastic, or 5mm foam core, and with Polyvinyl Chloride (PVC) as the outer two of the three layers. The layers were held together with double sided tape. Each shield design was hit with a different amount of force, 20, 30, or 40 Newtons. An air cannon was used to apply said force, with the projectile being two 1¾" PVC caps glued together. The indentation in each sample resulting from the impact by each shot was recorded in centimeters. The hypothesis failed to be rejected because the 10 mm corrugated plastic constantly had the smallest recorded depth, with a mean of 0.56 cm and had the least variation with a 0.11, and the 10 mm corrugated plastic also had the most significance in the statistical analysis.

THE IMPACT OF RIGHT WING AUTHORITARIANISM ON PERCEPTION OF INEQUALITY BASED ON GENDER

John "Jack" Wuori

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In past research, right wing authoritarianism has been linked to an inability to recognize hierarchical structures at large and a common feature of right wing governments is discrimination against LGBTQ people. The purpose of this research was to determine if right wing authoritarianism is specifically related to an inability to recognize inequality or disparity of outcome in various fields between people based on gender identity. It was hypothesized that different beliefs associated with right wing authoritarianism, namely conservatism, traditionalism, and authoritarianism, would be associated with a lesser perception of inequality. A survey was sent out and responses were collected from a randomized sample of high school students who were asked about their tendency to agree with beliefs related to right wing authoritarianism and their ability to recognize inequality based on gender identity. Scores were

determined using a Likert scale, numerical values were assigned to scores which were analyzed via linear regression. The regression revealed a statistically significant negative correlation between the scores for right wing authoritarianism and perception of inequality based on gender identity. The hypothesis was supported, indicating that those with right wing authoritarian views were less able to identify inequitable outcomes due to gender identity, aligning with previous research.

THE EFFECT OF THE TYPE OF WATER WITH CARBON NANOTUBES ON THE PRODUCTION OF CARBON DIOXIDE FROM MICROPLASTICS

Lyn Yu
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Plastic pollution in the world today has caused numerous threats to both the marine and terrestrial environments along with the organisms that live in those ecosystems. Marine environments contain various fragments of plastics along seabeds or shores. Due to this, the plastics break down into smaller pieces also known as microplastics. However, due to the increase in production of plastics, the amount of microplastics present in the Earth's ecosystems has increased significantly. This issue eventually leads to the research of how the use of different water types and carbon nanotubes can have an effect on the degradation of cellulose acetate microplastics and the production of CO₂. The resulting statistics of the experiment demonstrated a significant decrease in pH in the trials containing distilled water. It was hypothesized that both the use of distilled water and carbon nanotubes would be able to use heat to allow the degradation of microplastics. However, the data results reveal that only the different water types have a significant role in degrading microplastics and producing CO₂. This was shown by a two-way ANOVA when the results for the water types was $F(1, 108) = 4.02, p < .05$, while the carbon nanotubes was $F(1, 108) = 2.59, p > .05$. The results revealed that the use of distilled water would bring a greater degradation of microplastics compared to the use of salt water. This can demonstrate that freshwater environments will have a greater chance degrading the microplastics located in its environment compared to saltwater environments.

COMPARING MICROBIAL COMMUNITY STRUCTURE BETWEEN MFC AND AD

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Wastewater treatment research is pivotal to optimize the treatment and end products of wastewater technology systems. Additionally, understanding the structures and changes in microbial communities allow for more efficient control of these systems. The overarching question focused on during this research was "Does chemical oxygen demand (COD) or pH have a greater effect on the microbial communities in microbial fuel cells (MFC) and anaerobic digestion (AD) co-digesting municipal wastewater sludge with rendering wastewater (RW) or fats, oils, and grease (FOG)?" After extensive research, it was hypothesized that pH has a greater effect on the microbial communities because both waste systems have similar ending COD values. A system called RStudio Cloud (R) was used to analyze the microbial communities from two different systems (MFC and AD) co-digesting two different types of waste: fats, oils, and grease (FOG) and rendering wastewater (RW). RStudio Cloud was used to perform a series of tests: using the ggplot2 library from R, and then performing shannon alpha diversity, beta diversity with NMDS (non-metric dimensional analysis) ordination, the Mantel and ANOSIM (Analysis of Similarity) tests, and the Indicator test. It was concluded that neither pH nor COD have a significant effect on the microbial communities. Rather, waste type and systems have the greatest effect. In the future, analysis of the metagenomic sequencing data for this sample could be performed, which would allow us to gather

information on the potential functions of the communities. Additional variables could be observed, such as organics, solids, and nutrients.

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