EIGHTEENTH ANNUAL

KALMAN

RESEARCH SYMPOSIUM

SATURDAY, MARCH 30, 2019

Bucknell UNIVERSITY

KALMAN RESEARCH SYMPOSIUM

INTRODUCTION

SATURDAY, MARCH 30, 2019

Welcome to the eighteenth annual Kalman Research Symposium.

An important central element of the Bucknell experience is to offer our students in all disciplines the opportunity to engage in substantive out-of-the-classroom research projects with faculty. As stated in the mission statement for Bucknell's Program for Undergraduate Research, these opportunities allow students and faculty *to participate in collaborative learning processes designed to dissolve the distinction between teaching and research, and to create a community of learners in which scholarship serves as the basis for teaching and learning.*

This symposium showcases the breadth and variety of undergraduate research taking place at Bucknell, as is evidenced by the abstracts of the projects contained herein. Visitors are encouraged to attend both the oral presentations as well as the poster session to interact with the scholars and to learn more about their work.

This symposium is named in honor of Ernest Kalman, who graduated from Bucknell in 1956. In addition to his service as a University trustee, Ernie's generosity to his alma mater has taken many forms, one of which was a significant gift in support of undergraduate research.

The ***Kalman Research Symposium*** features projects sponsored or supported by the following:

- Michael Baker Jr. Summer Research Program
- Fund for Undergraduate Research in Biological and Chemical Sciences
- Department of Biology
- Department of Biomedical Engineering
- Bobko-Dennis Fund for Undergraduate Student Research
- David Burpee Endowment
- California Healthcare Undergraduate Research
- Douglas K. Candland Undergraduate Research Fund
- Department of Chemistry
- Culliton Family Fund for Undergraduate Research
- Dean's Fund for Summer Undergraduate Research in STEM
- Department of Electrical & Computer Engineering
- Emerging Scholars Program
- College of Engineering
- Department of Geology & Environmental Geosciences
- Department of Geology & Environmental Geosciences Marchand Fund
- Graduate Summer Research Fellowship
- Grand Challenges Scholars Program
- The Tom Greaves Fund for Research and Curricular Development

continued

The ***Kalman Research Symposium*** features projects sponsored or supported by the following: (continued)

- Harold W. Heine Undergraduate Research Fund in Chemistry
- Stephen Glenn Hobar Memorial Research Award
- John C. Hoover Scholarship
- John M. Hustler Undergraduate Research Fund
- Kalman Fund for Biomedical Research Fellows
- Kalman Fund for Undergraduate Research in the Sciences
- Clare Boothe Luce Research Scholarship
- Mayfield and Johnson Scholarship
- The Katherine Mabis McKenna Environmental Internship Program
- NASA Astrobiology Institute
- National Institutes of Health
- National Program for Playground Safety, University of Northern Iowa
- National Science Foundation Grant (NSF)
- (National Science Foundation) NSF ADVANCE
- PA Wild Resource Conservation Program
- PIC Math, a Mathematical Association of America (MAA) program funded by the National Science Foundation (NSF) and the National Security Agency (NSA)
- PPL Undergraduate Research Fund
- Presidential Fellowship
- Program for Undergraduate Research
- Reed-Garman Award Fund for Engineering Entrepreneurship
- James L.D. and Rebecca Roser Research Fund
- Helen E. Royer Undergraduate Research Fund
- Schotz Family Interdisciplinary Fund
- Sigma Xi Grant-in-Aid of Research
- Slonaker Fund
- Gary A. and Sandra K. Sojka Fund for Research, Teaching and Scholarship in Developmental Disabilities, Neuroscience & Human Health
- STEM Scholars
- Susquehanna River Heartland Coalition for Environmental Studies
- Tague Family Fund for Undergraduate Research in Biomedical, Biological and Biochemical Sciences
- Robert P. Vidinghoff Memorial Summer Internship
- Joann E. Walthour Undergraduate Research Fund

Lindsey Baker '19
Faculty Mentor: Professor Christopher Daniel, Geology & Environmental Geosciences
Funding Source: Clare Boothe Luce Research Scholarship
Testing Models of Mazatzal (1650 Ma) and Picuris Age (1400 Ma) Metamorphism in Near–Granulite Facies Metamorphic Rocks of the Northern Taos Range, New Mexico

Graeme Bazarian '20
Faculty Mentor: Professor Eric Kennedy, Biomedical Engineering
Funding Source: Program for Undergraduate Research
Analysis of Braking Force and Reaction Time Data of Healthy Subjects

Juliana Berhane, Graduate Student
Faculty Mentor: Professor Reggie Gazes, Psychology, Animal Behavior
Funding Source: Graduate Summer Research Fellowship
The Relationship between cognitive performance and social status in capuchin monkeys (*Cebus [Sapajus] apella*)

Kelsey Birmingham '19
Faculty Mentor: Professor Jasmine Mena, Psychology
Funding Source: Gary A. and Sandra K. Sojka Fund for Research, Teaching and Scholarship in Developmental Disabilities, Neuroscience & Human Health
Perceived Healthcare Discrimination: the Influence of Skin Color and Black Racial Centrality

Brianna Bjordahl '19
Faculty Mentor: Professor Mizuki Takahashi, Biology
Funding Source: Fund for Undergraduate Research in Biological and Chemical Sciences
Examining the distribution of Japanese giant salamanders (*Andrias japonicus*) in tributary streams of Hyōgo Prefecture, Japan

Corinne Bleecker '19
Faculty Mentor: Professor Brantley Gasaway, Religious Studies
Funding Source: Douglas K. Candland Undergraduate Research Fund
The Salvation Army's Social Crusade

Benjamin Bliss '19
Faculty Mentor: Professor Ellen Herman, Geology & Environmental Geosciences
Funding Source: The Katherine Mabis McKenna Environmental Internship Program
Tracking Annual, Seasonal, and Storm-to-Storm Changes in Three Pennsylvania Karst Springs to Determine Flow Paths and Recharge Patterns

Caroline Bolton '22
Faculty Mentor: Professor Elif Miskioglu, Chemical Engineering
Funding Source: Presidential Fellowship
Understanding the Link between Engineering Identity and Academic Motivation

Jen Borowka '20
Faculty Mentor: Professor Moria Chambers, Biology
Funding Source: Robert P. Vidinghoff Memorial Summer Internship
Female Mating Bias in Response to Infection Status of Male *Drosophila Melanogaster*

Tim Briggs '21, Ellie Siegfried '19, Derrick Yao '22
Faculty Mentor: Professor Nathan Ryan, Mathematics
Funding Source: PIC Math, a Mathematical Association of America (MAA) program funded by the National Science Foundation (NSF) and the National Security Agency (NSA)
The Lewisburg Area School District: Bus Routes Optimization

Maren Burling '19
Faculty Mentor: Professor Michelle Johnson, Sociology & Anthropology
Funding Source: The Tom Greaves Fund for Research and Curricular Development
Els Catalans Són Diferents (Catalans are Different): Catalonian Independence through a Cultural Lens

Donna Calia '19
Faculty Mentor: Professor Karen Altendorf, Sociology & Anthropology
False Convictions: Media Portrayal vs. Reality

Tyler Candelora '19
Faculty Mentor: Professor Katie Faull, Comparative Humanities
Funding Source: Douglas K. Candland Undergraduate Research Fund
Lota, Chile: Tourism and Heritage in a Chilean Coal Town

Kathryn Cantagallo '20
Faculty Mentor: Benjamin Hayes, Bucknell Center for Sustainability and the Environment
Funding Source: Susquehanna River Heartland Coalition for Environmental Studies
Ecosystem Services – Valuing Our Natural Capital Quantifying Carbon and Sediment Sequestration in the West Branch Susquehanna Watershed

Can Cao '20
Faculty Mentor: Professor Kevin Myers, Psychology
Funding Source: Gary A. and Sandra K. Sojka Fund for Research, Teaching and Scholarship in Developmental Disabilities, Neuroscience & Human Health
Relationship between Impulsivity and Diet Behaviors

Brielle Cenci '19
Faculty Mentor: Professor Eric Kennedy, Biomedical Engineering
Funding Source: Department of Biomedical Engineering
Creating a Device to Measure Surface Temperatures and Sunlight on Playgrounds

Yuxuan (Bill) Chen '21
Faculty Mentor: Professor Alan Marchiori, Computer Science
Funding Source: Program for Undergraduate Research
Low-Power Wide-Area Network Planning for Smart Cities

Benjamin Clegg, Graduate Student
Faculty Mentor: Professor Brian Smith, Chemistry
Funding Source: Department of Chemistry
Control of Acetaminophen Polymorphism by Nucleation on Lactose

Ian Coates '21, Laney Treacy '21
Faculty Mentor: Professor Kenny Mineart, Chemical Engineering
Funding Source: Program for Undergraduate Research
Adhesion of Block Polymeric Organogels

Jordan Collins '19
Faculty Mentor: Professor Jeff Csernica, Chemical Engineering
Formulating Bio-Based Composite Materials Using Acrylated Epoxidized Soybean Oil

Jewel Cook '20
Faculty Mentor: Professor Dabrina Dutcher, Chemical Engineering
Funding Source: Program for Undergraduate Research
Carbon Monoxide in Electronic Cigarette Effluent

Elise Covert '20, Zachary Feit '20, Alexandra Koumas '20, Megan Fournier '19
Faculty Mentor: Professor Nathan Ryan, Mathematics (MATH 219: Solving Industrial Problems)
Funding Source: PIC Math, a Mathematical Association of America (MAA) program funded by the National Science Foundation (NSF) and the National Security Agency (NSA)
Data-informed Recommendations for Fixed-route Public Transit in Greater Susquehanna Valley

Marissa Diehl '19
Faculty Mentor: Professor Alan Cheville, Electrical & Computer Engineering
Funding Source: PPL Undergraduate Research Fund
Gamification of Electrical Circuit Concepts

Joseph DiPalma '19
Faculty Mentor: Professor Joshua Stough, Computer Science
Funding Source: Program for Undergraduate Research
Convolutional Neural Networks for Cardiac MRI Segmentation

Katherine Edwards '19 (first author) Mae Lacey '18, Paige Caine '21 (co-authors)
Faculty Mentor: Professor Morgan Benowitz-Fredericks, Biology
Funding Source: Presidential Fellowship; Sigma Xi Grant-in-Aid of Research; Tague Family Fund for Undergraduate Research in Biomedical, Biological and Biochemical Sciences; NSF ADVANCE
Black-legged kittiwakes (*Rissa tridactyla*) do not buffer chicks from experimental food reduction

Charlie Espy '21
Faculty Mentor: Professor Brian Smith, Chemistry
Funding Source: Presidential Fellowship
Growth Methods for 2D and 3D Covalent Organic Frameworks

Jessica Eyster '19
Faculty Mentor: Professor Sarah MacKenzie-Dawson, Education
Funding Source: James L.D. and Rebecca Roser Research Fund
Elementary Writing Instruction: Best Practices Through the Analytic Lens of Poetic Inquiry

Caroline Fakharzadeh '20
Faculty Mentor: Professor Ryan Snyder, Chemical Engineering
Funding Source: Program for Undergraduate Research
Amorphous to Crystalline Phase Transformation Kinetics Using X-Ray Diffraction

Evan Filion '20
Faculty Mentor: Professor Mark Spiro, Biology
Funding Source: Kalman Fund for Undergraduate Research in the Sciences
Assessing the Impact of Organic Farming Practices on Soil Health

Benjamin Finley '19
Faculty Mentor: Professor Mary Beth Gray, Geology & Environmental Geosciences
Funding Source: National Science Foundation; Department of Geology & Environmental Geosciences
Grain-Scale Strain Analysis in Folded Sandstone, Shamokin, PA

Danyon Fischbach '19
Faculty Mentor: Professor Brian Smith, Chemistry
Funding Source: Stephen Glenn Hobar Memorial Research Award
Controlling crystalline structure of imine-linked 3D Covalent Organic Frameworks

Kyle Fouke '20
Faculty Mentor: Professor Jeff Trop, Geology & Environmental Geosciences
Funding Source: Department of Geology & Environmental Geosciences Marchand Fund; NASA Astrobiology Institute
Impact of Seafloor Diagenetic Alteration on Sea Surface Temperature Reconstructions from Coral Skeletons

Nathan Fretz, Graduate Student
Faculty Mentors: Professor Molly McGuire, Chemistry; Professor Ellen Herman, Geology & Environmental Geosciences
Funding Source: Graduate Summer Research Fellowship
Annular flume studies to investigate iron oxidation and precipitate deposition in AMD systems

Cole Gardner '19
Faculty Mentor: Professor Jeff Trop, Geology & Environmental Geosciences
Funding Source: Dean's Fund for Summer Undergraduate Research in STEM
Late Devonian Sedimentary Record of Appalachian Tectonics and Erosion: Geochronology and Geochemistry of Detrital Muscovite and Zircon from North-Central Pennsylvania Strata

Josh Gesselberty '21
Faculty Mentors: Professor Tim Raymond, Chemical Engineering; Professor Dabrina Dutcher, Chemical Engineering
Funding Source: James L.D. and Rebecca Roser Research Fund
Juul E-Cigs variations due to Relative Humidity

Keith Grega '21
Faculty Mentor: Professor Benjamin Wheatley, Mechanical Engineering
Funding Source: Kalman Fund for Undergraduate Research in the Sciences
Determination of *Sus scrofa domesticus* Shoulder Aponeurosis

Scott Gulizio '19, Katherine Edwards '19, Katelyn Heuer '21, Mikayla Cochrane '20
Faculty Mentor: Professor Regina Gazes, Psychology, Animal Behavior
Funding Source: Emerging Scholars in Psychology Fellowship 2017; Presidential Fellowship; STEM Scholars
The impact of social context on learning in capuchins monkeys (*Cebus apella*)

Soheil Habibian, Graduate Student
Faculty Mentor: Professor Keith Buffinton, Mechanical Engineering
Funding Source: Graduate Summer Research Fellowship
Finite Element Analysis of Fiber Reinforced Elastomeric Enclosures

Emma Hadley '20, Garrett Sommer '21
Faculty Mentor: Professor Kenneth Mineart, Chemical Engineering
Funding Source: Slonaker Fund
Measuring Diffusion of Micelles in Organogels

Stephanie Harper-Long '19
Faculty Mentors: Professor Christopher Martine, Biology; Burpee Post Doc Fellow Angela McDonnell, Biology
Funding Source: David Burpee Endowment
Molecular Evidence for Distinctiveness of Two Forms of the Hawaiian Endemic, Chenopodium oahuense (Amaranthaceae)

Hannah Hervieux '21
Faculty Mentor: Professor Bethany Collier, Music
Funding Source: Bobko-Dennis Fund for Undergraduate Student Research
Does The Mallet Teach?: A Comparative Study of Gamelan Pedagogy in America and Bali, Indonesia

Bridgette Holland '20
Faculty Mentor: Professor Anna Baker, Psychology
Funding Source: Gary A. and Sandra K. Sojka Fund for Research, Teaching and Scholarship in Developmental Disabilities, Neuroscience & Human Health
Systematic Review of the Social Effects of Food Allergy in Children

Cammie Hong '21
Faculty Mentor: Professor Kenny Mineart, Chemical Engineering
Funding Source: Program for Undergraduate Research
Establishing Relationships Between Molecular Interconnectivity and Mechanical Behavior of Organogels

Junjie Jiang '19
Faculty Mentors: Professor Nathan Ryan, Mathematics; Professor Vanessa Massaro, Geography
Funding Source: Schotz Family Interdisciplinary Fund
Reverse Engineering Secret Algorithms: Factors that Influence Parole Decisions

Peter Kaladius '21
Faculty Mentor: Professor Peter Jansson, Electrical & Computer Engineering
Funding Source: College of Engineering
On an investigation of Mach Principle

Justin Koss '19
Faculty Mentor: Professor Beth Capaldi, Animal Behavior
Funding Source: Kalman Fund for Biomedical Research Fellows
Histological Analysis of pads in the Gastrointestinal Tract of Carpenter Bees

Yvette Lai '19
Faculty Mentor: Professor Jessica Newlin, Civil & Environmental Engineering
Funding Source: Michael Baker Jr. Summer Research Program; The Katherine Mabis McKenna Environmental Internship Program
Analysis and Visualization of Spatial and Temporal Variation of Water Temperature in the West Branch of the Susquehanna River and Its Tributaries

Samantha Lauriola '19
Faculty Mentor: Professor Eric Kennedy, Biomedical Engineering
Funding Source: National Program for Playground Safety, University of Northern Iowa
Impact Attenuation Performance of Playground Surfacing Materials: Effects of Altering the Complying HIC Values of ASTM F1292

Samantha Lauriola '19
Faculty Mentor: Professor Eric Kennedy, Biomedical Engineering
Funding Source: National Program for Playground Safety, University of Northern Iowa
Do Playground Wear-mats Above Loose Fill Preserve Impact Attenuation Performance?

Amelia Lautenberg '20
Faculty Mentor: Professor Reggie Gazes, Psychology, Animal Behavior
Funding Source: Presidential Fellowship
Positive Reinforcement Based Training for Experimental and Veterinary Procedures in Captively Housed Squirrel Monkeys and Hamadryas Baboons

Nathan Lesnevich '19
Faculty Mentor: Professor Peter McNamara, Mathematics
Funding Source: Presidential Fellowship; John C. Hoover Scholarship
Positivity among P-partition generating functions of partially ordered sets

Sarah Lombel '19, Vitoria Ruozzi '19, Kyle Shtern '19
Faculty Mentor: Professor Julie Gates, Biology
Funding Source: Kalman Fund for Biomedical Research Fellows; Tague Family Fund for Undergraduate Research in Biomedical, Biological and Biochemical Sciences
Verification of Proteins Required for Ras Activity in the Developing Drosophila Eye

***Alexandra Longest '20**
Faculty Mentor: Professor Kevin Gilmore, Civil & Environmental Engineering
Funding Source: The Katherine Mabis McKenna Environmental Internship Program
Development of a Simple, Effective Activity Test for Combined Ammonium Oxidation (Comammox) Bacteria

David Lundy '21
Faculty Mentor: Professor Ryan Snyder, Chemical Engineering
Funding Source: Kalman Fund for Undergraduate Research in the Sciences
Effects of Excipient Ratio and Solvent Choice on Amorphous Solid Dispersions

Ming Ma '19
Faculty Mentor: Professor Jessica Newlin, Civil & Environmental Engineering
Funding Source: The Katherine Mabis McKenna Environmental Internship Program
Hyporheic Zone Analysis at Stream-bridge or Culvert Crossings

Michael Matirko '19, Ryan Pasculano '19
Faculty Mentor: Professor Alan Marchiori, Computer Science
Funding Source: Reed-Garman Award Fund for Engineering Entrepreneurship
Asynchronous Server-Source Protocol for Extraterrestrial Endpoints

Cheyenne McKinley '20
Faculty Mentor: Professor Sarah Lower, Biology
Evolution of a Firefly *Femme Fatale*: a Transcriptomic Analysis

Julia Medici '20
Faculty Mentors: Professor Evan Peck, Computer Science
Funding Source: Kalman Fund for Undergraduate Research in the Sciences

Cheyenne Moore, Graduate Student
Faculty Mentors: Professor Christopher Martine, Biology; Burpee Post Doc Fellow Angela McDonnell, Biology
Funding Source: David Burpee Endowment; PA Wild Resource Conservation Program
Status of *Baptisia australis* var. *australis* (Fabaceae) in Pennsylvania

Richard Noel '20
Faculty Mentor: Professor Peter Groff, Philosophy
Funding Source: Culliton Family Fund for Undergraduate Research
Nietzsche on Solitude and Self-Cultivation

Effiem Obasi '20
Faculty Mentor: Professor Bill Flack, Psychology
Funding Source: California Healthcare Undergraduate Research
Relative weight of diagnosis, treatment, and prevention research on psychological trauma

Brayson Pawelczyk '20
Faculty Mentor: Professor Rebecca Switzer, Chemistry
Funding Source: John M. Hustler Undergraduate Research Fund
Impact of Disease-Causing Mutations in the RFTS Domain on DNMT1 Stability and Activity

Zander Perelman '19
Faculty Mentor: Professor Mizuki Takahashi, Biology, Animal Behavior
Funding Source: Department of Biology
Detection of Snake Fungal Disease in an Eastern Ratsnake (*Pantherophis alleghaniensis*) in Pennsylvania

Amber Quinlan '20
Faculty Mentor: Professor Jasmine Mena, Psychology
Funding Source: Gary A. and Sandra K. Sojka Fund for Research, Teaching and Scholarship in Developmental Disabilities, Neuroscience & Human Health
The Education and Physical Quality of Life Relationship: Do Latinxs and Whites Differ?

Daphne Ratnarajah '19, Margarita Torres Loredo '22
Faculty Mentor: Professor Jimmy Chen, Management
Funding Source: Presidential Fellowship
Secret Formula for Success: Personal Attributes and Social Factors

Chelsea Reynolds '19
Faculty Mentor: Professor Christopher Daniel, Geology & Environmental Geosciences
Funding Source: Program for Undergraduate Research
Using Raman Laser Spectroscopy to Calculate Metamorphic Pressures of Entrapment of Quartz Inclusions within Garnet (Quig) in the Thompson Peak Region of New Mexico

Mark Roginkin '21
Faculty Mentor: Professor David Rovnyak, Chemistry
Funding Source: Chemistry Undergraduate Research Fund
Non-Uniform Sampling in NMR For Pharmaceutical Structure Elucidation

Avery Rosh '21
Faculty Mentors: Professor Erin Jablonski, Chemical Engineering; Professor Brandon Vogel, Chemical Engineering
Funding Source: Program for Undergraduate Research
Use of Microfluidic Devices for the Analysis of the Degradation of Methacrylated Dextran Hydrogels

Nicole Rupnik '19
Faculty Mentor: Professor Peter Judge, Animal Behavior
Funding Source: Program for Undergraduate Research
Metacognitive abilities of brown Capuchins (*Cebus [Sapajus] apella*)

Renee Russell, Graduate Student
Faculty Mentor: Professor Peter Judge, Animal Behavior
Funding Source: Graduate Summer Research Fellowship
Squirrel monkeys (*Saimiri sciureus*) demonstrate self-control in a food exchange task

Karen Santizo '21
Faculty Mentor: Professor Katsuyuki Wakabayashi, Chemical Engineering
Funding Source: Helen E. Royer Undergraduate Research Fund
Flax Composites: Towards Truly Renewable Materials for a Sustainable World

Francesco Satriale '19
Faculty Mentor: Professor Moria Chambers, Biology
Funding Source: Kalman Fund for Biomedical Research Fellows
Impact of Chronic Bacterial Infection on Host Immunity of *Drosophila melanogaster*

Zack Schiffer '20
Faculty Mentor: Professor Brian Smith, Chemistry
Funding Source: Mayfield and Johnson Scholarship; Dean's Fund for Summer Undergraduate Research in STEM; John M. Hustler Undergraduate Research Fund
Melting and Crystallization of Acetaminophen Using Differential Scanning Calorimetry

Andrew Schlicht '20
Faculty Mentor: Professor Corrie Walton-Macaulay, Civil & Environmental Engineering
Funding Source: Culliton Family Fund for Undergraduate Research
Using Iron Powder in Geothermal Systems to Enhance the Viability of Concrete

William Snyder '21
Faculty Mentor: Professor Vanessa Troiani, Bucknell-Geisinger Autism and Developmental Medicine Institute
Funding Source: Gary A. and Sandra K. Sojka Fund for Research, Teaching and Scholarship in Developmental Disabilities, Neuroscience & Human Health; National Institutes of Health
Evaluation of Automated Orbitofrontal Sulci Labeling

Kefan "Tony" Song '20
Faculty Mentor: Professor Eric Kennedy, Biomedical Engineering
Funding Source: Helen E. Royer Undergraduate Research Fund
Development and Validation of a Braking Force Assessment Device for Lower Extremity Trauma Patients

Richard Stover '20
Faculty Mentor: Professor John Penniman, Religious Studies
Funding Source: Helen E. Royer Undergraduate Research Fund
Religious Identity and Spirituality on College Campuses

Megan Summers '19
Faculty Mentor: Professor Kevin Myers, Psychology
Funding Source: Gary A. and Sandra K. Sojka Fund for Research, Teaching and Scholarship in Developmental Disabilities, Neuroscience & Human Health
Metabolic Preparatory Responses as a Result of Flavor Nutrient Learning in Rats

Haipu Sun '19
Faculty Mentor: Professor Alan Marchiori, Computer Science
Funding Source: James L.D. and Rebecca Roser Research Fund
Enabling Network Coverage of the Internet of Things

Anastassia Thibodeau '19
Faculty Mentors: Professor Christopher Daniel, Geology & Environmental Geosciences; Professor Jeff Trop, Geology & Environmental Geosciences
Funding Source: Department of Geology & Environmental Geosciences Marchand Fund
Comparison of Geochemistry of Detrital Muscovite and Muscovite Schist Clasts from the Spechty Kopf Formation, Northeastern Pennsylvania

Anurag Vaidya '21
Faculty Mentor: Professor Benjamin Wheatley, Mechanical Engineering
Funding Source: Program for Undergraduate Research
Effects of Boundary Conditions on the Compressive Behavior of Passive Skeletal Muscle

Aditi Vijayvergia '21, Joon Shin '20
Faculty Mentor: Professor Keith Buffinton, Mechanical Engineering
Funding Source: Department of Electrical & Computer Engineering; The Grand Challenges Scholars Program (respectively)
Experimental Verification of Finite Element Modeling and Improved Fabrication of FREEs (Fiber Reinforced Elastomeric Enclosures)

***Cameron Wade '20**
Faculty Mentor: Professor David Del Testa, History
Funding Source: Douglas K. Candland Undergraduate Research Fund
Music and Community in Huguenot Parishes

Howie Wang '20, Bryant Zhou '20
Faculty Mentor: Professor Charles Kim, Mechanical Engineering
Funding Source: James L.D. and Rebecca Roser Research Fund
Implementation of a Screw-Drive Extruder in a Desktop 3D-Printing System

Yili Wang '21
Faculty Mentor: Professor Christina Hamlet, Mathematics
Funding Source: Culliton Family Fund for Undergraduate Research
Computational Modeling of the Effects of the Sensory Feedback on Lamprey Swimming

Marlee Warwick '19, *Janey Woo '20
Faculty Mentor: Professor Ramona Fruja, Education
Funding Source: Joann E. Walthour Undergraduate Research Fund

Jenny Waters '21, Lindsey Trusal '20, Abbie Winter '19
Faculty Mentor: Professor Mizuki Takahashi, Biology
Funding Source: Department of Biology
Effect of Salt Pollution and Predation on Hatching Success and Incubation Period on *Ambystoma Maculatum*

Savannah Weaver '20, Emily Konishi '19
Faculty Mentor: Professor Matthew McTammany, Biology
Funding Source: The Katherine Mabis McKenna Environmental Internship Program
Lack of Lateral Mixing Downriver of Tributary Confluences

Jill Weiss '19
Faculty Mentor: Professor Rebecca Switzer, Chemistry
Funding Source: John M. Hustler Undergraduate Research Fund
Examination of Substituted Anthraquinones as Direct DNA-competitive Inhibitors of DNA Methyltransferase 1

Heather Wetreich '21
Faculty Mentors: Professor Christopher Martine, Biology; Burpee Post Doc Fellow Angela McDonnell, Biology
Funding Source: David Burpee Endowment
Solanum plastisexum, an enigmatic new bush tomato from the Australian Monsoon Tropics exhibiting breeding system fluidity

David Williams '20
Faculty Mentor: Professor Indranil Brahma, Mechanical Engineering
Funding Source: Program for Undergraduate Research
Mechanical Efficiency in Running

Christina Yu '21
Faculty Mentors: Professor Tom Solomon, Physics & Astronomy
Funding Source: National Science Foundation Grants (NSF)
The Behaviour of Swimming Bacteria in Vortex Flows

Chengtong Zhang '20
Faculty Mentors: Professor David Rovnyak, Chemistry; Professor Timothy Strein, Chemistry
Funding Source: National Science Foundation; Stephen Glenn Hobar Memorial Research Award; Harold W. Heine Undergraduate Research Fund in Chemistry
Molecular Dynamics Simulations of Bile Salt Self Aggregation

*Abroad Spring Semester 2019

Lindsey Baker '19

Faculty Mentor: Professor Christopher Daniel, Geology & Environmental Geosciences

Funding Source: Clare Boothe Luce Research Scholarship

Testing Models of Mazatzal (1650 Ma) and Picuris Age (1400 Ma) Metamorphism in Near–Granulite Facies Metamorphic Rocks of the Northern Taos Range, New Mexico

Cathodoluminescence (CL) imaging of zircon in metamorphic rocks with differing bulk compositions from Cedro Canyon reveals metamorphic zircon grains and metamorphic overgrowths on preexisting igneous and detrital zircon. LA-ICP-MS 207Pb/206Pb ages from metamorphic zircon range from 1424 Ma to 1409 Ma. These ages are consistent with upper amphibolite facies metamorphism (~700 °C, 7 kbar) and deformation associated with the ca. 1450–1360 Ma Picuris Orogeny. No evidence of an earlier high temperature metamorphic event associated with the 1650 Ma Mazatzal Orogeny metamorphism was observed.

The structurally highest sample, a gneissic granite (CC15-06) yields a crystallization age of 1714 Ma from concentrically zoned zircon cores with U/Th < 10. Metamorphic overgrowths with U/Th > 10 range from ~1410 Ma to ~1260 Ma. This new crystallization age is significantly older than previously reported ages of 1643 Ma and 1678 Ma for orthogneiss in the area. Undeformed pegmatite (CC15-02) crosscuts the gneissic granite and yields an upper intercept age of 1209 Ma.

Sil-bearing felsic gneiss, amphibolite, and ky-sil bearing quartzite were also sampled. Zircon cores from sil-bearing felsic gneiss (CC15-07) yield a crystallization age of ~1706 Ma with metamorphic overgrowths of 1422 Ma. Amphibolite (CC15-05) bears metamorphic zircon with relatively bright CL cores and dark CL rims that all show U/Th >> 10. Preliminary ages from the bright cores range from 1490 Ma to 1450 Ma and overgrowths yield an age of 1402 Ma. Quartzite (CC15-01) yields a unimodal detrital zircon age distribution (n=285) with a peak age of 1695 Ma. Metamorphic overgrowths, U/Th > 10, yield an age of ~1404 Ma.

Graeme Bazarian '20

Faculty Mentor: Professor Eric Kennedy, Biomedical Engineering

Funding Source: Program for Undergraduate Research

Analysis of Braking Force and Reaction Time Data of Healthy Subjects

Physicians are often faced with the difficult question of when a patient can resume driving after a surgery on their lower extremities. This study was conducted to collect and analyze braking force and reaction time data from healthy patients to develop average response corridors, so a post-surgical patient's ability to drive can later be compared to the healthy population. A driving simulator was built to simulate an emergency braking scenario in which the subject was instructed to brake as hard and fast as possible. An Arduino Due was used to collect data, which was then analyzed using Matlab to create average brake-force response corridors. Overall, 27 healthy subjects participated in the study, 11 males and 16 females, ranging from 19 to 83 years of age. The resulting corridors showed that most subjects had very similar reaction times with an average of 0.298 ± 0.067 s, but the maximum force applied varied greatly with an average of 100 ± 41.5 lbf. This large variation could be attributed to gender, because there was a trend of separation between male and female subjects. In the future more data will be collected by the physicians at Geisinger Medical Center in Danville, PA, and the analysis will be revised to determine how factors such as age and gender affect performance.

Juliana Berhane, Graduate Student

Faculty Mentor: Professor Reggie Gazes, Psychology, Animal Behavior

Funding Source: Graduate Summer Research Fellowship

The Relationship between cognitive performance and social status in capuchin monkeys (*Cebus [Sapajus] apella*)

The cognitive demand on animals to learn, maintain, and remember the complexities of social relationships is higher for species or individuals who live more complex social lives. Across species, as social complexity in a species increases, so does the ability to flexibly learn and manipulate information. Within species, individuals living in larger groups, both naturally occurring and artificially created, perform better on learning, memory, and transitive inference tasks compared to conspecifics living in smaller groups. Elucidating the relationship between social complexity and cognition is therefore essential to understanding how evolutionary pressures have shaped cognition. In the present study, I determined if there is a relationship between social complexity and cognitive performance on two standard tests of learning in a social living species of primate, brown-tufted capuchin monkeys (Cebus [Sapajus] apella). Subjects were 16 members of a socially housed group of capuchin monkeys. I conducted behavioral observations of affiliative social interactions, then used these interactions to determine how complex each monkey's social life was using the social network of the group. I will present results of analyses that determine

whether variation in sociality, measured by location in the social network, correlates with variation in cognitive performance on the two learning tasks at the individual level.

Kelsey Birmingham '19

Faculty Mentor: Professor Jasmine Mena, Psychology
Funding Source: Gary A. and Sandra K. Sojka Fund for Research, Teaching and Scholarship in Developmental Disabilities, Neuroscience & Human Health

Perceived Healthcare Discrimination: the Influence of Skin Color and Black Racial Centrality

This research examined the relationship between skin color and healthcare discrimination. The buffering effect of black racial centrality on the relationship between skin color and perception of healthcare discrimination was also examined because it would be useful to know if black racial centrality helps people cope with healthcare discrimination. Darker skinned individuals and those with higher levels of black racial centrality were expected to perceive more discrimination than lighter individuals. Methods: The participants were 326 self-identified Black individuals from New England States. Results: Individuals with increased levels of black centrality reported more frequent instances of discrimination in healthcare ($r = .27$, $p < .01$) and higher levels of discrimination stress ($r = .29$, $p < .01$). Individuals who perceived themselves as darker had higher levels of black centrality ($r = .24$, $p < .01$). Individuals who perceived themselves as darker also reported more frequent instances of discrimination ($r = .21$, $p < .01$). Black racial identity did not moderate the relationship between skin color and perceptions of healthcare discrimination. Discussion: We did not directly observe encounters; thus, we cannot say if darker skinned individuals actually experienced more frequent discrimination in healthcare. With that said, darker skinned individuals and individuals with stronger black centrality, were more likely to perceive healthcare encounters more negatively and more stressful than individuals with lighter skin. Healthcare providers are advised to attend to their relationship with marginalized patients who may be more likely to perceive their interactions as discriminatory.

Brianna Bjordahl '19

Faculty Mentor: Professor Mizuki Takahashi, Biology
Funding Source: Fund for Undergraduate Research in Biological and Chemical Sciences

Examining the distribution of Japanese giant salamanders (*Andrias japonicus*) in tributary streams of Hyōgo Prefecture, Japan

The Japanese giant salamander (*Andrias japonicus*) is a near threatened species endemic to the Western regions of Japan. It is a member of the *Cryptobranchidae* family along with the Eastern hellbender (*Cryptobranchus alleganiensis*) and the Chinese giant salamander (*Andrias davidianus*), and like other species in the *Cryptobranchidae*, it externally fertilizes and typically breeds in August and September. *A. japonicus* can be found in nesting cavities along the sides of riverbeds or under rock slabs. However, little is known about how this species utilizes small tributary streams or what their distributions in these streams may be. Although they are often too small for adult salamanders to utilize, some studies speculate that larval and juvenile salamanders inhabit these tributaries to avoid competition and predation. In summer 2018, our lab travelled to the Hyōgo Prefecture, Japan and hiked up three tributary streams, collecting water samples every few meters until the streams dried. We brought these collected samples back to our lab with the Hanazaki Research Institute, filtered them, and extracted each filter for environmental DNA (eDNA) using Qiagen DNeasy Blood and Tissue Kits. At our Bucknell University lab, we ran quantitative PCR (qPCR) analysis on each of the samples with four replicates each. Although we did not see any salamanders during the field sampling, the results of our eDNA analyses showed that salamanders were in every one of the tributary streams with eDNA signatures even at the streams' farthest reaches, which support the hypothesis that these streams are used by larvae and juveniles.

Corinne Bleecker '19

Faculty Mentor: Professor Brantley Gasaway, Religious Studies
Funding Source: Douglas K. Candland Undergraduate Research Fund

The Salvation Army's Social Crusade

My research involved the Salvation Army in the late nineteenth and early twentieth century, focusing on its activities and attitudes toward social issues, organizations, and movements. My main research questions concerned how the Salvation Army and its leaders addressed and interacted with social and political movements such as industrialization, women's suffrage, immigration, race relations, and prohibition. I sought to answer questions as to how the Salvation Army brought together its more conservative theological views with its more progressive social services, how the Salvation Army fit into the rhetoric of the Social Gospel, and how it interacted with other religious service organizations of the time.

The method used was scanning and reading of microfilm. We were in contact with the Salvation

Army's national archives in Alexandria, Virginia, and they very generously allowed us to borrow microfilm of the Salvation Army's weekly periodical The War Cry. The Archives are very reluctant to loan out any microfilm, and usually one has to go to the archives in order to access anything in their possession. There is no online database of this source, and we scanned from the years 1890 to 1913. I then read through these, looking for anything relating to my research questions. Unfortunately, because we did not get past 1913, some of my questions were left unanswered. For the most part, the lack of material present was just as telling as any material that would have addressed my questions.

Benjamin Bliss '19

Faculty Mentor: Professor Ellen Herman, Geology & Environmental Geosciences

Funding Source: The Katherine Mabis McKenna Environmental Internship Program

Tracking Annual, Seasonal, and Storm-to-Storm Changes in Three Pennsylvania Karst Springs to Determine Flow Paths and Recharge Patterns

Chemical and hydrological parameters were collected during storm events over four years at three karst springs in central Pennsylvania. Specific conductance (SpC), concentration of CO_2, concentration of NO_3-, and depth measured over the rising and falling limbs of storm hydrographs during different times of the year and under different antecedent conditions point to varying speeds, flow paths, and recharge patterns.

CO_2 concentrations increased from spring through summer and decreased during fall and winter. They increased together at each spring, though timing of arrival was different storm-to-storm. Storm-driven changes in concentrations of chemical parameters were greatest in wet antecedent conditions and during the largest storms which indicated activation of fast flow paths under these conditions.

Weaver Spring showed the greatest differences in [NO_3-] seasonally and during individual storms. During wet antecedent conditions, [CO_2], [NO_3-], and SpC followed similar trends through each storm event at Weaver Spring. Relative timing of pulses in discharge and chemical parameters pointed toward multiple flow paths with significant recharge and storage of water and contaminants in soil. At Smullton Sinks, parameter patterns were similar during individual storms, but storm-to-storm, peak [CO_2] arrival times were not the same. This may indicate a changing contribution of soil water seasonally and storm-to-storm. Springhouse Spring had the least seasonal chemical variation, but [NO_3-] varied from 6 to 13 ppm year to year. This variation may indicate the dominance of slow flow under most conditions, while fast flow paths activate depending on the recharge pattern and antecedent conditions.

Caroline Bolton '22

Faculty Mentor: Professor Elif Miskioglu, Chemical Engineering

Funding Source: Presidential Fellowship

Understanding the Link between Engineering Identity and Academic Motivation

A greater establishment of one's career identity has been shown to translate into greater career motivation. We hypothesize that this relationship may also hold true in the classroom setting; i.e., that a secure sense of academic identity directly correlates to academic motivation and subsequently success.

This study seeks to measure the motivation of an individual by analyzing their previous responses to failure. The subject population centers on a diverse group of students, ranging from "traditional" college students to veterans enrolled in an upper-level space mechanics course. Identity is measured using a validated instrument that focuses on how students view themselves within their chosen field of engineering. To measure motivation, we use critical incident technique, specifically having participants recall and describe a time in which they had a significant academic or professional failure. Did they continue to remain motivated despite the failure? Or did they willingly submit to the difficulty and give up all together? Perhaps, they landed somewhere in between – unhappy with defeat but also hesitant to face the same challenges again. Individual react differently to certain situations; their unique response is a part of what defines them.

Determining the disciplinary identity of students and its correlation with resilience can provide educators with ways to adjust their teaching techniques to better encompass the range of individuals taking their courses. In ongoing work, we continue to sort through the vast collection of variables contributing to the difference in individuals and their resulting motivation, such as underrepresentation, experience, and adaptability.

Jen Borowka '20

Faculty Mentor: Professor Moria Chambers, Biology

Funding Source: Robert P. Vidinghoff Memorial Summer Internship

Female Mating Bias in Response to Infection Status of Male *Drosophila Melanogaster*

Sexual selection is a type of natural selection that favors individuals with traits that make them a more

attractive mating partner. One factor that may affect the attractiveness of *Drosophila* when choosing a mate is their infection status. Through both competitive and non-competitive mating assays, the attractiveness and robustness of healthy male flies in comparison to males infected with varying dosages of *Providencia rettgeri* were tested and observed for their mating success, latency to begin mating, and copulation duration. Previous results in Chambers' Lab have shown that in competitive mating assays, male with a high dosage of infection are selected over uninfected males (McCarter and Chambers, 2018.) However, in these results there was no significance found for these factors in either mating assay. Therefore, the process of selection between the healthy and infected male remains unknown and under further investigation.

Tim Briggs '21, Ellie Siegfried '19, Derrick Yao '22

Faculty Mentor: Professor Nathan Ryan, Mathematics

Funding Source: PIC Math, a Mathematical Association of America (MAA) program funded by the National Science Foundation (NSF) and the National Security Agency (NSA)

The Lewisburg Area School District: Bus Routes Optimization

We analyze the bus scheduling problem for the Lewisburg Area School District (LASD); specifically, we optimize a solution in terms of time and distance students are on the bus and the number of buses used. There are 16 buses and a majority of them seat 81 students. The district has a two-tiered busing system meaning that the buses pick up students in two groups twice a day. Previously, LASD determined bus routes based on anecdotal knowledge. We develop an improved bus schedule for the LASD by applying tools from ArcGis and from operations research.

Maren Burling '19

Faculty Mentor: Professor Michelle Johnson, Sociology & Anthropology

Funding Source: The Tom Greaves Fund for Research and Curricular Development

Els Catalans Són Diferents (Catalans are Different): Catalonian Independence through a Cultural Lens

In Spring 2018, I studied abroad in Catalonia, Spain. While living with a host family and taking classes in Barcelona, I observed the cultural practices of those around me. Catalonia has a history of succession in Spain, and after a referendum for independence in 2017, the region has reclaimed its separatist movement and with it, its cultural roots.

In Spring 2018, I conducted my preliminary fieldwork through participant- observation, then, in Fall 2018, I conducted interviews with my informants to gain a deeper insight into perspectives on independence and Catalan difference. The question that framed my researched was: aside from political and economic differences between Catalonia and Spain, how do views about culture and identity influence how people feel about Catalanism?

My research and honors thesis focus solely on how Catalans create and perform their regional identity, and how cultural symbols of Catalan society – food, sports, language, and others – are uniquely different than those of the wider Spanish society. Both linguistic anthropology and symbolic/interpretive anthropology inform my writing and support my argument for the importance of language and other cultural symbols to Catalan identity, which are key to understanding Catalan separatism. My research contributes to current conversations in anthropology about the role of cultural identity in creating community. I argue that, in the Catalan case, cultural identity both shapes and is shaped by the ongoing independence movement.

Donna Calia '19

Faculty Mentor: Professor Karen Altendorf, Sociology & Anthropology

False Convictions: Media Portrayal vs. Reality

The aim of this study was to compare the media portrayal of false convictions and the reality of false convictions. This study utilized Netflix crime shows such as Making a Murderer, Confession Tapes, and the Innocent Man. These shows were compared with interrogation techniques, frequency of false convictions and false confessions, and the news surrounding these famous cases. An apparent gap was found between the entertainment world and criminal justice system. Further, this study addresses this gap and its implications on public opinion, fear, and knowledge of the criminal justice system.

Tyler Candelora '19

Faculty Mentor: Professor Katie Faull, Comparative Humanities

Funding Source: Douglas K. Candland Undergraduate Research Fund

Lota, Chile: Tourism and Heritage in a Chilean Coal Town

While studying abroad in Valparaíso, Chile during the spring of 2018, I visited the small coal mining town of Lota, Chile in order to study the impact of heritage sites on the collective memory of the town and their preservation of the coal mining history. This project expands upon previous research I conducted on monuments in my hometown of Shamokin, a small

anthracite coal mining town in central Pennsylvania. After discovering there was an absence of monuments dedicated to coal miners in Shamokin, I conducted a second research project to uncover monuments and memorials dedicated to coal miners throughout the PA anthracite coal region. I then wondered whether other countries, like Chile, with deep ties to the coal mining industry were representing this often polemicized part of history. After writing a research paper on the history of Chilean coal mining, I traveled to Lota and visited various tourist sites such as "El Chiflón del Diablo" mine, "El Pueblito Minero" the 19th century reconstruction of the coal miners' pavilions, and the Mueso de Lota, a museum dedicated to Lota's coal mining history. For the final project, I used the digital platform, Scalar, to create an online book and digital gallery. The site includes my detailed research paper, a digital map of Lota and its heritage sites, my field notes and photos, and information on impact of heritage sites on the collective memory of the town and the future of coal in Chile.

Kathryn Cantagallo '20

Faculty Mentor: Benjamin Hayes, Bucknell Center for Sustainability and the Environment

Funding Source: Susquehanna River Heartland Coalition for Environmental Studies

Ecosystem Services – Valuing Our Natural Capital Quantifying Carbon and Sediment Sequestration in the West Branch Susquehanna Watershed

Ecosystem services (ES) are a focus of research worldwide to estimate the value to humans offered by natural ecosystems such as forests, wetlands, and open space. Their benefits to society are widely accepted (e.g., crop production; recreation; erosion control; nutrient cycling; and carbon sequestration), but procedures to quantitatively link them to societal values are lacking. As a result, public agency decisions are uninformed with regard to the economic value that ES provide the local economy. This research is a first effort to develop an ES model for the central Susquehanna Valley region.

Numerous evaluation methods were critically reviewed and a wide variety of economic and geospatial data were collected to determine their reliability for computing ES values. Carbon sequestration was modeled for the West Branch Susquehanna River and sediment retention was modeled at a spatial resolution of 1-2 m for the Buffalo Creek watershed using ArcGIS and Stanford University's iNVEST model for a up to 17 different land use/land cover settings coupled with a digital terrain model.

Findings include: a) geospatial data are available at very fine resolutions, but procedures that translate land uses to financial values are less precise; b) forest, urban, wetland, and cropland areas in the West Branch Susquehanna River contribute over $128 million in economic value; c) riparian corridors sequester as much as 2 billion tons of sediment (and chemically-bound pollutants) that would otherwise make it to the Chesapeake Bay. The economic value of the sediment sequestration is currently being computed.

Can Cao '20

Faculty Mentor: Professor Kevin Myers, Psychology

Funding Source: Gary A. and Sandra K. Sojka Fund for Research, Teaching and Scholarship in Developmental Disabilities, Neuroscience & Human Health

Relationship between Impulsivity and Diet Behaviors

My research examined how impulsivity is related to high-fat, high-sugar diet and irregular meals. In the high-fat high-sugar division, the independent variable was the food type. In the irregular diet division, the independent variable was the portion of food given at fixed time slots. To test impulsivity, rats in both divisions were put into operant conditioning boxes that were attached with two levers connected to a feeder. Pressing one specific lever in the box led to one immediate food pellet, while pressing the other lever led to three delayed food pellets. Rats were trained to learn the associated food reward of each lever, and then were allowed to choose to press one lever freely. The delay for the three pellets was initially six seconds but would change based on the results of the free choice trials after the training. Choosing the lever with one immediate pellet led to a one second decrease in the delay, while choosing the lever with three delayed pellets led to a one second increase. The mean adjusted delay (MAD) measured the rat's impulsivity. Although we predicted that the MAD should have been stable after several days, none of the rats stabilized their MAD. Eventually, due to the malfunction of the operant box, we couldn't continue the study and thus didn't find significant results.

Brielle Cenci '19

Faculty Mentor: Professor Eric Kennedy, Biomedical Engineering

Funding Source: Department of Biomedical Engineering

Creating a Device to Measure Surface Temperatures and Sunlight on Playgrounds

The National Program for Playground Safety (NPPS) has identified "appropriate environment" as one of the four major potential risk factors on playgrounds. An appropriate environment encompasses issues such as age-appropriate equipment, using materials that do not easily overheat, and minimizing sun exposure

to children. Child thermal comfort is affected by air temperature, radiation, airflow, relative humidity, clothing, activity, and subjective factors, and it is an area that is relatively understudied. However, it is known that children can obtain significant injuries, such as burns and heat exhaustion, when coming in contact with overheated ground surfaces or playground equipment. Several factors contribute to the temperature of playground surfaces, such as the ambient temperature, color of the surface, the direction it faces, and how shaded it is throughout the day. In previous studies, the surface temperatures and shading of different playground surfaces have been tracked manually, but without a formalized system for a substantial period of time. The aim of this project is to develop a wireless, self-contained device that measures and temporally records both the temperature and solar radiation on exposed playground surfaces throughout the day. Once the final prototype is created, approximately 15 sensors will be made so that the measurements can be monitored at multiple sites throughout a single playground simultaneously. This data can lead to significant developments in regards to the thermal comfort of children for playgrounds, municipal pools, various playscapes, and other sites where thermal comfort issues affect human health.

Yuxuan (Bill) Chen ’21

Faculty Mentor: Professor Alan Marchiori, Computer Science

Funding Source: Program for Undergraduate Research

Low-Power Wide-Area Network Planning for Smart Cities

The goal of this project is to develop a new service for the city planning department tailored for planning low-power wireless network coverage within a city considering the actual infrastructure present. Our project builds on existing work developed for the PlanIt network coverage tool. During the summer, we set up with the MultiTech Conduit which is using LoRaWAN (Long Range Wide Area Network). The antenna for the Conduit was installed on the top of DANA building and can cover around the city. We collected data around Lewisburg by walking/driving/riding around the city to record wireless signal strength information. Then we compared it by making a contour graph to show the signal strength around Lewisburg.

Benjamin Clegg, Graduate Student

Faculty Mentor: Professor Brian Smith, Chemistry

Funding Source: Department of Chemistry

Control of Acetaminophen Polymorphism by Nucleation on Lactose

In the design of pharmaceutical formulation and drug delivery, controlling the crystal structure of the active pharmaceutical ingredient (API) is essential. An outstanding challenge in drug development is the prediction and selectivity over various possible crystal forms, or polymorphs. For example, the solid state structure of the drug directly affects its solubility, making insoluble crystals unable to deliver necessary medication. Controlling the nucleation conditions is the most direct method of polymorph control, which requires a fundamental understanding of the relationship between the nucleating surface structure and the polymorph selectivity. As a model system, we characterize acetaminophen crystal growth using its three well-defined polymorphs and its facile melt recrystallization. Exposing acetaminophen to lactose excipient during the recrystallization, both in bulk and surface-layered, increases selectivity for the metastable polymorph even at low lactose concentrations. The translation of these observations to functionalized silica surfaces will also be discussed.

Ian Coates ’21, Laney Treacy ’21

Faculty Mentor: Professor Kenny Mineart, Chemical Engineering

Funding Source: Program for Undergraduate Research

Adhesion of Block Polymeric Organogels

The physical properties of water-based gels have been extensively studied in the past; however, those of organic-based gels (i.e., organogels) have not been given the same attention. Our particular focus is on the adhesion properties of organogels, which are composed of a combination of mineral oil, diblock polymer, and triblock polymer. The goal of this research project is to establish the adhesive properties of organogels based upon their molecular composition and further provide an understanding for changes in adhesion based upon the internal nanostructure and polymer dynamic behavior. Through compressive adhesion testing, we observe that as the composition of diblock increases the adhesion also increases. Using rheology this trend will be explained through the analysis of the viscoelastic properties of each sample. Moving forward, the established trends and understanding will allow for the adhesion properties of organogels to be controlled. This may enable their use in a variety of applications including medical, athletic, or agricultural fields.

Jordan Collins ’19

Faculty Mentor: Professor Jeff Csernica, Chemical Engineering

Formulating Bio-Based Composite Materials Using Acrylated Epoxidized Soybean Oil

A thermosetting polymer becomes irreversibly hardened after it has been cured. In fiber-reinforced composites, thermosetting resins are important because they have good physical and chemical properties, thermal and chemical resistance, and begin as liquids before curing. Most commercially available thermosets are produced from petroleum-based chemicals. Due to depleting petroleum resources and increased environmental concerns, there is interest in exploring bio-based monomers and polymers from renewable sources to produce thermosetting resins and composite materials.

A promising feedstock for producing bio-based thermosetting polymers is vegetable oil. Acrylated epoxidized soybean oil (AESO) is soybean oil that is modified with acrylic groups that make it subject to free radical polymerization. AESO has been common for developing thermosetting resins for composites, but is very viscous at room temperature and its polymer has a low glass transition temperature. A comonomer is desired for AESO-based matrices to decrease the viscosity and increase the glass transition temperature.

In this experiment, hardened copolymers of AESO and isobornyl methacrylate (IBM) were successfully created in compositions ranging from 50-100 % AESO by curing in an oven at 120 degree Celsius for 2 hours and 160 degree Celsius for 4 hours. The material properties were tested using a flexural test and dynamic mechanical analysis, which resulted in expected trends based on the composition of AESO. Finally, composite materials were successfully created with 70% and 80% AESO mixtures and a single fiberglass mat. The stiffness was found to be roughly 50 times higher for the composite materials compared to the hardened copolymer samples.

Jewel Cook ’20

Faculty Mentor: Professor Dabrina Dutcher, Chemical Engineering

Funding Source: Program for Undergraduate Research

Carbon Monoxide in Electronic Cigarette Effluent

E-cigarettes have become vastly popular among current and new smokers. They have been marketed as the healthier alternative for traditional cigarettes and they provide a variety of flavors and nicotine levels for consumers to choose between. Some modern e-cigarettes offer customizable temperature/power levels as well. These have a lesser known health hazard from the presence of carbon monoxide in the e-cigarette effluent. Carbon monoxide is a colorless, odorless, fast-moving toxin that affects the binding of oxygen to hemoglobin, which prevents oxygen flow through the body and to the brain. This lack of oxygen can lead to health issues such as heart damage, brain and/ or nerve damage, and even death upon exposure above 100 ppm. This project utilizes diode laser spectroscopy to quantify the maximum concentration present in the effluent under various vaping conditions. The amount of carbon monoxide present appears to vary depending on the model of the e-cigarette, the power/temperature setting and the flavoring agents. The preliminary tests show that higher power settings have higher carbon monoxide maximum concentrations and of the flavors tested, the menthol appeared to have the highest carbon monoxide maximum concentration. The current models of e-cigarettes are customizable which can be dangerous if the consumer doesn’t understand how each factor affects how much carbon monoxide they will inhale. By observing these vaping conditions and understanding their possible health effects, regulators and manufacturers could set limits on the e-cigarettes settings and the flavor compositions to protect the e-cigarette users from carbon monoxide exposure.

Elise Covert ’20, Zachary Feit ’20, Alexandra Koumas ’20, Megan Fournier ’19

Faculty Mentor: Professor Nathan Ryan, Mathematics (MATH 219: Solving Industrial Problems)

Funding Source: PIC Math, a Mathematical Association of America (MAA) program funded by the National Science Foundation (NSF) and the National Security Agency (NSA)

Data-informed Recommendations for Fixed-route Public Transit in Greater Susquehanna Valley

Greater Susquehanna Valley United Way (GSVUW) aims to propose a fixed-route bus system across a mostly rural five-county region (Columbia, Montour, Northumberland, Snyder, and Union counties) in Central Pennsylvania to be operated by River Valley Transit. Regional needs assessments demonstrate that there is a critical lack of public transit, the implementation of which can increase access to medical care and facilitate workforce development. With input from GSVUW and other stakeholders, this project aims to provide data-informed recommendations for a bus route, bus stops, and time tables that optimize potential ridership and accessibility. Data from the American Community Survey, a United States Census household survey, and from Rabbit Transit, a local ride request service, are employed to quantify and visualize the distribution of potential demand for public transit within the region. Recommendations produced by such analyses will be used by GSVUW to apply for a Pennsylvania Department of Transportation feasibility grant to pilot the fixed route bus system.

Marissa Diehl '19

Faculty Mentor: Professor Alan Cheville, Electrical & Computer Engineering

Funding Source: PPL Undergraduate Research Fund

Gamification of Electrical Circuit Concepts

Are games the future of education? Can they teach deep academic concepts? This research is an explanatory feasibility study on whether it is possible to design a game that teaches difficult concepts. Gamification of circuits can intuitively teach otherwise difficult concepts through interaction and fun.

As a tutor and a senior EE student, I have seen many students struggle with the same problem, "I can do the math, but I don't understand the concept." Electricity is not intuitive. When we are young, we interact with balls to learn physics and talk to learn language. We believe we simulate the same experience with games and teach electrical intuition without any math. If successful, gamification could be the future of education.

In order to accomplish these goals, I learned unity and made a base game over the summer. During the fall semester, I worked with a team of senior computer science students for their senior design project to develop the game to a working level and this semester continue to work with one of those students Elliot Miller in finishing the alpha version of the game. Once the alpha version is complete, we can play testers give us feedback on how well they learned electronics, allowing refinement and the development of the future of circuit education.

Joseph DiPalma '19

Faculty Mentor: Professor Joshua Stough, Computer Science

Funding Source: Program for Undergraduate Research

Convolutional Neural Networks for Cardiac MRI Segmentation

Automatic segmentation of cardiac MR images is an open problem in the field of medical imaging. The results will allow doctors to quantitatively assess the effects of cardiovascular diseases. Currently, cardiac MR images are manually segmented by a skilled technician. This is a time-consuming process and there can be variability between different technicians. To address these problems, we used a convolutional neural network to automatically segment the images. The objective is to eventually automatically segment over 15 years' worth of Cardiac MR images from the Geisinger Medical Center.

Using the TensorFlow deep learning library, the work of earlier researchers was extended to better suit the dataset provided by the Geisinger Cardiac Imaging Technology Laboratory. A data pipeline was created to allow for automatic retrieval of the images and their associated contours. After creating a data pipeline to facilitate the neural network learning process, we ran the network on the images. It produced state-of-the-art results for left ventricle endocardium (LV), left ventricle epicardium (Epi), and right ventricle endocardium (RV). The automatically produced results were compared to the manual using both the Dice coefficient, a measure of overlap, and the discretized Hausdorff distance, which measures the maximum discrepancy.

Additionally, I designed a new architecture using multi-task learning to simultaneously segment the images and classify images as empty or not. In contrast to other widely available datasets, images without contours were included. As a result, the network is more generalizable to the uncurated data that comprise the Geisinger historical dataset.

Katherine Edwards '19 (first author)
Mae Lacey '18, Paige Caine '21 (co-authors)

Faculty Mentor: Professor Morgan Benowitz-Fredericks, Biology

Funding Source: Presidential Fellowship; Sigma Xi Grant-in-Aid of Research; Tague Family Fund for Undergraduate Research in Biomedical, Biological and Biochemical Sciences; NSF ADVANCE

Black-legged kittiwakes (*Rissa tridactyla*) do not buffer chicks from experimental food reduction

Life history theory posits trade offs between parental investment in current and future offspring. Breeding animals may adjust effort to meet offspring needs (flexible investment), or they may not increase effort above a threshold (fixed investment). In seabirds, fixed versus flexible investment can be revealed by the willingness of parents to buffer their chicks from variations in environmental conditions like food availability. To determine which strategy black-legged kittiwakes (*Rissa tridactyla*) employ, we provided nesting kittiwakes with additional food daily before withdrawing the supplemental food from a subset of nests ("W") with young chicks. Chick mass was measured before and 3 days after food withdrawal (or during the same interval for non-withdrawal control nests, "C"), and blood samples were taken simultaneously for quantification of plasma triglycerides, a lipid substrate involved in energy storage that reflects avian nutritional state and change in body mass. We compared changes in chick body mass, plasma triglycerides, survival, and long-term growth between W and C chicks and the post-withdrawal mass and triglycerides to those of unfed chicks (parents never received food supplementation). While there was no difference in

post-withdrawal mass across treatments after 3 days, post-withdrawal triglyceride levels, long-term growth, and survival of unfed and withdrawal chicks were significantly lower than control chicks. Withdrawal chicks gained significantly less mass and showed a significant decrease in triglyceride levels. Consistent with the predictions of the fixed investment hypothesis and expectations for long-lived animals, kittiwakes did not protect chicks from the costs of reduced food availability.

Charlie Espy '21

Faculty Mentor: Professor Brian Smith, Chemistry

Funding Source: Presidential Fellowship

Growth Methods for 2D and 3D Covalent Organic Frameworks

Covalent Organic Frameworks (COFs) are a class of organic compounds that are characterized by repeating multidimensional crystalline polymer structures connected by covalent bonds. In this study, the synthesis of COF-300, a 3D framework, is compared to TAPB-PDA COF, a 2D framework. Both COFs rely on the same reversible imine bonding mechanisms. The dimensionality differences stem from either a trigonal planar or tetrahedral monomer. The differences in growth conditions are explored, and the resulting frameworks are characterized using powder x-ray diffraction and BET surface area analysis. Methods for reducing interpenetration of 3D systems are discussed based on potential for usage in growth of a practically applicable COF system.

Jessica Eyster '19

Faculty Mentor: Professor Sarah MacKenzie-Dawson, Education

Funding Source: James L.D. and Rebecca Roser Research Fund

Elementary Writing Instruction: Best Practices Through the Analytic Lens of Poetic Inquiry

The focus of this research is on the best, research-based practices relating to elementary level instruction. This work draws from existing literature on elementary level writing instruction, using the analytic lens of poetic inquiry, an arts-based research approach, as a means of creating space for shared dialogue and co-constructed knowledge among teachers, school administrators, and researchers. By examining both foundational and emerging research relating to writing instruction, responding to the data and ideas presented within such texts through poetry, while also drawing on experiential data as a pre-service teacher, new and digestible information is presented. Through the creation of an online website, this research seeks to make ideas presented through previous research on writing instruction understandable, applicable, and accessible to elementary school teachers. This research contributes to the growing body of knowledge on writing instruction by using poetic inquiry to synthesize and express ideas from past research, emerging research, and personal narrative; extending conversation and urging teachers to re-evaluate their practices.

Caroline Fakharzadeh '20

Faculty Mentor: Professor Ryan Snyder, Chemical Engineering

Funding Source: Program for Undergraduate Research

Amorphous to Crystalline Phase Transformation Kinetics Using X-Ray Diffraction

In recent years, pharmaceutical companies have been producing new compounds with increasingly complex structures. This increase in complexity often negatively effects the solubility and/or the permeability of the compound in the human body. One method for increasing the solubility of these compounds is to form amorphous dispersions of the pharmaceutical. Unlike crystalline structures, amorphous structures do not have long range order and have higher solubility, but potentially decreased stability. Amorphous dispersions can be formed by dissolving polymer excipients, such as polyvinylpyrrolidone (PVP), along with a model active pharmaceutical ingredient (API) in solution. Particles are then formed through droplet evaporation. For this research, dicarboxylic acids are used as the model API. Once amorphous dispersions are formed, in some cases they maintain their amorphous character for long times, while in other cases some crystallization occurs.

The primary objective of this research is to demonstrate our ability to determine kinetics of amorphous to crystalline phase transformation. Solutions are made by dissolving varying ratios of wt% dicarboxylic acid to PVP in isopropanol. Particles are then formed using a Vibrating Orifice Aerosol Generator.

The crystallinity of the particles is analyzed using X-Ray diffraction (XRD). The kinetics are determined using a partial least squares regression on the XRD data, and is then fit to an Avrami model. This research focuses on particles made from a solution of 31.25 wt% suberic acid to 68.75 wt% PVP dissolved in isopropanol. Results show that this method of quantifying crystallinity and understanding the kinetics of crystallization is accurate.

Evan Filion ’20

Faculty Mentor: Professor Mark Spiro, Biology

Funding Source: Kalman Fund for Undergraduate Research in the Sciences

Assessing the Impact of Organic Farming Practices on Soil Health

A half-acre of land at the Bucknell University Farm has been utilized for an organic agriculture study. Initially, the study site consisted of an old-field ecology containing many prolific conventional weeds, including thistles, goldenrod, and perennial grasses. It is a unique scientific opportunity to study the transition from an abandoned field to an agricultural plot during the initiation of a local farming project. Our experimental design addresses transitional strategies commonly used by organic small farmers and gardeners without the aid of heavy farm equipment. The goal of this study is to identify the most effective field management strategy for converting unused land to small-scale agriculture while suppressing mature weed populations and maintaining soil health. The field management techniques implemented in this study consist of four treatments: 1) cardboard sheet mulching with an oat straw and compost layering above, 2) long-term smothering with black plastic sheeting, 3) shallow rototilling followed by a cereal rye and hairy vetch over-winter cover crop combination, and 4) shallow rototilling with an oilseed radish winter-kill cover crop. Three replications for each treatment were applied through a completely randomized assignment of twelve 11 ft x 45 ft subplots. Comprehensive soil health is measured through quantifying both the diversity of functional assemblages of microorganisms in the mycorrhizosphere with a BIOLOG EcoPlate™ assay, and the physical, chemical, and biochemical characteristics measured by the Cornell Soil Health Testing Laboratory. Weed populations and comparative agricultural yield will be tracked annually following the treatments.

Benjamin Finley ’19

Faculty Mentor: Professor Mary Beth Gray, Geology & Environmental Geosciences

Funding Source: National Science Foundation; Department of Geology & Environmental Geosciences

Grain-Scale Strain Analysis in Folded Sandstone, Shamokin, PA

This study examines patterns of grain-scale finite strain in a folded sandstone layer within the Appalachian mountain belt. The abandoned Bear Valley Strip Mine in Shamokin, PA. presents an exceptional site at which to study three-dimensional strain. A large fold known as the “Whaleback” is well exposed in three-dimensions within the mine. This fold consists of a single continuous layer of folded sandstone within the Pennsylvanian Llewellyn Formation. At sixteen sites throughout the fold, thin section images of three different cut planes were made from oriented core samples. Two-dimensional grain scale strain was calculated using the shape matrix eigenvector method. The strain calculations from each set of thin section images were then used to calculate a representative three-dimensional finite strain ellipsoid that approximates the average sand grain shape at each locality.

Once the three-dimensional finite strain was determined, it was possible to compute the strain in the bedding plane of the sandstone as well as in a vertical N-S profile of the fold. Grain-scale strain magnitudes (the ratio between the long and short axes) range from 1.03 to as much as 1.31. This range of magnitudes is consistent with previous findings of the grain scale strain calculated using other methods in previous studies within the Bear Valley Strip Mine and the surrounding region. Principal finite strain axes orientations across and along the fold are widely variable. The complex finite strain patterns in the Whaleback are interpreted to be the result of overprinting deformation prior to and during folding.

Danyon Fischbach ’19

Faculty Mentor: Professor Brian Smith, Chemistry

Funding Source: Stephen Glenn Hobar Memorial Research Award

Controlling crystalline structure of imine-linked 3D Covalent Organic Frameworks

The synthesis of high surface area materials with nano-scale pores and the ability to incorporate chemical functionality is ideal for a wide range of applications, from salt water purification for agriculture to heterogeneous catalysis. An ideal system for strategic synthetic control is through the use of crystalline multi-dimensional polymers known as covalent organic frameworks (COFs). Here we report a mechanistic study into the synthesis and purification of imine-linked COF-300 (recently published in *Chemical Communications*). To achieve the target potential for various applications, fundamental synthetic challenges must be addressed, including optimizing initial growth conditions to yield the useful, highly porous form over a collapsed structure with low surface area and porosity. We confirm that 3D imine COFs crystalize through an amorphous polymer intermediate, whose conditional state is key for preferential formation of the ideal porous structure over the collapsed hydrated form.

Kyle Fouke '20

Faculty Mentor: Professor Jeff Trop, Geology & Environmental Geosciences

Funding Source: Department of Geology & Environmental Geosciences Marchand Fund; NASA Astrobiology Institute

Impact of Seafloor Diagenetic Alteration on Sea Surface Temperature Reconstructions from Coral Skeletons

Reconstruction of sea surface temperature (SST) from the $\delta^{18}O$ and Sr/Ca composition of coral skeletal density banding (CSDB) provides invaluable centuries-long records of ocean circulation and climate change. Comparison with instrument measurements over the last 125 years has proven CSDB-derived SST to be reliable. However, some CSDB intervals yield SST underestimates of as much as 9°C with respect to instrument-based SST, while the accuracy of SST reconstructions from older and deeper water coral skeletons is uncertain. Here we apply high-resolution optical and electron microscopy to determine the impact of seafloor physical, chemical, and biological alteration (*diagenesis*) on causing anomalies in CSDB-derived SST. Diagenetic aragonite cementation of coral skeleton pore spaces in high- and low-density bands serves to modify skeletal density and CSDB stratigraphy, as well as structurally reinforce the coral skeletons. Here we establish reliable correction factors for CSDB-derived SST by applying the percent mixing of diagenetic aragonite cement with original skeleton (as determined from microscopy) to binary mixing models and testing this model with existing globally distributed coral $\delta^{18}O$ and Sr/Ca data sets. This new approach will accurately restore modern and fossil CSDB-derived SST records and indicates that as little as 5% mixing with diagenetic aragonite cement will cause SST anomalies of 0.9°C.

Nathan Fretz, Graduate Student

Faculty Mentors: Professor Molly McGuire, Chemistry; Professor Ellen Herman, Geology & Environmental Geosciences

Funding Source: Graduate Summer Research Fellowship

Annular flume studies to investigate iron oxidation and precipitate deposition in AMD systems

Abandoned mine drainage (AMD) is a direct consequence of coal mining operations and is known for contributing acidity and heavy metals to the surrounding environment, resulting in the degradation of ecosystems and clean waterways. The oxidation of pyrite (FeS^2) is a main contributor to this system, producing high concentrations of dissolved Fe2+ that oxidizes and forms iron oxyhydroxide precipitates. Suspended iron oxyhydroxide precipitates can facilitate contaminant transport in the environment, therefore by understanding mechanisms that catalyze or remove these precipitates we can predict the mobility and stability of these species.

To further investigate these processes, we simulated AMD stream conditions using an annular flume, a circular channel 18 cm in width and 170 cm in diameter, while examining the effect of bed material on iron kinetics and speciation in the system. AMD was synthesized by using aqueous concentrations of iron, silicate, and sulfate similar to field sites in the anthracite coal region. Our experiments investigated the effect of bed material composition and bed size, using the absence of bed material as a control. The synthetic AMD was collected at specific time intervals, and the concentrations of dissolved and total iron were measured. An acid digestion procedure was developed and implemented into our study to determine the total iron concentration. Measurements such as temperature, pH and dissolved oxygen were also recorded. Our results indicate that coating the bed with goethite does not affect the rate of iron oxidation, and the presence of bed material does affect the rate of precipitate deposition.

Cole Gardner '19

Faculty Mentor: Professor Jeff Trop, Geology & Environmental Geosciences

Funding Source: Dean's Fund for Summer Undergraduate Research in STEM

Late Devonian Sedimentary Record of Appalachian Tectonics and Erosion: Geochronology and Geochemistry of Detrital Muscovite and Zircon from North-Central Pennsylvania Strata

Foreland sediment deposition in North-Central Pennsylvania during Late Devonian time records active collisional tectonics of the Acadian orogeny. The Catskill clastic wedge preserves a coarsening-upwards stratigraphic succession from marine to fluvial environments associated with sediment progradation and marine regression, yet depositional timescales and quantitative provenance data are currently unknown.

New U/Pb detrital zircon ages (n=737) and synorogenic $^{40}Ar/^{39}Ar$ detrital muscovite ages (n=341) spanning >2 km of stratigraphy in Lycoming County, Pennsylvania, overlap with ages reported from exposed hinterland Appalachian bedrock sources. The youngest population of detrital zircon ages from the lowermost sample indicates a maximum depositional age of ~369 Ma, and the youngest population of detrital muscovite ages from the uppermost sample yields a maximum depositional age of ~361 Ma. These new ages are consistent with Late Devonian fossil vertebrates

and palynomorphs reported from the sampled strata, implying deposition within 10 M.y.

LA-ICP-MS geochemistry of detrital muscovite and muscovite within schistose lithic grains implies mixed igneous and metamorphic provenance. Populations of detrital muscovite display significantly higher incompatible element values relative to muscovite within schistose clasts, implying igneous provenance. Detrital grains matching schistose muscovite incompatible element values indicate metamorphic provenance.

Collectively, new detrital mineral data indicates erosion of igneous and metamorphic bedrock sources to the east and transport westward into the foreland basin, consistent with previously reported sedimentology. The <6 m.y. lag time between cooling of Late Devonian detrital muscovite and deposition implies rapid exhumation/erosion, consistent with muscovite cooling ages reported from hinterland sources and evidence for regional glaciation.

Josh Gesselberty '21

Faculty Mentors: Professor Tim Raymond, Chemical Engineering; Professor Dabrina Dutcher, Chemical Engineering

Funding Source: James L.D. and Rebecca Roser Research Fund

Juul E-Cigs variations due to Relative Humidity

The focus of the research over the summer was to figure out if relative humidity would change the particles produced by a Juul E-cigarette. A Juul was altered to be able to puff its vapor particles into a chamber for analysis. Then, measurements of the particles began to take place using a SMPS; these measure the particle size and concentrations of each. The equipment then analyzed the particles at different relative humidity levels, starting with 10 percent and ending at 80 percent. The first question that arose when looking at the data it produced was why two peaks were produced on the graph generated by the SMPS. The small peak seemed to be too large to be metallic nanoparticles, which was consistent with previous students' work. The small peak at 10 percent relative humidity was around 50 nm. The large peak at 10 percent relative humidity was around 290 nm. After running multiple trials at 10 percent relative humidity, I ran t at 80 percent relative humidity. In looking at the data from those trials it showed the opposite of what was expected. The expected results were for the particles to take on some of the water in the air, increasing the particle size. Although, the data showed that the particle sizes of both peaks decreased. This brought about another question of why increasing the relative humidity of the air when puffing a Juul decreases the particle size of the aerosol.

Keith Grega '21

Faculty Mentor: Professor Benjamin Wheatley, Mechanical Engineering

Funding Source: Kalman Fund for Undergraduate Research in the Sciences

Determination of *Sus scrofa domesticus* Shoulder Aponeurosis

The purpose of this research is to determine the anisotropic elastic modulus of the *Sus scrofa domesticus* porcine shoulder aponeurosis. Aponeurosis is a fibrous connective tissue that joins flat sheath muscle to tendon with wide attachment areas. Aponeuroses are strong elastic components that transmit force efficiently from muscle to bone to assist with locomotion. To further understand the role of the aponeurosis in the body, we have conducted uniaxial tension tests to evaluate material properties of the aponeurosis in tension. The elastic modulus, which is a measurement of strength, is an inherent property of solid materials. We hypothesized that the aponeurosis will exhibit moduli values similar to or less than that of tendon. Uniaxial tensile tests of porcine shoulder aponeurosis were conducted on an Instron universal testing machine to measure both aponeurosis load and grip to grip displacement. Sample thickness was measured using light microscopy at multiple lengths along the specimen. The elastic modulus of the longitudinal aponeurosis was measured to be 51.54 ± 26.17 MPa. In comparison, studies on tendon have shown an elastic modulus up to 1880 MPa. In addition to better understanding force transmission in skeletal muscle, the data from this study can be utilized for future research to accurately develop computational models of muscles with attached aponeuroses. The benefit of these computational models is to explore clinical applications of connected skeletal muscle systems for treatment modalities such as post-surgery prediction of muscle function and the comparison between weak or diseased muscle to healthy muscle.

Scott Gulizio '19, Katherine Edwards '19, Katelyn Heuer '21, Mikayla Cochrane '20

Faculty Mentor: Professor Regina Gazes, Psychology, Animal Behavior

Funding Source: Emerging Scholars in Psychology Fellowship 2017; Presidential Fellowship; STEM Scholars

The impact of social context on learning in capuchins monkeys (*Cebus apella*)

For animals that live in social groups, learning new information often occurs in a social context and can be influenced by the presence of other individuals. How those individuals affect learning may be shaped by the relative dominance rank of the individuals involved. For example, as a group, low ranking monkeys perform

worse on a learning task when high ranking animals are present. However, few studies have examined how the social environment influences the ability of individual animals to learn a new task. In the present study we tested the ability of capuchin monkeys (*Cebus apella*) to learn a simple discrimination task both alone and in the presence of a higher or lower ranking monkey. We predicted that the presence of higher ranking individuals would inhibit learning in low ranking monkeys, such that they would learn slower with another monkey nearby than they would alone. In contrast, the presence of a lower ranking monkey is not expected to inhibit learning in high ranking individuals - they should perform similarly regardless of the presence of another monkey. Preliminary results support these predictions, demonstrating that low ranking monkeys make significantly more errors when paired with a higher ranking monkey than when alone, while high ranking monkeys do not differ in the number of errors between these conditions.

Soheil Habibian, Graduate Student

Faculty Mentor: Professor Keith Buffinton, Mechanical Engineering

Funding Source: Graduate Summer Research Fellowship

Finite Element Analysis of Fiber Reinforced Elastomeric Enclosures

Over the past few years, the importance of the safety of robots working in a human environment has heightened the need to study soft robotics. Soft robots exceed the capabilities of traditional rigid robots in several ways, such as compatibility, degrees of freedom, manufacturing costs, and safe interactions with the environment. In the conducted research, we focused on modeling Fiber Reinforced Elastomeric Enclosures (FREEs), as one special type of soft actuator using Finite Element Analysis (FEA). The developed finite element model is a powerful, valuable tool for rapidly investigating the capabilities of FREEs for use in a robotic arm. We expanded upon existing research on a similar type of pneumatic actuator by studying various cases and investigating the effect of fundamental material properties on overall response. In addition to proposing new modeling considerations and techniques, this research emphasized the importance of material selection, geometry, and adhesives on FREEs' kinematics (extension, expansion, and rotation).

Emma Hadley '20, Garrett Sommer '21

Faculty Mentor: Professor Kenneth Mineart, Chemical Engineering

Funding Source: Slonaker Fund

Measuring Diffusion of Micelles in Organogels

The goal of this research is to measure the release rate of micelles from organic-based gels based on their molecular architecture. The organogels of interest are composed of mineral oil, styrene-ethylene/butylene-styrene polymer (SEBS), and aerosol-OT surfactant (AOT) and include several useful advantages like their ability to hold micelles and their facile process-ability/recyclability. Previous research has found that AOT forms the micelles of interest within the gels. This study utilizes continuous bulk elution to measure the release rate of micelles from the loaded organogels. This process consists of submerging loaded organogels into aqueous baths (i.e. water) over an extended period of time and measuring AOT content periodically with Fourier-transform infrared spectroscopy (FTIR). FTIR is an instrument that irradiates a sample with a full spectral light beam and subsequently collects the light transmitted through the sample. The resulting intensity-wavelength spectrum can be correlated to functional groups present in the sample. The study measured concentration of AOT in organogels based on peak height and area at approximately 1720 cm-1, which is the characteristic position for an ester group (AOT has two). Diffusional measurements have been taken for various gel compositions, including varied polymer weight percents and varied polymer types, over a 30 day period. It has been confirmed that AOT concentration decreases over time submerged in water and further investigation is being conducted to determine exact diffusion coefficients. Additionally, diffusional studies of organogels loaded with oleic acid, which we hypothesize do not form micelles, are being conducted with the same methods.

Stephanie Harper-Long '19

Faculty Mentors: Professor Christopher Martine, Biology; Burpee Post Doc Fellow Angela McDonnell, Biology

Funding Source: David Burpee Endowment

Molecular Evidence for Distinctiveness of Two Forms of the Hawaiian Endemic, Chenopodium oahuense (Amaranthaceae)

Boasting the highest sea cliffs in the world, the northwestern coast of Moloka'i presents numerous challenges to plant life there, including constant battering by high winds and salt water from North Pacific swells and limited annual precipitation in some areas. The harshness of these volcanic sea cliff habitats demands adaptability in its flora, including one population of Chenopodium long presumed to be an unusual form of C. oahense. Not only does this population thrive, but it is morphologically different from other C. oahuense populations found across the Hawaiian archipelago. Chenopodium oahuense leaves typically present with a large trilobed phenotype coupled with an erect stem growth habit. Alternatively, the Moloka'i population's leaves are almost reniform and the stems are markedly decumbent. Inspired by the divergent morphological traits we observed within the

Moloka'i population, we have conducted a phylogenetic study of the Hawaiian plants via DNA extraction from 23 individuals and sequencing of the plastid gene rpl32-trnL and the ITS1-5.85 rDNA-ITS2 nuclear region. We explore whether a divergence event has occurred using maximum likelihood analyses, which suggest some molecular divergence in the sampled DNA regions. Our results suggest that the Moloka'I populations warrant recognition as distinct from C. oahuense at some level. Continued study of Chenopodium 'sp. Moloka'i' will lead to a better understanding of how plants have evolved to thrive in extreme habitats, specifically environments subject to high salinity and little fresh water, and may contribute to efforts to conserve other unusual plant populations in Moloka'i.

Hannah Hervieux '21

Faculty Mentor: Professor Bethany Collier, Music

Funding Source: Bobko-Dennis Fund for Undergraduate Student Research

Does The Mallet Teach?: A Comparative Study of Gamelan Pedagogy in America and Bali, Indonesia

Gamelan is a traditional Indonesian ensemble of metallophones, gongs, drums, and flutes. Commonly compared to an orchestra, Balinese gamelan is used for almost all Hindu-Balinese religious ceremonies, cultural festivals, and tourist performances. Gamelan has risen to popularity around the globe and is now a staple ensemble in many American universities. To date, scholarly research on Balinese gamelan pedagogy has focused primarily on gamelan's usefulness in American music education contexts, gender bias in Balinese groups, teaching Balinese children, and American teachers of gamelan, but little published work explores gamelan pedagogy from a comparative perspective.

My presentation begins to fill this gap, focusing on one Balinese teacher's pedagogy in two different contexts. This research investigates if I Gusti Nyoman Darta's pedagogical approach differs when he teaches American and Balinese students, and asks to what extent contextual factors (location, student preparation, etc.) impacts his teaching style. My research shows that while Gusti Komin teaches Balinese gamelan traditionally -- by modeling small sections of the piece, with the student listening and copying until the whole piece is internalized and played with accurate notes, rhythms, and dynamics -- he also uses specific technologies to help teach the music more quickly. This comparative study confirms that Gusti Komin's pedagogy remains consistent whether at Bucknell or in Bali, but the student's level of experience with gamelan, exposure to the music, and familiarity with traditional learning styles that allows the Balinese students to learn, and therefore allows Gusti Komin to teach at, a much faster rate than with American students.

Bridgette Holland '20

Faculty Mentor: Professor Anna Baker, Psychology

Funding Source: Gary A. and Sandra K. Sojka Fund for Research, Teaching and Scholarship in Developmental Disabilities, Neuroscience & Human Health

Systematic Review of the Social Effects of Food Allergy in Children

To review and synthesize the most recent literature on the social impacts of food allergies on school-aged children and their families.

Psycinfo, Web of Science, and Pubmed were searched using with the key words Food allergy/Celiac/Peanut, Children/Youth and Social/Psychosocial or Family/Parent. The studies were narrowed by date, peer review, title relevance, and abstract review to yield 42 included studies.

Within quality of life measures, social functioning is consistently the most negatively impacted area, although it is unclear what aspects of food allergy contribute to disruption. Both parents and children report a lack of understanding and exclusion as central to the burden or social stressors they experience due to FA within qualitative interviews. The process of normalization and risk-taking appears to mediate this relationship. Also, parental social experience and psychological functioning may impact the child with food allergies and the family's social functioning. Many studies cite reduced social attendance, but there is a paucity of research on the effects of this restriction, particularly in autonomous social development and separation anxiety at later ages.

Social functioning of the family and child with food allergies is impacted, but the degree and severity of this impact is unclear, as well as the mediating factors that may or may not influence the experience.

Cammie Hong '21

Faculty Mentor: Professor Kenny Mineart, Chemical Engineering

Funding Source: Program for Undergraduate Research

Establishing Relationships Between Molecular Interconnectivity and Mechanical Behavior of Organogels

The purpose of my research is to establish a relationship between the molecular interconnectivity of mineral oil-based gels and their mechanical behavior. These gels are composed of mineral oil, diblock copolymer, and triblock copolymer. By varying the relative amounts of diblock and triblock copolymer, we alter the interconnectivity of these gels. In parallel to changes in interconnectivity, we monitor the static nanoscale structure using small-angle x-ray scattering (SAXS). We hypothesize that our formulation-driven control of gel interconnectivity affects mechanical properties. Specifically, we predict that

higher degrees of interconnectivity will result in gels with a larger modulus and toughness, which are extracted via quasi-static tensile experiments. We will present data for gels at 10, 20, and 30% polymer. Our results confirm the hypothesis stated above. These results allude to a facile approach to substantially change mechanical properties, which make them applicable to a wide range of tissue replacements.

Junjie Jiang '19

Faculty Mentors: Professor Nathan Ryan, Mathematics; Professor Vanessa Massaro, Geography

Funding Source: Schotz Family Interdisciplinary Fund

Reverse Engineering Secret Algorithms: Factors that Influence Parole Decisions

We used web scraping and GET methods to acquire parole data from government websites. We then used Python and R to clean these data. We made sheets for data from different states or cities, including New York, South Carolina and Virginia. Then, we used R to analyze the data to see the influence of different attributes on final parole decisions. Preliminary results according to logistic regression showed that race and sex do not appear to significantly influence final parole decisions. More careful and thorough analyses should be made for more accurate results.

Peter Kaladius '21

Faculty Mentor: Professor Peter Jansson, Electrical & Computer Engineering

Funding Source: College of Engineering

On an investigation of Mach Principle

Inertia is a property of matter and is proportional to mass. It is considered to be a force by a minority of scientists. Mach's Principle is the most successful theory at explaining where inertia originates, assuming inertia is a force. Mach proposed that every piece of matter in the universe acts on any object that has changed the speed or the direction of its motion; therefore, the force of inertia is equal in any direction because the universe is isotropic (equally distributed in matter). The most recent research regarding Mach's Principle was conducted over this past summer (2018) to investigate a hypothesis derived from Mach's Principle stating that local celestial mass alignments (producing temporarily uneven matter distribution in near space) may give rise to slight differences in inertial reactions that can be detected. The device used for experimentation is a spherical frame with eight arms going from top to bottom connected to 2 rings, each arm carrying 6 batteries; the top positive ring and the bottom ground ring supply power to run two motors that rotate the central inertial wheel of the device; the batteries' voltages are measured before and after (as well as during) the experiment to calculate the voltage delta. This research raises the probability of validating Mach's Principle by obtaining voltage drainage incidents that are 4 standard deviations away from the mean on the arms that point to the significant celestial mass alignments where the claimed interaction is be expected to be magnified.

Justin Koss '19

Faculty Mentor: Professor Beth Capaldi, Animal Behavior

Funding Source: Kalman Fund for Biomedical Research Fellows

Histological Analysis of pads in the Gastrointestinal Tract of Carpenter Bees

One of the biggest problems facing those that study bees today is how they digest pollen. Many theories have been proposed as to how bees achieve this feat ranging from physically cracking open the pollen grains, to digesting the pollen grain with enzymes, and all the way to utilizing pressure gradients inside their gastrointestinal tract to "pop" the pollen grains through osmotic shock. Determining just how bees digest pollen will give great insight into conservation efforts. Slices of pads found within the gastrointestinal tract of carpenter bees were histologically prepared and analyzed to determine the cell type that makes up these pads to deduce the function of these pads in an effort to gain an insight into pollen digestion. At the conclusion of the study the slices of the pads have been completely prepared and are awaiting histological analysis.

Yvette Lai '19

Faculty Mentor: Professor Jessica Newlin, Civil & Environmental Engineering

Funding Source: Michael Baker Jr. Summer Research Program; The Katherine Mabis McKenna Environmental Internship Program

Analysis and Visualization of Spatial and Temporal Variation of Water Temperature in the West Branch of the Susquehanna River and Its Tributaries

Water temperature in rivers can be used as an indicator of aquatic health, changes in human impact, and thermal pollution. The West Branch of the Susquehanna River (WBSR) supports a range of aquatic ecosystem types within various physical environments. Between 2014 and 2015, over sixty temperature data loggers were placed longitudinally along the centerline of the channel and perpendicularly across the channel where major tributaries enter the WBSR. Periodic collection of the logged data was attempted between 2014 and 2016 and was successful at approximately forty sites. This research project aimed at analyzing and visualizing water temperature variation, interpreting and studying the relationship and trends, and determining the dominator factors influencing the water temperature

using the observed data. With the use of interactive data visualization tools, water temperature data analysis is possible at multiple spatial (e.g. reach, cross-channel) and temporal (e.g. seasonal, daily) scales. In large complex river systems, the dominant factors influencing water temperature are not constant in space or time. A more nuanced understanding of the correlations between water temperature, physical characteristics, weather parameters, and hydrologic factors is necessary to inform water management decisions that consider long-term sustainability of river health.

Samantha Lauriola '19

Faculty Mentor: Professor Eric Kennedy, Biomedical Engineering

Funding Source: National Program for Playground Safety, University of Northern Iowa

Impact Attenuation Performance of Playground Surfacing Materials: Effects of Altering the Complying HIC Values of ASTM F1292

ASTM F1292 is the standard that addresses playground surfacing impact attenuation requirements. Currently the standard requires impact tests to be below the threshold of 1000 HIC (Head Injury Criterion) averaging the second and third drop at each test site. The purpose of this study is to assess the change in compliance of a variety of already installed playground surfacing materials if the HIC score were altered from 1000 to 700.

Following ASTM F1292 field testing provision procedures, impact attenuation testing occurred on sand, pea gravel, unitary surfacing and wood products.

Unitary surfaces yielded the largest percentage of test locations above 1000 HIC (19.6%), while wood products presented the lowest percentage above 1000 HIC (2.4%). Pea gravel had the greatest percentage of locations with HIC above 700 (42.5%), while wood products still presented the lowest percentage above 700 HIC (7.9%).

The compliance of the playground surfacing materials is uniquely affected by changing the standard from HIC <1000 to HIC <700. Wood products are marginally affected, while pea gravel experiences a significant increase in non-complying test locations. Unitary surfacing materials performed the worst in complying with 1000 HIC, while pea gravel performed the worst in complying with 700 HIC. This implies that pea gravel has more attenuation performance within the 700 – 1000 HIC range. In the future, a method of adopting a new standard may be proposed with research through a phase-in process to ensure existing playgrounds meet tighter standards.

Samantha Lauriola '19

Faculty Mentor: Professor Eric Kennedy, Biomedical Engineering

Funding Source: National Program for Playground Safety, University of Northern Iowa

Do Playground Wear-mats Above Loose Fill Preserve Impact Attenuation Performance?

Over 200,000 children are injured, requiring an emergency room visit, on playgrounds every year, with 81% of those injuries related to falls or impacts with equipment. To help combat this trend, wear-mats are commonly used on playgrounds across the country underneath heavy-use equipment to prevent the dispersion of loose fill to be able to properly attenuate an impact. This paper will focus on wear-mats above the loose fill on public playgrounds to analyze their effect on impact attenuation.

The wear-mats and the surrounding loose fill were tested following the field testing provision found in ASTM F1292, which involves 3 sets of 3 test drops on the wear-mat and surrounding loose fill, respectively. The Head Injury Criterion of the wear-mat and surrounding loose fill were compared.

The presence of the wear-mat introduces a firmer surface that affects the impact attenuation of the loose fill material underneath. All immediately adjacent loose fill test sites (n=15) were compliant with F1292 HIC threshold (HIC<1000), averaging 371 HIC, while wear-mats placed above the loose fill (n=15) average 1195 HIC, a 322% increase in HIC (increasing the risk from 2% to 29% for a potentially serious head injury).

The lack of uniformity between wear-mats has resulted in a large variability in the impact attenuation performances, with more than half of the wear mats being non-compliant with the F1292 standard. This underscores the need for increased awareness and modifications for wear-mat testing in order to ensure the safety of children on playgrounds across the country.

Amelia Lautenberg '20

Faculty Mentor: Professor Reggie Gazes, Psychology, Animal Behavior

Funding Source: Presidential Fellowship

Positive Reinforcement Based Training for Experimental and Veterinary Procedures in Captively Housed Squirrel Monkeys and Hamadryas Baboons

Training and habituation can reduce stress associated with veterinary or experimental procedures in captively housed animals, thereby improving animal welfare and care. I will present the procedures and results of positive reinforcement based training plans I developed and implemented for two species of non-human primate

housed at the Bucknell University Animal Behavior Lab. I will present the procedures and results of positive reinforcement based training plans I developed and present the shaping plans I devised to teach the animals behaviors such as crate training, presenting for an injection, and target training. Squirrel monkeys were trained to voluntarily enter a transport cage to facilitate easy movement for cognitive testing and veterinary procedures. An adult male hamadryas baboon was trained to move throughout his enclosure on command and to calmly present his arm for injection when asked. These trained behaviors have made it easier for researchers, caretakers, and veterinary professionals to work with the animals, and have considerably reduced the stress of these procedures for the animals involved.

Nathan Lesnevich '19

Faculty Mentor: Professor Peter McNamara, Mathematics

Funding Source: Presidential Fellowship;
John C. Hoover Scholarship

Positivity among P-partition generating functions of partially ordered sets

A partially ordered set (poset) is precisely what its name would suggest: a set where some pairs of elements have an order relation between them (i.e. one element is "bigger"' than the other), and other pairs do not. For every poset, we can label its elements 1,2,...,n in any fashion. Then to any such labeled poset we associate an algebraic object called a P-partition generating function. These P-partition generating functions are quasisymmetric functions that are positive in the fundamental basis for quasisymmetric functions. We seek to explain how and when the difference between two posets' generating functions are also positive.

Sarah Lombel '19, Vitoria Ruozzi '19, Kyle Shtern '19

Faculty Mentor: Professor Julie Gates, Biology

Funding Source: Kalman Fund for Biomedical Research Fellows; Tague Family Fund for Undergraduate Research in Biomedical, Biological and Biochemical Sciences

Verification of Proteins Required for Ras Activity in the Developing Drosophila Eye

Cancer results from the accumulation of multiple mutations in genes that control cell division. A mutation in the gene *ras* that results in a constitutively active, or always "on," protein is involved in ~20% of human tumors. *Ras* encodes a small GTPase involved in intracellular signal transduction cascades, including pathways for cell division. Ras must be attached to the plasma membrane for activity, thus studying ways to prevent Ras from attaching to the membrane has been a goal of cancer research. Dr. James Mahaffey identified ten candidate proteins that could be required for Ras membrane attachment. He performed this study in single mammalian cells in a culture dish, but since cancer occurs in intact tissue, we set out to verify whether the candidate proteins are required for Ras membrane attachment in an intact organ. Ras serves an equivalent function in the regulation of cell division as it does in the specification of cell fate in the developing *Drosophila* eye. A constitutively active Ras protein causes morphological distortion of the fly eye, known as the rough eye phenotype. Using standard genetic techniques, flies were generated that expressed constitutively active Ras and had reduced levels of a candidate protein. If the candidate protein is required for Ras membrane attachment, then reducing its protein levels would eliminate the rough eye phenotype. Our results suggest that a subset of the candidate proteins are required for Ras membrane attachment and further studies of these candidate proteins could lead to drug targets for cancer therapies.

***Alexandra Longest '20**

Faculty Mentor: Professor Kevin Gilmore, Civil & Environmental Engineering

Funding Source: The Katherine Mabis McKenna Environmental Internship Program

Development of a Simple, Effective Activity Test for Combined Ammonium Oxidation (Comammox) Bacteria

The goals of this research was to develop a simple but effective assay to detect the active presence of Comammox in samples by exploiting its ability to oxidize ammonia to nitrate in the presence of the inhibitor (chlorite) which it should be able to detoxify, determine an effective inhibition dose of chlorite on non-Comammox nitrifying bacteria, and quantify the extent of inhibition on the rates of two different oxidation processes of ammonia and nitrite. This was performed through multiple experiments throughout the summer by batch tests with different biomass samples and spikes of ammonia and nitrite. Different concentrations of chlorite were tested, and the effective inhibitory dose of chlorite for further experiments was found to be 0.01 mmol/g VSS. Samples were taken throughout the experiment and analysed by ion chromatography to determine the effect of chlorite injections on the oxidation rates of ammonia and nitrite. Two main results came from this research. The first result was that the Comammox hypothesis, that states Comammox possesses an enzyme that degrades chlorite to chloride that would allow for the allow for the development of a bench test to verify the presence of it in water, was not proven. The second that ammonia oxidation is inhibited by chlorite but not nitrite oxidation.

David Lundy ’21

Faculty Mentor: Professor Ryan Snyder, Chemical Engineering

Funding Source: Kalman Fund for Undergraduate Research in the Sciences

Effects of Excipient Ratio and Solvent Choice on Amorphous Solid Dispersions

Bioavailability, the proportion of a drug that enters the circulatory system and is able to have an active effect, of active pharmaceutical ingredients (APIs) is a growing challenge in the pharmaceutical industry. Decreased bioavailability in many molecules is a direct result of a general trend of increased molecule complexity. To increase bioavailability, APIs are made into amorphous dispersions. These dispersions are made of amorphous solids which, unlike crystalline solids, do not have an overall repeating pattern on a particulate level. Because of their minimal internal structure, amorphous solids have lower stability and higher solubility than crystalline solids. For this reason, forming amorphous dispersions has been a reliable way to solve the solubility issue of APIs. Long, polymer chain excipients, which are inactive substances that serve as vehicles for pharmaceuticals, are added to the API of interest and dissolved in a chosen solvent to increase amorphous character of the mixture.

The goal of this work is to determine the effects of carbon chain length and solvent choice on the crystallinity of the sample. Amorphous dispersions are made using a Vibrating Orifice Aerosol Generator (VOAG) which produces a jet from solution. Solutions are made by dissolving a specific mass ratio of dicarboxylic acid to excipient (polyvinylpyrrolidone) in a chosen solvent, either isopropyl alcohol or ethyl alcohol. Internal structure is analyzed using X-ray Diffraction (XRD) while morphology and size are determined using Scanning Electron Microscopy (SEM).

Ming Ma ’19

Faculty Mentor: Professor Jessica Newlin, Civil & Environmental Engineering

Funding Source: The Katherine Mabis McKenna Environmental Internship Program

Hyporheic Zone Analysis at Stream-bridge or Culvert Crossings

The hyporheic zone in a stream or river is defined as an active zone between the surface stream and groundwater where exchanges of water occur in response to variations in discharge, bed topography, and porosity. The hyporehic zone has received considerable research attention because of its importance to hydrological and ecological functions in streams, such as regulating streamwater temperature and supporting fish spawning. However, there is limited scientific investigation on special cases when there are discontinuities in streams due to bridges or culvert crossings. Bridges and culverts influence the topography of the channel and floodplain and the bed sediment characteristics. Understanding how these discontinuities impact the hyporheic zone dynamics will enable improved effectiveness of the design of bridge crossings to limit adverse impacts to the natural environment. Stream tracer studies are field experiments that can lead to characterization of the hyporheic exchange in small streams. A preliminary tracer study was designed and implemented on Miller Run on Bucknell’s campus. The stream section included a reach that was not impacted by a culvert crossing and a section that was impacted by a culvert crossing. The tracer study results from the two different settings were compared to understand the impact that a culvert crossing has on the hyporheic zone in a small stream. As a preliminary investigation, the results also led to proposed improveme in field data collection to enable further understanding of the impact of bridge and culvert crossings on the dynamics of the hyporheic zone under varying field conditions.

Michael Matirko ’19, Ryan Pasculano ’19

Faculty Mentor: Professor Alan Marchiori, Computer Science

Funding Source: Reed-Garman Award Fund for Engineering Entrepreneurship

Asynchronous Server-Source Protocol for Extraterrestrial Endpoints

Multiple Instruction, Single Data (MISD) is a technique used in a variety of disciplines to ensure data accuracy and reliability by means of redundant data transmissions. The Asynchronous Server-Source Protocol for Extraterrestrial Endpoints is a protocol that utilizes UDP, an unreliable transport layer protocol, in conjunction with the principles of MISD to transmit data reliably on unreliable networks, for example networks with high latency or high packet loss rates. This protocol is intended to be simple to implement with relatively low overhead compared to other network protocols, while still delivering acceptable speed for most applications. A primacy use case of this protocol is extremely long distance (extraterrestrial) communication, where repeated back-and-forth transmissions are undesirable due to the time required for a signal to travel the required distances (i.e, high RTT). The protocol was developed using Python 3 for the CSCI363 “Computer Networks” class, although could easily be ported to other languages, including C or Java.

Cheyenne McKinley ’20

Faculty Mentor: Professor Sarah Lower, Biology

Evolution of a Firefly *Femme Fatale*: a Transcriptomic Analysis

Understanding how evolutionary pressures affect genes and the associated physical characteristics is a key step in understanding biodiversity and speciation. While it is thought that evolutionary changes in light signal patterns are the primary reason for reproductive isolation and speciation in fireflies, fireflies in the Photuris genus lack a single diagnostic flash pattern and physically appear almost identical. This suggests they are undergoing rapid evolutionary diversification. Females of some Photuris species show aggressive mimicry, known as *femme fatale* behavior. To explore the evolutionary forces responsible for diversification and the genetic underpinnings of this behavior, we compared the evolutionary rates of genes that are "turned on" in a predatory firefly, *Photuris quadrifulgens*, with those from the non-predatory *Photuris frontalis*. We controlled for changes due to baseline firefly evolution by comparing these to a species in a different genus, *Photinus pyralis*. By generating transcriptome assemblies, grouping genes into families based on sequence similarity, and looking for evidence of evolution, we identified nine evolving gene families, including genes involved in digestion, vision, detoxification, and insecticide resistance. These results show predatory fireflies may be adapting to continue to digest other fireflies and detoxify the toxic chemicals their prey contain. It is a topic of concern that light pollution may be making it harder for fireflies to mate, and the rapid evolution of visual genes supports that. Insecticides may also be having an impact upon firefly populations. This study shines a light on what is impacting fireflies, and directs us to areas of further study.

Julia Medici '20

Faculty Mentors: Professor Evan Peck, Computer Science

Funding Source: Kalman Fund for Undergraduate Research in the Sciences

Consider how often the average person searches for data online - how many times do they have to reword or reformat their query to find exactly what they're looking for. Then, even once a user has found this seemingly perfect data, do they consider other factors, like source? With the amount of open data available on the web - it is crucial that the average user is able find reliable and pertinent sources.

We set out to implement a more comprehensive interface that would streamline the process for finding relevant data visualizations online. We aimed for our interface to tackle three main concerns: reduce the barrier of technology by automatically generating advanced search parameters, negating the challenges that users face in trying to articulate unfamiliar terminology, encourage reflection on the data's source through visual design, and clustering web visualizations by visual characteristics.

Using a combination of CSS and HTML, we created a prototype that both clustered web visualizations based on their chart type and helped format queries for the user using Google keywords.

To test our user interface, we had participants attempt to find "data" on Google that answered a list of questions with random topics, we then had these participants complete the same task with new topics using our interface, and finally we had them complete the same task again with a new set of topics using Google once more.

By tracking variables like number of queries, timing throughout sections, and the quality of data provided - our preliminary results suggest improvement in all sectors when using our interface and that even when not using our interface, users became more comfortable with formatting a Google query. With time, our interface could become an important learning tool and aid when users are attempting to find data best fitting to their searches. By taking user feedback we can continue to improve upon the user interface, which may include becoming more comprehensive through added parameters or by reformatting the aesthetic.

Cheyenne Moore, Graduate Student

Faculty Mentors: Professor Christopher Martine, Biology; Burpee Post Doc Fellow Angela McDonnell, Biology

Funding Source: David Burpee Endowment; PA Wild Resource Conservation Program

Status of *Baptisia australis* var. *australis* (Fabaceae) in Pennsylvania

The perennial wildflower *Baptisia australis* var. *australis* (L.) R. Br. (Fabaceae) represents an ideal model for examining gene flow in riparian plant populations. Within Pennsylvania, *B. australis* var. *australis* is comprised of two metapopulations along four waterways: the Allegheny River, Youghiogheny River, Clarion River, and Red Bank Creek. Despite the location of these watersheds within the greater Ohio River drainage, there is still considerable distance between the metapopulations. Because of its limited distribution and small number of extant populations, *B. australis* is considered state-threatened in Pennsylvania. In addition, the riparian prairie habitat that Pennsylvania *Baptisia australis* var. *australis* is restricted to is also in decline and considered vulnerable in the state. Given that *B. australis* var. *australis* is a species of conservation concern, I am interested in exploring the potential impacts of habitat loss, insect herbivory, and invasive species. Tools such as field surveys, and herbarium collections are utilized to investigate these threats. ddRAD sequencing is used for population genetics work.

The overall study seeks to answer the following research questions 1) What is the status of the remaining wild populations of *B. australis* in Pennsylvania? 2) What is the genetic structure of those known native populations? and 3) What is the relationship of population sizes to the ecological condition of the plant communities that harbor the species? Through answering these questions, I hope to inform the conservation status of *Baptisia australis* var. *australis* in Pennsylvania, as well as clarify lingering uncertainties about gene flow in riparian plant populations.

Richard Noel '20

Faculty Mentor: Professor Peter Groff, Philosophy

Funding Source: Culliton Family Fund for Undergraduate Research

Nietzsche on Solitude and Self-Cultivation

This paper attends to the importance of solitude in the ethics of Nietzsche's middle period. In his view, retreating into solitude allows individuals to reevaluate their lives without cultural interference. Individuals preoccupied with the social and political neglect self-cultivation and thus fail to realize the highest ends of human life. For Nietzsche, solitude is both a means and an end: private self-reflection and self-education allow individuals to reshape their spirits, but solitude itself is desirable. Only in solitude is it possible to escape the influence of unproductive and diseased cultures—"squanderers of spirit"—which obstruct individuals' attempts to cultivate that which is most valuable to the human: spirit.

Effiem Obasi '20

Faculty Mentor: Professor Bill Flack, Psychology

Funding Source: California Healthcare Undergraduate Research

Relative weight of diagnosis, treatment, and prevention research on psychological trauma

Posttraumatic Stress Disorder (PTSD) is a psychiatric disorder that can occur after experiencing traumatic events such as military combat, sexual assault, witnessing life-threatening events, natural disasters, and serious accidents that have long lasting effects. Most people that experience trauma are able to heal after a short period of time but there are some people that will have stress reactions that develop into more serious psychological issues. Understanding that PTSD often requires long periods of treatment, absence of work, loss of productivity, increased labor turnover, and creates a tremendous emotional toll on the individual as well as their family members or close relationships, it is essential that general prevention and promotion of mental health be incorporated in the research to build preventative measures. On the other hand, mental disorders such as PTSD often occur due to the interaction of environmental and social factors, therefore it is important to understand the role of the factors that affect mental health and ways to combat them. A literary search was conducted in the major trauma journals and coded into clusters of diagnosis, treatment, and prevention. Research in trauma psychology is more focused on diagnosis and treatment and not so much on prevention. Given that we know the cause(s) of PTSD and how patients receive treatment, why is it that the field does not focus more on prevention?

Brayson Pawelczyk '20

Faculty Mentor: Professor Rebecca Switzer, Chemistry

Funding Source: John M. Hustler Undergraduate Research Fund

Impact of Disease-Causing Mutations in the RFTS Domain on DNMT1 Stability and Activity

DNA methyltransferases (DNMTs) are responsible for genome methylation, which is an epigenetic process with broad effects. My work focuses on DNMT1, the enzyme responsible for methylating hemi-methylated DNA. DNMT1 consists of a C-terminal methyltransferase domain and an N-terminal regulatory region. The replication focus targeting sequence (RFTS) domain, of the N-terminal region, is an endogenous inhibitor of DNMT1; it binds the catalytic site and prevents DNA binding. Recently, a link between RFTS domain point mutations and development of adult onset neurodegenerative diseases has been reported. Patients with RFTS mutations exhibit altered DNA methylation patterns. However, how these mutations impact the structure and function of DNMT1 is unknown. I am exploring how the disease associated mutations G589A and V590F impact DNMT1. Given that the RFTS domain binds the catalytic site, we hypothesized that RFTS domain mutations weaken this intramolecular interaction and therefore weaken RFTS-mediated inhibition. Differential scanning fluorimetry was used to investigate protein stability. In all conditions examined, the mutant proteins exhibited lower melting temperatures than wild-type DNMT1, indicating the mutations are destabilizing. In addition, I am using an endonuclease-coupled fluorogenic DNA methylation assay to investigate catalytic activity. Preliminary results indicate the mutant enzymes are more active than wild-type DNMT1, suggesting partial relief of normal RFTS-mediated inhibition. Taken together, this work indicates that the disease-causing mutations result in less stable, yet hyperactive enzymes. Ultimately, we hope our research will reveal the consequences of these disease-causing mutations and aid in our understanding of the mechanisms of disease formation.

Zander Perelman ’19

Faculty Mentor: Professor Mizuki Takahashi, Biology, Animal Behavior

Funding Source: Department of Biology

Detection of Snake Fungal Disease in an Eastern Ratsnake (*Pantherophis alleghaniensis*) in Pennsylvania

Ophidiomyces ophiodiicola is a fungus found within various snake species in the U.S. and has been shown to lead to the development of Snake Fungal Disease (SFD). SFD has been linked to widespread mortality of various species in the U.S., including common species such as timber rattlesnakes (*Crotalus horridus*), eastern massasauga rattlesnakes (*Sisterus catenatus*), eastern ratsnakes (*Pantherophis alleghaniensis*), and northern water snakes (*Nerodia s. sipedon*). Notable symptoms of SFD include skin lesions, such as crusty scales, scabs, and skin swelling, often near the nasal area of the snake, usually accompanied by ocular cloudiness. Unfortunately, the prevalence of *O. ophiodiicola* has not yet been studied in many states, including Pennsylvania. The goal of this study was to use molecular assay to assess the prevalence of *O. ophiodiicola* among snakes in PA. Snakes were wild caught by Mizuki Takahashi and I, examined on site, swabbed to collect DNA, and any notable skin irregularities were photographed and sampled. Samples were then brought back to the lab, and DNA extraction followed by PCR was performed to assess the prevalence of *O. ophiodiicola* among the sampled snakes, using fungus specific primers. Preliminary analysis suggests that there was one snake carrying *O. ophiodiicola* and was likely killed due to SFD infection. This snake was an Eastern ratsnake found dead in a shale quarry, displaying clouded eyes along with notable skin irregularities, closely matching the symptoms of SFD. This finding suggests that SFD may be present in PA, the first confirmed case.

Amber Quinlan ’20

Faculty Mentor: Professor Jasmine Mena, Psychology

Funding Source: Gary A. and Sandra K. Sojka Fund for Research, Teaching and Scholarship in Developmental Disabilities, Neuroscience & Human Health

The Education and Physical Quality of Life Relationship: Do Latinxs and Whites Differ?

The relationship between education level and physical quality of life (QOL) was examined with a population of Latinx and non-Latinx White participants due to research evidence that the health outcomes of these groups may differ. Due to the social disadvantages Latinxs face, it was expected that the relation between education level and physical QOL would differ and that ethnicity would moderate the relationship where Latinxs with higher education levels would report lower physical QOL than Whites with lower education levels. The sample (N = 137) was recruited from two health centers in Rhode Island who completed a survey assessing physical health, psychological health, and use of health resources and known moderators of QOL. In aggregate, higher education levels were associated with better physical QOL. Whites with higher education levels reported higher physical QOL compared to Whites with lower education levels, however this pattern was not observed with Latinxs with different education levels. Ethnicity did not moderate the relation between education level and physical QOL. Higher education levels are associated with higher physical QOL for Whites, however this pattern was not observed with Latinxs (within group) indicating that higher education levels do not always extend the same benefits to physical QOL in a context of social disadvantage. That said, since Whites with lower education levels did not report better physical QOL compared to Latinxs with higher education level, it appears that education confers some protection despite social disadvantage.

Daphne Ratnarajah ’19, Margarita Torres Loredo ’22

Faculty Mentor: Professor Jimmy Chen, Management

Funding Source: Presidential Fellowship

Secret Formula for Success: Personal Attributes and Social Factors

Undergraduate students are often overwhelmed by the opportunities and challenges lie in front of them. Making future plans can be critical at this precious phase of their life. We believe the life experience of successful individuals in the society can be inspirational and a worthy role model for undergraduate students to look up to. Therefore, our research question is to identify an individual’s personal traits and social factors that could contribute to an individual’s attainment of success. To this end, we collect data from excerpts in the Bloomberg Businessweek magazine that published the autobiographies of 107 individuals who are considered successful in their respective fields. We apply business analytics to analyze and visualize the data through which we can identify any hidden patterns. The preliminary findings suggest that advanced level of educational attainment is not influential: almost all of the surveyed individuals received a college degree, yet only 48% of the individuals received a graduate degree. Furthermore, successful individuals tend to have had many jobs before being considered successful, as 83% of the surveyed individuals had over five jobs, with the highest number being eight jobs. The goal of this research is to offer insights for undergraduate students planning for their personal or career development. The limitation of this research is that the surveyed individuals are

chosen by the Businessweek magazine that might have preferred definition of success, such as leaders in business sectors or people in CEO positions.

Chelsea Reynolds '19

Faculty Mentor: Professor Christopher Daniel, Geology & Environmental Geosciences

Funding Source: Program for Undergraduate Research

Using Raman Laser Spectroscopy to Calculate Metamorphic Pressures of Entrapment of Quartz Inclusions within Garnet (Quig) in the Thompson Peak Region of New Mexico

A method of determining pressures of entrapment of quartz inclusions within garnet (QuiG) using Raman laser spectroscopy is explored. At room temperature and pressure, quartz has a high intensity Raman peak of about 464.8 cm-1. Previous studies have experimentally quantified the amount of peak shift based on increasing confining pressures. The goal of this study is to compare pressure estimate from the QuiG method with previously determined pressure estimates based upon the assumption of chemical equilibrium during a net transfer reaction. Quartz inclusions within two garnet crystals from a garnet amphibolite and five garnet crystals from a garnet schist collected from the Thompson Peak region were tested. In the garnet amphibolite, nine inclusions were measured in the first garnet and five inclusions were measured in the second garnet. After correcting for instrument drift, the highest peak shift from garnet one was 0.91 ± 0.14 and the highest peak shift from garnet two was 0.45 ± 0.24. In the garnet schist, two samples from the same schist were tested. In sample one, two garnet crystals yielded peak shifts of 0.72 ± 0.02 and 0.62 ± 0.06. In sample two, three garnet crystal were tested yielding peak shifts of 0.91 ± 0.30 and 0.49 ± 0.07. Pressure estimates in both rocks were calculated to be approximately 4-6 kbar. Results are comparable to pressure estimates of 5-7 kbar calculated from net transfer reaction thermometry previously reported for the study area.

Mark Roginkin '21

Faculty Mentor: Professor David Rovnyak, Chemistry

Funding Source: Chemistry Undergraduate Research Fund

Non-Uniform Sampling in NMR For Pharmaceutical Structure Elucidation

Nuclear magnetic resonance (NMR) is an essential technique in chemistry. In pharmaceutical research, NMR is mission-critical for discovering the specific atomic structure of an unknown molecule. However, as a molecule's complexity grows, the NMR technique may not obtain complete information to solve the molecular structure, where sensitivity is often the most serious limitation. New techniques to achieve higher sensitivity include non-uniform sampling (NUS), which enhances the NMR signal by sampling points that are more "data rich", rather than those with less signal amplitude. This is achieved by using a sampling schedule, a carefully chosen list of numbers which dictates which time points to choose during the signal evolution. A sampling schedule must also preserve a parallel goal of NMR, which is to correctly distinguish similar signals. Two prominent methods for designing the NUS schedule are Quantile Sampling (QS), developed at Bucknell University, and Poisson Gap (PG) sampling, developed at Harvard Medical School. Specifically, the QS and PG methods were critically compared, in collaboration with Merck Research Laboratories, on advanced NMR experiments that fill in the 'blind spots' needed to solve complex structures, but which are also sensitivity challenged. First, this work employed subsampling, in which a fully sampled spectrum was resampled using either the QS or PG schedules to compare performance. Next, authentic NUS spectra were acquired following these recommendations. Overall, while NUS outperformed conventional sampling, greater sensitivity was observed with quantile sampling, indicating that the Quantile Sampling technique offers advantages over existing methods.

Avery Rosh '21

Faculty Mentors: Professor Erin Jablonski, Chemical Engineering; Professor Brandon Vogel, Chemical Engineering

Funding Source: Program for Undergraduate Research

Use of Microfluidic Devices for the Analysis of the Degradation of Methacrylated Dextran Hydrogels

Microfluidic devices are utilized in order to observe the erosion kinetics of methacrylated dextran (dex-MA) hydrogels under different conditions. Over the course of the experimental time frame of 100 hours, a solution composed of phosphate buffer solution and sodium hydroxide is pumped through a channel in the hydrogel; the solution is in constant surface contact with the channel causing the width of the channel to increase. The solution tested was one of three pHs, 9.6, 10.6 or 11.6, and the hydrogel had a degree of substitution of 6.67 percent. The degree of substitution, which relates directly to the cross-link density of the gel, is given its numerical value from the methacrylate groups per one hundred dextran glucopyranose residues; Nuclear Magnetic Resonance (NMR) is used to determine the degree of substitution. The experimental set-up includes four stereomicroscopes controlled by Motic Image Software. Over the course of the experimental time frame, the microscopes would capture images of the channel at timed intervals. The images would, over the period of 100 hours, show the increase in channel width. Image Analysis code, using the Simulink function

on Matlab, would then use the images to create a plot where the x-axis is time and the y-axis is change in channel width in pixels. The initial width of the channel, at time zero, is zero and both positive and negative changes are recorded, showing both gel swelling and gel degrading

Nicole Rupnik '19

Faculty Mentor: Professor Peter Judge, Animal Behavior

Funding Source: Program for Undergraduate Research

Metacognitive abilities of brown Capuchins (*Cebus [Sapajus] apella*)

Metacognition is the ability to determine what one knows and what one doesn't know; and with this knowledge, one can seek out additional information to complete tasks. Humans possess a metacognitive system, and chimpanzees (*Pan troglodytes*) provide evidence for metacognition in nonhuman primates. No evidence has been presented for the presence of this ability in brown capuchin monkeys (*Cebus [Sapajus] apella*). To test for metacognition, we trained 3 capuchins to associate and exchange a washer for a raisin and a bolt for an apple. The capuchins were then tested in an information-seeking task where the identity of the food placed in a cup was the piece of critical information required to get the reward. The capuchins were either shown or not shown this food and then the food container was raised. The capuchins were given the option to seek information by climbing the caging to look into the container before selecting a token or immediately selecting a token without looking. The food reward was only received if the token selected was associated with the food in the cup. Of the three capuchins tested thus far, all were significantly more likely to look into the cup before selecting a token if they had not been shown what was inside the cup and not look when they had seen the contents of the cup. Results provide evidence for metacognition in capuchins based on the data that they sought additional information to successfully perform the task.

Renee Russell, Graduate Student

Faculty Mentor: Professor Peter Judge, Animal Behavior

Funding Source: Graduate Summer Research Fellowship

Squirrel monkeys (*Saimiri sciureus*) demonstrate self-control in a food exchange task

Self-control is considered a prerequisite for more complex cognitive processes, such as cooperation and planning. I used an existing food exchange paradigm to test for self-control in squirrel monkeys (*Saimiri sciureus*). All monkeys first completed a presumably easier token exchange paradigm, where they were offered a choice between a lower-valued food and a token associated with a higher-valued food. If selected, the token could then be exchanged for the high-value food. Four of five monkeys chose to forego the immediately available low-value food in favor of the token significantly more often than chance ($p<.05$, binomial test). In the present food exchange study, all five subjects successfully exchanged a low-value food for a high-value food, regardless of their performance in the previous task. Control tests ensured that the monkeys had not formed a simple associative rule such as "always exchange." All but one monkey refused to exchange a higher-valued food for a lower-valued food, indicating that they were not using a simple rule and were indeed using self-control. To further explore their self-control abilities, I conducted a series of trials to determine how long they would wait to complete the exchange. Monkeys successfully tolerated delays ranging from 10-20 seconds. Successful performances indicated that squirrel monkeys were capable of displaying self-control and possess this prerequisite for more complex cognitive processes. However, the results also indicate that not all self-control paradigms measure the same aspect of self-control, as the token and food exchange paradigms produced different results for some monkeys.

Karen Santizo '21

Faculty Mentor: Professor Katsuyuki Wakabayashi, Chemical Engineering

Funding Source: Helen E. Royer Undergraduate Research Fund

Flax Composites: Towards Truly Renewable Materials for a Sustainable World

As polymers and plastics continue to be fashioned from petroleum-based resources, this continues to contribute some negative effects to the environment. We have developed a renewable alternative from traditional polymers through the use of epoxidized soybean oil. Epoxidized soybean oil still has many properties to that of traditional epoxy in which it can cure to an epoxy-like thermoset polymer. Because it has inferior mechanical properties compared to traditional epoxy, equal parts of traditional and bio epoxies were combined. With use of SuperSap ONF hardener, the epoxy blend results in a product that is 44 percent bio-based. The epoxy blend was reinforced with unidirectional flax fibers via vacuum assisted resin transfer molding (VARTM). The performance of the resulting composite were tested with tensile test, dynamic mechanical analysis, Izod impact test, and hardness test. We initially formulated a suitable base epoxy blend by varying the percentage of VikoFlex (epoxidized soybean oil), EPON 828 (traditional epoxy resin), and SSH (SuperSap ONF hardener), so that the mechanical properties are similar to to traditional epoxy. The final formulation of 50 percent VikoFlex, 50 percent EPON, and 30 percent SSH was used for both the base polymer and for the composites. In addition, the hardener content led to softer and malleable behavior of

the sample, which could result in another alternative for the base polymer for a different use.

Francesco Satriale '19

Faculty Mentor: Professor Moria Chambers, Biology
Funding Source: Kalman Fund for Biomedical Research Fellows

Impact of Chronic Bacterial Infection on Host Immunity of *Drosophila melanogaster*

The use of non-mammalian infection models like *Drosophila melanogaster* has made it easier to study bacterial pathogenesis. *D. melanogaster* proves to be an excellent model in that the innate immunity pathways and tissue physiology of this organism are similar to those of mammals. Bacterial pathogenesis can prove to be lethal when the microbe is injected into the thorax of the fly, but our lab has found that microbes lingering from a previous pathogenic infection can provide significant protection against future acute infection. The aim of this project was to distinguish whether this protection was due primarily to an increase in tolerance or resistance to infection. For this experiment, we chronically infected flies with either *Serratia marcescens* or *Enterococcus faecalis* and then hit them with a secondary infection of *Providencia rettgeri* at a range of doses. Impact on tolerance and resistance was assessed using both linear and logistic modeling. Results suggest that the protective benefit is due to increased tolerance for the tested combinations of chronic and secondary infection, specifically that flies with chronic infections exhibit increased vigor and decreased disease severity. Flies that had *E. faecalis* and *S. marcescens* as the chronic infection showed a general increase in survival of *P. rettgeri* at every bacterial load. Future directions include experiments to determine whether localization of the secondary infection is altered by chronic infection using fluorescence microscopy and work in mutant lines with known tolerance defects to see if they are still protected by chronic infection.

Zack Schiffer '20

Faculty Mentor: Professor Brian Smith, Chemistry
Funding Source: Mayfield and Johnson Scholarship; Dean's Fund for Summer Undergraduate Research in STEM; John M. Hustler Undergraduate Research Fund

Melting and Crystallization of Acetaminophen Using Differential Scanning Calorimetry

A central component of drug formulation is control over the crystal form, or polymorph, of the compound. These polymorphs have the same exact chemical makeup, but each polymorph can exhibit different qualities and interact with other molecules in different ways. Acetaminophen is used as a model drug to identifyvarious factors that affect the small energetic differences between polymorphs. Using Differential Scanning Calorimetry [DSC] and Powder X-Ray Diffraction [PXRD], thermodynamic data corresponding to each of the drug's three polymorphs can be analyzed. Polymorphic form three is metastable and more difficult to crystalize than both forms one and two. Using DSC and PXRD as complementary techniques, we identify the key recrystallization conditions that increase the selectivity for the metastable form three, isolating the crystal form without additional excipients. In particular, we identify powder compression as a major variable in acetaminophen polymorph selectivity.

Andrew Schlicht '20

Faculty Mentor: Professor Corrie Walton-Macaulay, Civil & Environmental Engineering
Funding Source: Culliton Family Fund for Undergraduate Research

Using Iron Powder in Geothermal Systems to Enhance the Viability of Concrete

The goal of this project is to develop a concrete mixture strong enough to support structures while increasing its thermal conductivity to be using in geothermal piles. Geothermal piles are sizable concrete masses placed in the ground to support structures and used in conjunction with geothermal energy systems.

Piping systems installed underground exchange energy with the earth and bring the constant subsurface 53˚ F temperature to the surface with circulated water. Without oil or coal directly involved, the system is efficient and environmentally kind.

The hypothesis is that since concrete is not an effective thermal conductor, enhancements can be achieved with additives. Otherwise, little energy would transfer between the water and soil, rendering the geothermal system inept. This project works to address the problem by adding iron powder to the concrete mixture to increase thermal conductivity.

The process involved constructing a small scale experiment. Starting with concrete tests for strength, a compressive strength goal was set to simulate the stress necessary to support large buildings. Once met, iron powder was added to the concrete mix. Water was circulated through two different concrete molds, one with iron power, and one without. The water was brought to either a high or low temperature before being pumped. It is the rate the temperature within the concrete molds changed that was measured. With a large enough thermal difference between the two trials and the iron powdered batch performing well in structural testing, then energy piles will look more promising.

William Snyder '21

Faculty Mentor: Professor Vanessa Troiani, Bucknell-Geisinger Autism and Developmental Medicine Institute

Funding Source: Gary A. and Sandra K. Sojka Fund for Research, Teaching and Scholarship in Developmental Disabilities, Neuroscience & Human Health; National Institutes of Health

Evaluation of Automated Orbitofrontal Sulci Labeling

Abnormalities in the orbitofrontal cortex (OFC) of the brain have been linked to brain disorders, but the origins of these deficits remain elusive, potentially due to the large degree of individual variability in the OFC. Thus, innovative methods to characterize OFC structure will be valuable for understanding the etiology and manifestation of multiple brain disorders. Characterization of stereotyped OFC sulcogyral patterns formed by the medial and lateral orbitofrontal sulci (MOS and LOS) is one method of characterizing individual variability, but current methods are largely manual and have potential for subjective influence.

The present study establishes an automated method for sulcal tracing and characterization of OFC sulcogyral patterns.

100 subjects from a published collection of manual OFC tracings and characterizations of patients with bipolar disorder, schizophrenia, and typical controls were used to evaluate an automatic tracing procedure implemented in the BrainVISA Morphologist Pipeline.

Automated tracings of OFC sulci were found to (1) accurately identify caudal and rostral segments of the medial (MOSc/MOSr) and lateral (LOSc/LOSr) orbitofrontal sulci, as well as the intermediate (IOS) and transverse orbitofrontal sulci (TOS); (2) accurately portray sulci continuity; and (3) reliably inform manual sulcogyral pattern characterization.

These results suggest that automatic OFC sulci tracing methods using the BrainVISA Morphologist pipeline are feasible. Automatic OFC sulci tracing methods will improve reliability and reproducibility of sulcogyral characterizations. In ongoing analyses, this pipeline is being applied to 580 individuals that are monozygotic or dizygotic twins in order to evaluate OFC sulcal pattern heritability.

Kefan "Tony" Song '20

Faculty Mentor: Professor Eric Kennedy, Biomedical Engineering

Funding Source: Helen E. Royer Undergraduate Research Fund

Development and Validation of a Braking Force Assessment Device for Lower Extremity Trauma Patients

The ability to brake efficiently under emergencies is critical to driving safety. However, individuals that suffer lower extremity trauma might lack that ability post-surgery. More than 300,000 injuries involved lower extremities in 2016, and there is no existing standard to clear patients for driving after surgery. Therefore, a braking force assessment device was designed to establish a standard by generating and analyzing data related to the braking ability of test subjects. The device was built with a simulated accelerator and instrumented hydraulic brake system. A light box was used to signal test and machine conditions. An Arduino microcontroller was integrated to control the lights and to record data. Through these data, relevant time and force parameters can be calculated. The device then underwent verification. First, the accuracy of the pressure data recorded by the pressure transducer and Arduino was evaluated against an integrated brake system pressure gauge. Moreover, after the machine was integrated, a load cell was fixed onto the brake pedal, and the applied force from the load cell was compared to the calculated force by the device (less than 7% error). This simulator has been deployed in the research setting to establish a standard according to the braking performance of healthy adults. After that, it will be deployed clinically to compare post-surgical patient's performance to healthy subjects, in order to better understand post-operative recovery and to facilitate better assessment for return-to-driving clearance.

Richard Stover '20

Faculty Mentor: Professor John Penniman, Religious Studies

Funding Source: Helen E. Royer Undergraduate Research Fund

Religious Identity and Spirituality on College Campuses

The objective of my summer research was to gain an understanding of the academic discussion regarding religious identity and spirituality of college students on college campuses in the United States, and how these held identities contribute or detract from the student's sense of belonging. College student populations are becoming increasingly diverse as the ethos of the secular intellectual identity is growing progressively sparse. And while students are participating less in the organized structures of religion, student involvement and spirituality remain high. The purpose of conducting this research is to provide the foundation for a future investigation of religious identity on Bucknell's campus.

I thoroughly searched sociological, religious, and higher education databases for relevant scholarly articles pertaining to religious and spiritual identity, religious minorities, and religious student groups on college campuses. Surprisingly, the majority of academic research conducted on college students representing

non-majority religious perspectives lags far behind research conducted on Christian students. In addition, there is a growing body of research concerning the "nones," who are individuals who claim no religious preference. Nones present an interesting avenue of inquiry because studies have examined three categories: atheists, agnostics, and unchurched believers. Atheists, of course, have very low levels of spirituality and oppose religion the most vehemently in the public sphere. Studies have shown that agnostics, though they neither confirm nor deny the existence of God, are far more likely to pray/meditate than atheists and are not as opposed to religion in the public sphere. Unchurched believers are those who claim no religion but maintain a connection with some form of higher power. Interestingly, unchurched believers are also more opposed than agnostics to religion in the public sphere. The investigation of nones is relevant to college students because of the increase of the "spiritual but not religious" identity claim.

In the future I plan to conduct my own research of the student body of Bucknell using qualitative and ethnographic methods. Because of the gap in the research, I plan to investigate religious minorities and those who claim no religious identification.

Megan Summers '19

Faculty Mentor: Professor Kevin Myers, Psychology
Funding Source: Gary A. and Sandra K. Sojka Fund for Research, Teaching and Scholarship in Developmental Disabilities, Neuroscience & Human Health

Metabolic Preparatory Responses as a Result of Flavor Nutrient Learning in Rats

Historically, in order to survive in the wild we needed to learn what foods were edible. Strong abilities to learn the flavor of a food and its nutritional value would increase the chance of obtaining healthy food sources and surviving. This associative learning has been termed flavor-nutrient learning (FNL) and has been shown to increase meal size as well as flavor palatability. The present experiment investigates the learned control of metabolic preparatory response when given only sensory properties of the associated flavor as a way to prepare the body for the anticipated metabolic load. In order to learn associations, rats were trained to drink a flavored saccharin solution during which time an intragastric infusion (IG) occurs to match the volume of liquid consumed by mouth. This allows us to separate the nutritional value from the taste. One flavor has been paired with IG glucose (CS+) while one flavor has been paired with IG water (CS-). An investigation into the learned control of gastric emptying, as measured by acetaminophen containing gastric infusions in conjunction with consumption of a flavor, resulted in no significant difference between the CS+ and CS- flavor. Diet-induced thermogenesis experiments, measuring the energy expenditure in order to digest food, demonstrated no overall temperature differences between CS+ and CS- flavors. In the last experiment, investigating learned control of metabolic rate, as measured by the rats containment in a metabolic chamber after exposure to a flavor stimulus, resulted in no significant difference between CS+ and CS- flavors.

Haipu Sun '19

Faculty Mentor: Professor Alan Marchiori, Computer Science
Funding Source: James L.D. and Rebecca Roser Research Fund

Enabling Network Coverage of the Internet of Things

As the term "smart city" becomes more popular, it is important to have more efficient wireless networks; therefore, our research focused on understanding and developing new Low-power Wide-Area networks (LPWAN) network standards. Our goal is to develop a web-based application for smart city LPWAN planning. The application will allow the user to define a set of city infrastructure and its location. Then using RF simulation models, it will compute signal strength between this city infrastructure to indicate LPWAN reliability.

Our job was to reimplement and improve a previously developed web-based application PlanIt, an online LPWAN network coverage estimation tool. The previous version of PlanIt was developed with AngularJS and python and to increase the efficiency of the application and allow it to be used in Google Cloud Platform, we reimplemented it into NodeJS. We kept using original models of RF propagation and geographic information to estimate path loss between locations. With the result generated by the calculation, we could compare the results with the collected data from Bill Chen's summer research. I also redesigned the layout of PlanIt for better looking and accessibility to different functions. Besides, because the shape files of geo-information are large and hard to handle, we couldn't use normal mongoose to handle fetch, and we implement a REST api to get the data files from MongoDB.

Anastassia Thibodeau '19

Faculty Mentors: Professor Christopher Daniel, Geology & Environmental Geosciences; Professor Jeff Trop, Geology & Environmental Geosciences
Funding Source: Department of Geology & Environmental Geosciences Marchand Fund

Comparison of Geochemistry of Detrital Muscovite and Muscovite Schist Clasts from the Spechty Kopf Formation, Northeastern Pennsylvania

This study examines the chemistry of matrix detrital muscovite grains and muscovite within schist clasts from the Spechty Kopf Formation to determine if the matrix grains are derived from the schist clasts or represent grains from a second source. The late Devonian Spechty Kopf formation consists of sandstones interbedded with diamictite with minor mudstones. Samples were collected from one Spechty Kopf locality, route 309 near Wilkes-Barre Twp. Blvd, in Hanover Township PA.The major element chemistry of individual muscovite grains and muscovite grains within pebble-sized metamorphic clasts were examined using the scanning electron microscope and energy dispersive spectroscopy (EDS).

Major element analyses were collected for 26 muscovite grains from four schist clasts and 45 matrix muscovite grains. Plots of major element concentrations (Wt%) of Na, Mg, Al, K, and Fe, Fe+Mg, Na+K against Si show that muscovite grains from schist clasts and the matrix have nearly identical chemistry. As Si increases in muscovite, Al tends to decrease, in both types of muscovite. Muscovite in schist clasts tends to show a increasing Al concentration with increasing concentrations of Fe+Mg, compared to the matrix analysis which show lower concentrations of Al with increasing Fe+Mg. From the results, it is evident that the clast and detrital grains are indistinguishable based upon major element chemistry. Results will be compared with muscovite analyses from similar age rocks of the Catskill clastic wedge farther to the east to test if they were derived from different or similar source areas as the Spechty Kopf Formation.

Anurag Vaidya ’21

Faculty Mentor: Professor Benjamin Wheatley, Mechanical Engineering

Funding Source: Program for Undergraduate Research

Effects of Boundary Conditions on the Compressive Behavior of Passive Skeletal Muscle

Understanding compressive mechanical properties of muscles can help improve automotive safety and prevent damages due to bedrest. We aim to understand the stress relaxation behavior of porcine tibialis anterior (TA) in unconfined compression at different strain rates. We hypothesize that increasing the strain rate inhibits fiber relaxation, causing greater stiffness and greater relaxation. TA was dissected into transverse-oriented cuboids (thickness=7.9mm±0.5mm) and stress relaxation testing was done using a 10N load cell. Samples were compressed to 40 percent strain at 5%/s (slow) and 40%/s (fast) and relaxed for 400s. A two-term power law model was fit to the hold phase. Peak and equilibrium modulus and three relaxation ratios (RR) (0-5s, 5-100s, 100-300s) were also calculated. The hold model for 5%/s (b-value= -0.55±0.02) was statistically different from that for 40%/s (b-value= -0.21±0.04). The greater b-value for 40%/s indicates that muscle compressed at higher strain rates exhibits greater relaxation. The peak modulus for 5%/s trials (0.16±0.05MPa) was different from that for 40%/s tests (0.54±0.09MPa), indicating that muscle is stiffer at higher strain rates. RR for 0-5s and 5-100s were different for the strain rates. 0-5s RR for 5%/s was lower than that for 40%/s trials (0.44±0.01 and 0.61±0.03, respectively). This relationship reverses for 5-100s as the RR for 5%/s is higher than that for 40%/s (0.24±0.01 and0.19±0.01, respectively). Hence, samples with higher strain rates initially relax quickly and then relaxation rate lowers. In all, this study sheds light on how muscle behaves in compression, which can help develop better computational models of skeletal muscles.

Aditi Vijayvergia ’21, Joon Shin ’20

Faculty Mentor: Professor Keith Buffinton, Mechanical Engineering

Funding Source: Department of Electrical & Computer Engineering; The Grand Challenges Scholars Program (respectively)

Experimental Verification of Finite Element Modeling and Improved Fabrication of FREEs (Fiber Reinforced Elastomeric Enclosures)

The study of soft robotics provides a cornerstone to shifting the growing presence of robots in the world from industrial settings to residential spaces. In order for this shift in paradigm to occur, soft robots must be accurately modeled and tested to prove their capabilities and reliability. Fiber reinforced elastomeric enclosures (FREEs) are one type of soft robotic actuator made with readily available materials, such as a latex tube wound with a set of cotton fibers at particular angles. Through this research, fabrication of FREEs was improved upon by studying different methods and materials. Arduino and LabVIEW interfaces were developed to pneumatically actuate the FREEs and measure rotation and elongation. Experimental data were compared with predicted behavior generated with the software package Abaqus to verify a finite element model.

*Cameron Wade ’20

Faculty Mentor: Professor David Del Testa, History

Funding Source: Douglas K. Candland Undergraduate Research Fund

Music and Community in Huguenot Parishes

French Wars of Religion, this research project examines the role of the lack of religious art music in establishing Protestant communities in France and seeks to explore the strategic disadvantage that this void created in Protestant conflicts with the Catholic majority

throughout the 16th century. This poster will highlight the importance of the *Genevan Psalter*, a book of psalm verses with simple and unoriginal melodies that was written by John Calvin and used by his followers in Huguenot (the name for French Protestants) Parishes during the 16th century. Calvin believed that complex music was sinful and only included Psalms with simple and unoriginal melodies in his book. Huguenots were limited to these songs in their effort to spread their religion and were forced to contend with the innovative and popular music of the Catholic Church. I intend to include images of the *Genevan Psalter* and compare them with the complexity of contemporary French Catholic music in this poster presentation. This project is not complete, however I feel that it is sufficiently developed for a quality poster presentation. I have continued my research in France this Spring and anticipate that it will culminate with a Senior Honors Thesis during the 2019-2020 academic year.

Howie Wang ’20, Bryant Zhou ’20

Faculty Mentor: Professor Charles Kim, Mechanical Engineering

Funding Source: James L.D. and Rebecca Roser Research Fund

Implementation of a Screw-Drive Extruder in a Desktop 3D-Printing System

At Bucknell, extensive researches on the extrusion mechanism of commercial 3D printers have started in 2013. Researchers have innovated a small-scale screw-drive resin extruder which can be applied to desktop 3D printing systems. This enables 3D printing using multiple types of pelletized materials that are more economic than traditional filaments. The objective of this research is to obtain a dynamic control paradigm of the new extruder, and to incorporate it with a CNC system for 3D printing.

The project consists of three major areas: mechanical design, kinetic control, and thermal control. Multiple changes in mechanical design were made regarding the extruder’s robustness, torque requirements and thermal insulation of the hotend. For kinetic control, an H-Bot kinematics system translates the printbed horizontally, with a lead screw driving the extruder vertically. For thermal control, the hotend was heated by PID-controlled cartridge heaters surrounding the nozzle.

To better incorporate the extruder with the Smoothieboard system, a computer interface was used to alter printing temperature, extrusion rate, and slicing of 3D printing files. A temperature range was firstly determined for suitable viscosity of the material. All other parameter adjustments (filament diameter, printing speed, etc.) were made within the predetermined temperature range. Through trial and error, optimal combinations of software settings were obtained for different materials.

The 3D-printer prototype featuring the screw-drive extruder has been able to print mostly rectangular objects such as a cube and a Chinese character with TPE pellets, and a calibration cube with indented XYZ letters on its surfaces using PLA pellets.

Yili Wang ’21

Faculty Mentor: Professor Christina Hamlet, Mathematics

Funding Source: Culliton Family Fund for Undergraduate Research

Computational Modeling of the Effects of the Sensory Feedback on Lamprey Swimming

The lamprey, a basal vertebrate, is able to move under the effect of a central pattern generator (CPG), a neural circuit located along the spine. Muscles are activated by signals from the CPG, inducing movement. The lamprey is a model animal for locomotion because it has a relatively simple neural. Learning how different types of sensory feedback to the CPG affect a lamprey’s swimming helps us understand how sensory feedback change animals’ movement in a general sense.

Some previous studies have modeled a lamprey’s CPG by using coupled oscillators. We use two chains of 280 oscillators and model the intersegmental connections in CPG. The oscillators are connected and influence each other such that when one oscillator receives a forcing stimulus, the whole chain can change.

We are interested in how changes to the CPG due to feedback affects how the lamprey will swim. We model body-sensing feedback using the curvature and the rate of curvature along the body to represent stretch. We know that the edge cells, stretch receptors located along spinal cord, send signals to the CPG when body is bending. However, the precise form of the signal is not well understood.

Our research investigates how the neural activation signal from the CPG changes, when different types of forcing and feedback are added to the oscillator model, and whether the lamprey moves differently. The outward forcing we add to the lamprey’s CPG helps us see how animals react to the change of environment or maneuver around rocks when swimming.

Marlee Warwick ’19, *Janey Woo ’20

Faculty Mentor: Professor Ramona Fruja, Education

Funding Source: Joann E. Walthour Undergraduate Research Fund

The purpose of this research is to investigate the lifestyles and educational experiences of low-income, minority youth living in a predominantly white rural

area. The data is drawn from participant observations over the course of eight weeks at the "Lunch-and-Learn" summer program hosted by the Bucknell Office of Civic Engagement. It analyzed Meadow View and Essex Place, two Equal Housing Opportunity communities in Lewisburg, PA, populated primarily by black and Puerto Rican families. Possible effects of various factors, such as age, gender, and living conditions, were also considered in the conduction of this research. This year, the theme of the "Lunch-and-Learn" program was arts and self-expression. Through this, the study aims to gain insight into how these children perceive these identity-forming experiences, and process them through creative methods. The results demonstrated strong ingroup relationships among race and family, negative experiences in the classroom, and low levels of school-relevant self. Dialogues with the children exposed feelings of being victims of racism at school at the hand of their teachers and peers alike, leading to lacks of academic self-confidence, willingness to engage, and future aspirations.

Jenny Waters '21, Lindsey Trusal '20, Abbie Winter '19

Faculty Mentor: Professor Mizuki Takahashi, Biology

Funding Source: Department of Biology

Effect of Salt Pollution and Predation on Hatching Success and Incubation Period on *Ambystoma Maculatum*

Salt (NaCl) pollution from salting roads during the winter has been disruptive in ecosystems, particularly in freshwater habitats that are popular amphibian breeding sites. The spotted salamander (*Ambystoma maculatum*) in particular has been found to be affected by salt pollution, showing delayed hatching or deformities. Their egg clutch is surrounded by gelatinous layers, which are often eaten away by predators such as wood frog tadpoles (*Lithobates sylvaticus*), exposing the salamander embryos to the environment. Thus, the presence of tadpoles may exacerbate the effect of salt pollution on the salamander embryos. In spring 2018, we conducted a laboratory experiment with a factorial design involving the presence or absence of road salt, wood frog tadpoles, and surrounding jelly. Daily, we recorded the number of salamander embryos that hatched and preserved them for measurement of their developmental stages and body lengths. We predicted that the presence of salt as well as predators, and the absence of jelly layers would cause greater mortality and earlier hatching, resulting in less developed and smaller hatchlings. Our data suggests no effects of salt on development and growth. Hatchlings in the presence of tadpoles were less developed and had shorter body lengths. The presence of jelly layers and tadpoles interactively affected salamander development; the presence of jelly layers tended to delay their development but this trend was observed only in the absence of tadpoles The absence of jelly layer and the absence of tadpoles independently increased hatching success. Salt decreased the incubation period, and the absence of salt and the presence of tadpoles resulted in the shortest incubation period. These results provide mixed support for our hypothesis.

Savannah Weaver '20, Emily Konishi '19

Faculty Mentor: Professor Matthew McTammany, Biology

Funding Source: The Katherine Mabis McKenna Environmental Internship Program

Lack of Lateral Mixing Downriver of Tributary Confluences

The river continuum concept describes changes to physical conditions, such as stream width, depth, and turbidity, that cause habitat gradient along rivers which affect ecosystem metabolism. In studying water quality and metabolism throughout the Susquehanna River in central Pennsylvania, we found evidence of lateral mixing patterns. We arranged our study sites into two groups based on major confluences: Group A - Milton (West Branch), Danville (North Branch), and their downriver site Isle of Que (Main Stem); Group B - Greenwood (Juniata River) and its downriver match Fort Hunter (Lower Stem). Numerical modeling of river water mixing calculated that lateral diffusion will be completed at a distance of 25 to 37 channel widths downflow of the confluence at low flow and high flow, respectively. Previous research shows faster lateral dispersion for stretches with sharp curves and more islands, so we expected relatively rapid mixing due to the many islands mid-channel throughout our study reach. If complete mixing were to occur 30 widths downriver, we would expect lateral diffusion to be complete approximately 25 km downriver of the Group A confluence and 36 km downriver of the Group B confluence. We did not observe complete mixing within these distances. To test extent of mixing, we took lateral transect samples at each site and compared upriver-downriver pairs: Milton-Que, Danville-Que, Greenwood-Fort Hunter, and Que-Fort Hunter. We found similar water chemistry for Milton-Que West, Danville-Que East, and Greenwood-Fort Hunter West. The Fort Hunter transect retained some similarity to the Isle of Que transect. Water chemistry similarities show a pattern between tributaries and corresponding sites downflow. Lateral stratification may have profound effects on river ecology, affecting predictions about species and their suitable habitats and having repercussions on ecosystem metabolism. Based on our observations, water sampling in large rivers should take multiple samples throughout a lateral transect: a single bank sample will unlikely be representative of the entire area. Further research on this may look to quantify exact river size (width, depth, flow rate) at which lateral incongruity becomes apparent or how tributary size affects lateral mixing.

Jill Weiss '19

Faculty Mentor: Professor Rebecca Switzer, Chemistry

Funding Source: John M. Hustler Undergraduate Research Fund

Examination of Substituted Anthraquinones as Direct DNA-competitive Inhibitors of DNA Methyltransferase 1

DNA methylation, the addition of a methyl group onto the fifth carbon of a cytosine base, is a type of epigenetic signal; methylation silences gene expression. DNA methyltransferases (DNMTs) are a family of enzymes that catalyze methyl group addition. Abnormal methylation patterns have been linked to the onset and progression of several different cancers. These epigenetic modifications are reversible, and as a result, drug discovery aimed at identifying DNMT inhibitors is a rapidly advancing field of study. A highly substituted anthraquinone natural product, laccaic acid A (LCA), was recently shown to be a direct, DNA-competitive inhibitor of DNMT1. It has been suggested that substituted anthraquinones could serve as a scaffold for novel DNMT inhibitors. To this end, our lab has screened a small library of substituted anthraquinones for DNMT1 inhibition. Two substituted anthraquinones were discovered that are direct DNMT1 inhibitors. The aim of this project was to determine the mechanism of inhibition of these novel inhibitors. A fluorescence polarization assay was used to determine if the novel anthraquinone inhibitors retain a DNA-competitive mechanism. DNMT1 bound the fluorophore-tagged DNA with a Kd of ~50 nM. LCA was used to define parameters for a competition assay in which inhibitor displaces the bound DNA resulting in a change in polarization. Preliminary evidence suggests that the novel inhibitors are significantly less potent than LCA, but retain a DNA-competitive mechanism of action. This data indicates that substituted anthraquinones could serve as a novel scaffold for developing DNA-competitive DNMT1 inhibitors.

Heather Wetreich '21

Faculty Mentors: Professor Christopher Martine, Biology; Burpee Post Doc Fellow Angela McDonnell, Biology

Funding Source: David Burpee Endowment

Solanum plastisexum, an enigmatic new bush tomato from the Australian Monsoon Tropics exhibiting breeding system fluidity

A bush tomato that has evaded classification by solanologists for decades has been identified and is described as a new species belonging to the Australian "*Solanum dioicum* group" of the Ord Victoria Plain biogeographic region in the monsoon tropics of the Northern Territory. While now recognized as an andromonoecious species, *S. plastisexum* has been found exhibiting multiple reproductive phenotypes: with solitary perfect flowers, a few staminate flowers, or with cymes composed of a basal hermaphrodite and an extended rachis of several to many distal staminate flowers. When in fruit, the species also may drop the distal rachis. A member of *Solanum* subgenus *Leptostemonum, Solanum plastisexum* Martine & McDonnell sp. nov. is allied to the *S. eburneum* Symon species group. Morphometric analyses presented here reveal that *S. plastisexum* differs statistically from all of its closest relatives including *S. eburneum, S. diversiflorum* F.Muell.*S. jobsonii* Martine, J. Cantley, & L.M. Lacey, S. *succosum* A.R. Bean & Albr., and S. *watneyi* Martine & Frawley in both reproductive and vegetative characters. We present morphometric evidence supporting the recognition of *S. plastisexum* as a distinctive entity, a description of the species, representative photographs, a map showing the distribution of members of the *S. eburneum* species group, and a key to the andromonoecious *Solanum* species of the Northern Territory. This new species is apparently labile in its reproductive expression, lending to its epithet; and this plant is a model for the sort of sexual fluidity that is present across Kingdom Plantae.

David Williams '20

Faculty Mentor: Professor Indranil Brahma, Mechanical Engineering

Funding Source: Program for Undergraduate Research

Mechanical Efficiency in Running

Videos of a 6-minute mile pace for 30 different runners were analyzed using a tracker program to produce position data for the subjects. The videos and position data were used to find characteristics and trends between the runners and non-runners. The positional data was then used along with some other individual characteristics to calculate a uniform efficiency unit of Joules per kilogram per meter. No trend was established with the uniform efficiency unit using this method of video analysis. Even though there was no trend found with the efficiency, a separation between runners and non-runners was established using the ground contact time and the time from ground contact to ankle vertical position in relation to the cycle time. This uniform comparison between subjects showed clear cutoffs in the data with a 23% threshold for Ankle Vertical Time and 28% for Ground Contact Time. Along with a linear cutoff, these thresholds encapsulated all the runners in the data set as well as a few elite runners who were tested using online competition videos. This relationship shows characteristics that could be used to differentiate effectively between most runners and nonrunners.

Christina Yu ’21

Faculty Mentors: Professor Tom Solomon, Physics & Astronomy

Funding Source: National Science Foundation Grants (NSF)

The Behaviour of Swimming Bacteria in Vortex Flows

We are studying the behaviour of swimming micro-organisms in imposed fluid flows. We generate vortex flows in microfluidic configurations through magneto-hydrodynamic forcing, flow focusing techniques, and miscellaneous hyperbolic systems. We explore how these affect the motion of bacteria in specific regions of fluid circulating around in a confined area. We present the results from the perspective of swimming invariant manifold theory.

Chengtong Zhang ’20

Faculty Mentors: Professor David Rovnyak, Chemistry; Professor Timothy Strein, Chemistry

Funding Source: National Science Foundation; Stephen Glenn Hobar Memorial Research Award; Harold W. Heine Undergraduate Research Fund in Chemistry

Molecular Dynamics Simulations of Bile Salt Self Aggregation

Bile molecules have multiple functions in our body, such as helping the digestion and transport of fats, and also have distinctive guest-host properties. In this work, we investigated the ability of bile molecules to aggregate based on molecular dynamics (MD) calculations. By computational modeling, we can test for spontaneous bile aggregation under different conditions (temperature; type of bile molecule; number of bile molecules). This work used the AMBER suite, a set of biomolecular simulation programs, to study two types of bile molecules: cholate and deoxycholate. These molecules can aggregate since they are amphiphilic, which means that they have both hydrophobic and hydrophilic regions. This work first demonstrates unbiased, spontaneous self-aggregation of bile molecules in MD calculations over several temperatures. Interestingly, the simulations suggest that stable aggregates are slightly favored at 300 K, where the longest duration of self-aggregation is observed compared to other temperatures. These results support the formation of hydrophobic interiors of the aggregates and support experimentally derived models. Measuring the distances between the methyl groups of separate molecules reports on the interaction between the molecules. Dimers are shown to be characterized by inter-molecular distance between methyl groups as close as 5 angstroms. We used visual representations of the interactions between the bile molecules to classify structural motifs of the aggregates. There are different forms of aggregations, however a common arrangement is an anti-parallel dimer. Work in progress on deoxycholate structural motifs will also be presented.

*Abroad Spring Semester 2019

Ziwei Chen ’19

Faculty Mentor: Professor Allen Tran, Sociology & Anthropology

Exhibiting Class: Art Exhibitions and the new Chinese Middle Class

Kanzhan, translated at “going to exhibitions,” has emerged as one of the most popular leisure activities in urban China. Contemporary art exhibitions cover a wide range of subjects, including world-renown artists, jewelry and fashion brands, and pop-up museums. More and more visitors are taking art exhibitions experience as a way to exhibit their personal taste, which reflect the rise of middle-class values such as individuality and self-development in China. This paper is an anthropological exploration of the relationship between visitors and art exhibits and what those art exhibitions tell about the new middle class in China.

My research is based on original field research in the summer of 2018 and winter of 2019. I conducted participant observation and semi-structured interviews in art exhibitions in the city of Beijing and Shanghai. Drawing on anthropological theories of cosmopolitanism, body and emotion, and photography and self-presentation, I argue that going to art exhibitions is a critical means of performing and reinforcing one’s middle-class identity and aspirations in contemporary China. As such, the thesis contributes to the anthropological understanding of the role of aesthetics and taste in the production of class.

Maddie Knott, Graduate Student

Faculty Mentor: Professor Beth Capaldi, Animal Behavior

Funding Source: Graduate Summer Research Fellowship

Foraging behavior of bumblebees (Bombus impatiens) sonicating a dioecious Solanum

Sonication, or buzz pollination, is a behavior of bees in the genus Bombus that allows them to obtain pollen from the roughly 20,000 plant species, including Solanum, that have poricidal anthers. Plants with poricidal anthers do not engage in passive pollen release; instead, poricidal anthers conceal their pollen inside of impenetrable tube-like structures. A pore at the tip of the anthers allows the pollen to escape the tube-like structures, but only at specific frequencies of vibration. This project aims to assess the foraging behavior of sonicating bumblebees (Bombus impatiens) when they are presented with randomly generated arrays of plants from a dioecious species with poricidal anthers (Solanum dioicum). Each of the arrays contains equal numbers of male and female plants, allowing bees to make four different types of transitions between plants— male-to-male, male to female, female to female, and female to male. A chi-square goodness-of-fit test was conducted to determine whether the four transition types were equally preferred. Preference for the four transition types were not equal, with male-to-male transitions occurring most often. The difference in the occurrence of each transition type is significant, $X2 (3, N = 29) = 2280.609, p < .0001$.

*Carolyn Marino ’20

Faculty Mentor: Professor Alf Siewers, English

Funding Source: Douglas K. Candland Undergraduate Research Fund

Violence and Community: Social Justice in *The Brothers Karamazov* and *War and Peace*

My paper expounds upon social justice theories and interprets justice in three waves: righteousness, fairness, and distribution. Justice as righteousness is interpreted by Classic philosophers, such as Plato and Aristotle, and is derived from biblical Greek. The phrase “justice as fairness” is attributed to John Rawls, a late twentieth century philosopher whose theory is often derived from Kantian ideals and is rooted in deontology. Distributive justice is often associated with neo-Marxism and relates to allotment of physical materials, such as property. However, distributism, a nineteenth century economic ideology, is aligned with Catholic social teaching.

This paper contemplates both Dostoevsky’s and Tolstoy’s mediation between these three waves of justice in The Brothers Karamazov and War and Peace. Being born into different social classes, Dostoevsky and Tolstoy view class inequities through opposite lenses. Dotoevsky believes that freedom can be realized through a just government, whereas Tolstoy’s anarchistic mindset aligns with determinism. However, both authors rely on Eastern biblical notions of natural law to account for earthly injustices. Furthermore, justice is a communal effort for both, which is impossible to achieve through violent means.

*Abroad Spring Semester 2019

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