



**POSTERS
ON THE HILL**

2020



POSTER SESSION GUIDE

Brought to you by the Council on Undergraduate Research

April 21, 2020



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To Our Posters on the Hill (POH) Participants:

Congratulations to all of our undergraduate researchers on their acceptance to the prestigious 24th Posters on the Hill. Approximately 400 applications from around the United States went through a rigorous, highly competitive review process and only 60 were selected. The Council on Undergraduate Research (CUR) is overwhelmed by these students' accomplishments.

We cannot let the hard work, determination, and support of the faculty, staff advisors, and mentors be forgotten. They serve as stellar examples of the best in higher education. Thank you.

We are also appreciative of our continued support from the American Chemical Society (ACS) and IEEE-USA. ACS has been a partner on this event for years and we are most thankful for their willingness to move virtual this year. ACS, a premier nonprofit organization and the largest scientific society in the world, is a global leader in chemistry education, research, and advocacy.

IEEE-USA, an organizational unit of the Institute of Electrical and Electronics Engineers (IEEE), has joined as a supporter of POH for a second year, their support benefits our participants and the advocacy message around undergraduate research. IEEE-USA was created in 1971 to support the career and public policy interests of IEEE's U.S. members.

This year is a little different as we embark on a virtual celebration. We are forced to push ourselves to meet a new screen-to-screen relationship standard. Our students, who are used to taking months of hard work and putting it into one poster they can speak to, have expertly shifted gears to share their experience and research to a predefined number of characters. This Twitter takeover will spread the message of undergraduate research and showcase their research and studies to a global audience. The students will show their future employers, academic institutions, and advisors and mentors just how much their undergraduate research experience has impacted them as they exhibit your ability to be flexible, open-minded, and influential.

I am certain that our POH participants will help advance knowledge through their research, scholarly, and creative discoveries. Whether they pursue a career in academia, business, industry, or public service, their undergraduate research experience adds a significant advantage to their professional preparation.

Please make sure to follow @CURinAction, #POH2020, and #POH Goes Virtual to witness the future of our nation.

Congratulations!

Lindsay Currie
Executive Officer
Council on Undergraduate Research



A SPECIAL THANK YOU TO:

Albion College	University of Colorado at Boulder
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Established Program to Stimulate Competitive Research	U.S. Department of Health and Human Services
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San Francisco State University	National Institutes of Health - National Institute on Minority Health
St. Catherine University	and Health Disparities
University of Central Oklahoma	Utah State University
University of Chicago Neuroscience Department	Vermont Genetics Network

Without your support and generosity these posters would not be possible.



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ALABAMA

Student(s): Harsharandeep Kaur

Research Institution: University of Alabama at Birmingham

Lead Student Home Institution: University of Alabama at Birmingham

Lead Student Home State: Alabama

Faculty Advisers: Despina Stavrinou | Benjamin McManus | Gareth Jones

Division: Psychology

Exercise, Caffeine, and Well-Being in Medical and Surgical Residents

*Funding Agency: National Institute for Occupational Safety and Health (NIOSH)
Grant No.: 2T420H008436*

Regular exercise improves wellness and reduces burnout by positively affecting mental health and disease prevention. Many jobs have demanding schedules that leave little time for exercise and cause a reliance on caffeine. Although caffeine can improve alertness and enhance cognitive performance, negative side effects from excessive use range from suppressed immune system responses and elevated cortisol levels to depression. This project is among the first to examine associations of daily exercise and caffeine with wellness in a population with particularly demanding schedules—medical and surgical residents. It was hypothesized that greater exercise frequency would be associated with better wellness. Twenty-five medical and surgical residents logged daily caffeine consumption and exercise for approximately one week and completed well-validated assessments of work stress, life stress, and sleep quality. Residents exercised, on average, fewer than two days per week, with one-third logging no exercise at all. Residents consumed nearly two caffeine products daily. Increased daily caffeine usage was associated with increased life stress. Greater exercise frequency was correlated with decreased life stress. Greater exercise frequency was also associated with greater time in residency. Greater time in residency was correlated with decreased life stress. Residents further into residency may have schedules or duties more conducive to exercise, which may contribute to lower life stress. These more senior residents may have developed exercise time as a stress mitigation strategy. Education and policy should consider the unique challenges in the first years of residency to optimize schedules, monitor stress and wellness, and make exercise time available.

ARIZONA

Student(s): Brittney Childress

Research Institution: University of Arizona

Lead Student Home Institution: University of Arizona

Lead Student Home State: Arizona

Faculty Advisers: Monica Kraft | Dave Francisco

Division: Health Sciences

Club Cell Secretory Protein 16 Deficiency May Lead to a Predominantly Non-Allergic Inflammatory Response in a Mouse Model of Asthma

Asthma is a chronic disease that affects more than 25 million Americans. Despite the disease's prevalence, much is not understood about the disease, including how the inflammatory responses associated with it can be mediated. An allergic inflammatory response and a non-allergic inflammatory response both show different inflammatory pathways being stimulated leading to the common symptoms of asthma. A protein that may play a role in modulating these inflammatory responses in the airways is Club Cell Secretory Protein 16 (CC16). CC16 is produced by club cells throughout the airways and has been shown to have both anti-inflammatory and antioxidant effects with decreased levels being associated with the development of asthma, COPD, and decreased lung function. Due to the effects that decreased levels of CC16 seem to have on the development of airway disease and inflammation, the researchers wanted to observe how a deficiency of this protein may result in elevated inflammation in response to the asthmatic stimulus house dust mite. What the preliminary results have demonstrated is that a deficiency of this protein leads to an increased overall inflammatory response. Further examination has elucidated that there was a predominantly non-allergic asthmatic response, or even a mixed-type response, occurring in the airways of CC16-deficient mice that is associated with a severe form of asthma.



ARKANSAS

Student(s): Lauren Camp | Carlon Gragg | Cecily Rodriguez | Kaylie Wheelless
Research Institution: Henderson State University
Lead Student Home Institution: Henderson State University
Lead Student Home State: Arkansas
Faculty Advisers: James Engman
Division: Biology

Genetic Analysis of Microbial Samples from a Cave System with a Biological Community Functioning Independently of Photosynthesis

*Funding Agency: McNair Scholars/TRIO Program at Henderson State University
Henderson State University Work Study Position | Grant No.: P217A120073*

Although most biological communities require energy from sunlight and photosynthesis, a few powered solely by chemical energy have been discovered, primarily in deep-sea hydrothermal vents and a few unique cave systems around the world. In this study, samples of bacterial communities were taken from an incompletely explored cave in central Tennessee, currently mapped to a length of 12 miles. Samples were collected from a pool in an area named “Petroleum Passage” due to a strong odor of petroleum. The pool has a sandy bottom with scattered patches that give off black droplets of a tar-like substance and are surrounded by concentric rings of colored sand, suggesting microbial activity. Samples analyzed include the patches and bands, water, and actively growing cave formations. Samples were analyzed with a technique allowing DNA to be removed directly, base sequences read, and matched to a large database to determine the identity of the organisms present. For six samples analyzed, 494 different bacteria were identified, including many unique species that metabolize sulfur and methane compounds, previously associated with deep sea thermal vents, and others that degrade hydrocarbons. The results of this survey provide insight into not only microbial species in extreme environments on Earth but also a new example of a type of system that has been suggested as a potential model for life in subsurface environments on Mars.

CALIFORNIA

Student(s): Isaiah Thompson
Research Institution: California State University, Fullerton
Lead Student Home Institution: California State University, Fullerton
Lead Student Home State: California
Faculty Advisers: Jochen Burgdorf
Division: Arts and Humanities

Lessons from the Finkenwalde Seminary (1935–1937): The Rejection of Racism in Nazi Germany

Funding Agency: The Mellon Mays Undergraduate Fellowship

The German pastor and theologian Dietrich Bonhoeffer (1906-1945) has been praised as a hero of social activism against Nazi ideology, and recent scholarship notes his unique response to the problem of racism both inside and outside the Protestant church. However, the present understanding of Bonhoeffer’s rejection of racism is incomplete, as scholars have given little attention to his theological rejection of racism from 1935 to 1937. During these years, Bonhoeffer directed an underground, illegal seminary located in the small town of Finkenwalde. This research explores Bonhoeffer’s response to racism at this seminary. After surveying the primary lecture materials—composed of written lectures, Bonhoeffer’s lecture notes, and notes from his students—it is evident that Bonhoeffer explicitly rejected racism at the seminary. In addition to Bonhoeffer’s rejection of racism, he also locates and addresses influencers of racism. Influencers such as hero-worship of political leaders, certain biblical interpretations, and hypernationalism are all confronted themes. Preliminary findings suggest that these influencers are active within the church today. Although influencers may not be racist in and of themselves, they have the ability to create racial outcomes. Locating influencers that have potential racist outcomes is a necessary step for eradicating racial discrimination. History allows for the witnessing of how potential forms of racism became concrete, and the Finkenwalde Seminary is an appropriate example of how an individual can identify and respond to influencers of racism to prevent the encouragement and actualization of racist outcomes inside and outside the church community today.



COLORADO

Student(s): Maureen McNamara

Research Institution: University of Colorado at Boulder

Lead Student Home Institution: University of Colorado at Boulder

Lead Student Home State: Colorado

Faculty Advisers: Barbara Demmig Adams

Division: Biology

Cooptimization of Duckweed Biomass, Nutritional Quality, and Energy-Use Efficiency for Human Consumption in Space

Funding Agency: Biological Sciences Initiative Scholars Program

Development of a regenerative, nutritious, and reliable food source is essential for long-duration human spaceflight such as a mission to Mars. Duckweed is uniquely suitable for growth in space, as it is a floating plant that can grow in the microgravity space environment, which lacks the gravity most plants rely on for support. Duckweed has a fast growth rate and high nutritional content, which will provide astronauts with a constant food supply rich in proteins, healthy fats, and micronutrients. This research seeks to identify conditions that minimize the energy resources needed to grow the duckweed *Lemna gibba* while maximizing biomass output and nutritional quality. Environmental conditions will be defined that maximize plant content of protein, micronutrients, vitamins and other desirable constituents. Experiments have already been completed to characterize the growth light intensity required for high micronutrient and vitamin output. Ongoing tests will define conditions that maximize protein concentration. The majority of a plant's proteins are used in photosynthesis, a process that converts light into chemical energy. Therefore, it is hypothesized that protein content will peak under relatively low light conditions when photosynthetic activity needs to be maximized so that the plant's energy supply will be maintained. Findings regarding ideal conditions for maximizing protein concentration will be combined with results from tests of biomass, vitamins, and micronutrient production to determine the optimal conditions under which duckweed's output of all of these substances is maximized.

CONNECTICUT

Student(s): Crystal Harris

Research Institution: University of New Haven

Lead Student Home Institution: University of New Haven

Lead Student Home State: Connecticut

Faculty Advisers: Alireza Senejani

Division: Biology

An Examination of the Expression of APOE in Neuron Cells Infected with Lyme-Causing Bacteria

Funding Agency: Summer Undergraduate Research Fellowship

Alzheimer's is a progressive neurodegenerative disease that currently affects 5.8 million people. This disease does not have one specific cause, but there are factors that influence the formation of plaques in the brain, one of the defining characteristics of Alzheimer's disease (AD). The gene Apolipoprotein E (APOE) is associated with increased risk for developing AD. APOE, a gene that provides instructions for making protein necessary for healthy pathways in the brain, was one of the first known risk factors for late-onset AD (LOAD). Along with the effect of genes in the onset of AD, there is evidence to suggest a correlation between AD and *Borrelia burgdorferi*, bacteria that causes Lyme disease, but this possible link has not been fully proven. Given the possible link between AD and infectious bacteria, and the relationship between APOE and AD, the expression of APOE should be increased in the presence of infectious bacteria. To test this hypothesis, cells from the brain were infected with Lyme-causing bacteria, *B. burgdorferi*, and genetic analyses were conducted to investigate the role of the bacteria in the expression of the APOE gene and the APOE protein. Preliminary results of this research show that the expression of APOE increases after infection with the bacteria. An increase in APOE expression after infection can show a possible link between AD and the Lyme disease-causing bacteria. These results can spark further investigations to the link between certain infectious diseases and neurodegenerative diseases, including AD.



DELAWARE

Student(s): Sylvia Okafor

Research Institution: Delaware State University

Lead Student Home Institution: Delaware State University

Lead Student Home State: Virginia

Faculty Advisers: Linda Polasko

Division: Biology

Interactions between Presynaptic Modulators of Dopaminergic Transmission

Funding Agency: National Institutes of Health

Grant No.: NIGMS-1P20GM103653-01A1

Dopamine is a key neurotransmitter that is associated with learning, memory, behavior, and locomotion. Dysregulation of dopamine signaling is associated with numerous neurological and mood disorders such as Parkinson's, schizophrenia, and ADHD. Although both D1-like and D2-like dopamine receptors are known to contribute to the control of postsynaptic dopaminergic activity, the interactions of specialized presynaptic D1-like dopamine autoreceptors in regulating decision-making are still largely unclear. Specific genetic modulators of dopamine synaptic transmission have previously been described: DAT-1 is a sodium-dependent dopamine symporter that is involved in clearing the presynaptic cleft of exogenous dopamine. DOP-2 is a dopamine agonist and Gprotein-coupled receptor that inhibits adenylyl cyclase activation as well as calcium channels to regulate dopamine synthesis. ASIC-1 is a subunit for a proton-gated sodium channel in a positive feedback mechanism involved in decreasing the pH in the synaptic cleft. A number of behavioral phenotypes can be used to determine interactions between various dopamine regulatory genes to characterize pathway crosstalk in this highly regulated process. Using *asic-1*, *dop-2*, and *dat-1* deletion mutant *C. elegans* nematodes and their crossed double deletion mutants, it was hypothesized that the associative learning and behavioral characteristics displayed in a swimming-induced paralysis (SWIP) and sodium chloride associative learning assay will indicate positive genetic interactions between genes of interest. Preliminary results indicate that genes encoding presynaptic dopamine regulatory proteins interact via crosstalking pathways that are likely to be critical for precise modulation of dopaminergic transmission.

DELAWARE

Student(s): Osama Mahmoud

Research Institution: Wesley College

Lead Student Home Institution: Wesley College

Lead Student Home State: Delaware

Faculty Advisers: Malcolm D'Souza | Fady Geroges

Division: Biology

New Clinical-Based Screening Methodology for Delaware's Anal Cancers

Funding Agency: IDeA Program, National Institute of General Medical Sciences, National Institutes of Health | Established Program to Stimulate Competitive Research (EPSCoR), National Science Foundation | Grant No.: P20GM103446 | OIA-1757353

This past decade, high-risk, HPV-related, anal intraepithelial neoplasia (AIN) has increased in prevalence and intensity. Specific cohorts in Delaware—especially some within the Sussex County population—are identified to be at increased risk. Studies have suggested that the rate of progression of high-grade AIN lesions to invasive anal cancer is around 5 percent; in the past, anal cytology (cell biology) was the screening tool of choice. However, very little correlation between the anal cytology screening and actual pathology (cause and effect) was observed. This project's main goal was to develop a reproducible clinical-based screening methodology that includes both clinical (symptomatic) screening and histologic (microscopic) evaluation. Here, patients undergoing colonoscopy underwent targeted biopsy for suspicious anal lesions/changes with or without acetic acid (vinegar) application followed by routine histologic evaluation as well as molecular HPV studies. In collaboration with an ambulatory surgery center in southern Delaware, the researchers identified 31 patients who qualified for study inclusion. These patients were evaluated both retrospectively as well as prospectively to correlate clinical findings with measurable pathology-based identifiers at the Green Clinics Laboratory in Dover, DE. The results of this pilot study provide proof for the validity and reproducibility of identifying high-risk populations by a simple clinical method to test for high-risk lesions, including precancerous and cancerous AIN.



FLORIDA

Student(s): Miranda White

Research Institution: Bethune-Cookman University

Lead Student Home Institution: Bethune-Cookman University

Lead Student Home State: Florida

Faculty Advisers: Michael Reiter

Division: Biology

Using a Bayesian Conditional Probabilistic Model to Identify Efficient Environmental Indicators of Harmful Algal Blooms within the Indian River Lagoon, Florida, USA

The Indian River Lagoon (IRL), an estuary along the eastern coast of Florida, has lost 75 percent of its salt marsh area to agriculture and urbanization. The resulting increase in stormwater runoff combines with wastewater discharges, septic system inputs, and excess fertilizer applications to contribute harmful levels of nutrients into the lagoon. *Aureoumbra lagunensis*, a “brown tide” alga that can lead to fish kills, is present in the IRL. Existing literature indicators are still relatively poor at predicting the development of a new bloom, so it is important to find a leading indicator of brown tide that is widely available and quickly estimated. Bayesian Conditional Probability Analysis (CPA) provides information about the probability of observing one event given that another event has occurred. Using Chlorophyll *a* as a bloom indicator, the researcher utilized CPA on a multiyear upper IRL data set of commonly measured environmental parameters separately and in combination, lagged and unlagged. According to the CPA, the strongest indicators of high Chlorophyll *a* are total phosphorus (with a probability of 0.950) followed by total nitrogen (0.715), whereas the lowest are water temperature (0.548) and salinity (0.552). However, studies have confirmed that the IRL has historically been nitrogen-limited. New CPA time series analyses are being completed to determine if a shift in limiting agents in the IRL to phosphorus has occurred recently, as such a shift would suggest a need to modify strategies for algal bloom control.

FLORIDA

Student(s): Jessica Olivier

Research Institution: Florida Atlantic University and FAU's Offsite Archaeological Facility Memorandum with the Sicilian Regional Government at Rocchicella di Mineo, Sicily

Lead Student Home Institution: Florida Atlantic University

Lead Student Home State: Florida

Faculty Advisers: Brian McConnell

Division: Arts and Humanities

Analysis of Archaeological Remains at Tre Portelle (Mineo, Sicily)

*Funding Agency: Summer Undergraduate Research Fellowship (SURF) | Study Abroad
Scholarship from the Department of Visual Arts and Art History*

This project focuses on the study and interpretation of the excavation results at the archaeological site of Tre Portelle, located in Mineo, Sicily. In 2007, Tre Portelle was explored systematically by the Soprintendenza di Catania in advance of the construction of wind turbines. Tre Portelle was once inhabited by the island's indigenous Sikel peoples. This complex existed at least from the Early Bronze Age (late 3rd–2nd millennia BC) (Nicoletti 1998). Sikel culture emerges politically in the fifth century BC with the foundation of a league of cities based at the Sanctuary of the Divine Palikoi by Douketios in Mineo. From the excavation journals and examination of recovered pottery fragments and reconstructed vessels, there is no indication of a clear Classical (5th–4th centuries BC) Greek presence. Nevertheless, Greek culture exerted a strong influence over this society in the Archaic period (7th–6th centuries BC), attested by the possible presence of a Greek pastas-type house found on site, Greek-style vessel- and tile-forms, and evidence of large amphorae trade (Dominguez 2006). Further exploration is needed in the immediate area of Tre Portelle to identify why the site seems to have been abandoned. The area may have been raided repeatedly or abandoned after an uprising of the Sikel league during the Classical era, or the Sikels simply may have continued the production of local pottery after the Archaic period. Rich in Greek pottery fragments, this dramatic location offers opportunities for determining the complete scale and chronology of its settlements.



FLORIDA

Student(s): Josephine Spiegelberg
Research Institution: Rollins College
Lead Student Home Institution: Rollins College
Lead Student Home State: Florida
Faculty Advisers: Christopher Fuse
Division: Physics and Astronomy

Formation of Ice Giant Satellites during Thommes Model Migration

Funding Agency: Rollins College Student-Faculty Collaborative Scholarship

Studies of planet formation provide a new perspective on the origins of both our own solar system and extrasolar planets. The current theory of planet formation, which hypothesizes that planets grow through the accumulation of material from the cloud of gas and dust from which the sun was formed, date back to Immanuel Kant in 1755. However, objects farther from the sun orbit more slowly, and it has since been found that, due to their extreme distances, Uranus and Neptune could not have grown to their current masses in their current orbits. Thommes and colleagues (1999) attempt to reconcile this inconsistency by positing that young Uranus and Neptune began forming on orbits between Jupiter and Saturn. Their theory proposes that complex gravitational fields from the giant planets caused Uranus and Neptune to be ejected to their current locations. Past investigations (Neville and Fuse 2011) have successfully simulated Thommes migration and reproduced both the configuration of planets in the outer solar system and the largest moons of Jupiter and Saturn. To further examine the effects of Thommes model migration on the formation of moons, multibody simulations of gravitational interactions within the Uranus and Neptune satellite systems were performed. The project found that the moons of Uranus were stripped from the planet during migration. The inability to replicate the Uranus moon system suggests limitations on the timing of Thommes migration. This research focuses on the simulation methods used along with the resulting trends in moon stability both in place and during migration.

GEORGIA

Student(s): Kara Heller
Research Institution: Kennesaw State University
Lead Student Home Institution: Florida Atlantic University
Lead Student Home State: Georgia
Faculty Advisers: Susan Mathews Hardy
Division: Mathematics and Computer Sciences

Marketing to Electric Vehicle Owners: A Win for the Environment, a Win for the Company, a Win for the Customer

As a corporate analyst intern for a local electric membership corporation, the researcher is passionate about minimizing the impact of electricity generation on the environment. To reduce peak usage of electricity, current research suggests spreading out major appliance usage and using programmable thermostats. In this study, the focus is on predicting which customers of an electric company own electric vehicles so that the company can market time-of-use plans to these customers to encourage them to shift their vehicle charging to off-peak hours. Such a move will reduce peak energy usage. When power generation is shifted to off-peak hours, additional higher-cost power generation facilities do not need to come online to meet peak demand, reducing the impact on the environment. In general, these additional higher-cost facilities also produce more pollution than base-load facilities. Thus, shifting power to off-peak times reduces environmental impact, the corporation's cost for electricity, and the cost for the customers who choose the time-of-use plan. Data was collected on 993 customers from the local company, with loglinear regression used to predict whether a customer has an electric vehicle. Descriptive analysis was then used to compute the average kilowatt hours saved if electric vehicle owners switch to time-of-use pricing. This research enables the company to estimate its savings and the customers' savings, as well as enables more effective marketing. This should reduce the number of generation facilities brought online at peak hours. Identifying electric vehicle owners and marketing time-of-use plans to them creates a win for the environment, the company, and the customer.



GEORGIA

Student(s): Jordan Teng | Michelle Jung
Research Institution: Mercer University
Lead Student Home Institution: Mercer University
Lead Student Home State: Georgia
Faculty Advisers: Sinjae Hyun | Scott Schultz
Division: Engineering

Touch3D Yearbook for the Blind

The blind and visually-impaired student population is severely lacking in physical resources that allow students to connect with their visually-abled counterparts. To solve this problem, the Touch3D™ Team from Mercer University created a 3D yearbook for the graduating seniors of the Georgia Academy for the Blind. The Touch3D™ Yearbook was designed to create realistic models of the students in a way that allows each graduate to visualize their classmates' faces when they touch the yearbook. This yearbook is the first of its kind in the world and an example of community-responsive engineering. The 3D yearbooks were created using a newly developed, five-step process: 3D scanning, 3D modeling, 3D printing, casting and molding, and assembly. The casting and molding process came directly from research into more efficient means of 3D production. This new process has reduced the manufacturing time by 88 percent. This project was designed to provide blind students with the ability to visualize their peers by their 3D-printed faces, comparable to how the visually-abled students can remember their peers' faces in a regular yearbook. Two generations of the 3D yearbooks have been produced for the Georgia Academy of the Blind, and the response has been overwhelming. The production manual for the Touch3D™ yearbook has been created and distributed to blind schools across the United States. The team has taught the production technology to North Korean refugees living in South Korea, so that they can produce these yearbooks for their local blind schools.

HAWAII

Student(s): Mackenzie Jahnke
Research Institution: Kapi'olani Community College
Lead Student Home Institution: Honolulu Community College, University of Hawai'i
Lead Student Home State: Hawaii
Faculty Advisers: Wendy Kuntz
Division: Biology

Student Scientists Provide Evidence of Successful Community-Led Restoration of Hawaiian Bay

Funding Agency: Louis Stokes Alliances for Minority Participation (LSAMP), National Science Foundation

Maunalua Bay, HI, has been adversely impacted by industrialization and the introduction of the invasive algae species *Avrainvillea amadelpha* (AA). In hopes of restoring Maunalua's health, the community group Malama Maunalua (MM) was formed, with the primary focus of removing the AA invasive algae. In 2009, a \$3.4-million grant was given to MM via the American Recovery and Reinvestment Act (ARRA) supporting the "Great Huki" in which 75 full-time workers were hired to remove more than 3 million pounds of algae. To maintain the progress ignited by the ARRA funding, a volunteer program was established. Students from Kapi'olani Community College (KCC) have participated in the program, collecting quantitative data on the removal effort. This study analyzed 10 years of data, collected by 20 classes of KCC students, for patterns and long-term trends in algae composition. Results show a dramatic reduction of the invasive AA in the bay, with coverage decreasing from 85 to 23 percent within the 10 years, whereas native populations increased by 25 percent. Findings show that the effort to reduce the invasive species has been an overwhelming success. The legacy of the ARRA grant has been sustained by the community and has led to a complete transformation of the bay. The improvements within the bay exemplify a new approach to ecological restoration, one in which it is understood that there are no quick fixes and consistent, prolonged community-based efforts must become the new standard.



ILLINOIS

Student(s): Rahul Kukreja

Research Institution: University of Chicago

Lead Student Home Institution: Mason Lab

(University of Chicago Department of Neuroscience)

Lead Student Home State: Illinois

Faculty Advisers: Peggy Mason

Division: Psychology

Rats Eating Together Increases Empathic Helping Behavior

Funding Agency: University of Chicago Neuroscience Department

Previous studies have shown that helping behavior in rats is driven by empathy and is specific to members of a rat's social in-group. Rats within an in-group can include different strains of mice, a feature that primarily depends on how much time these rats have spent with one another. Studies show that white-coated Sprague-Dawley (SD) rats will help black-caped Long-Evans (LE) rats over rats in their own strain if they have lived with LE rats and not SD rats. This information raises the question of what other ways besides living together exist to create these social in-groups. Other studies show that human strangers who have a short shared experience, such as playing a video game, will display greater empathy toward each other. It was hypothesized that allowing rats to have a shared experience, such as eating food, would serve as a facilitator to increase helping behavior. This was studied by putting different strains of rats together (SD and LE rats) and by determining the impact of eating food together on their helping behavior compared to the impact of having no food when put together for short periods of time. This study found that eating food together can predict the degree of helping behavior displayed by rats, regardless of the strain of the particular rat. The shared experience of eating food can serve as a facilitator to increase empathy and confer helping behaviors between two different strains.

ILLINOIS

Student(s): Sophie Rogers

Research Institution: University of Chicago

Lead Student Home Institution: University of Chicago

Lead Student Home State: New York

Faculty Advisers: Ming Xu

Division: Biology

Genetically Engineered Skin Graft-Derived Prevents Cue-induced Relapse to Cocaine

In the United States, cocaine-related deaths increase every year, and cocaine abuse takes a large economic toll on the country's health-care system. Risk of bingeing or overdose due to relapse precipitated by encountering a trigger such as touching drug paraphernalia—cue-induced relapse (CIR)—persists throughout abstinence due to neurological adaptations that link such cues with drug-taking. Recently, the peptide GLP1, involved in appetite-related behavior, has been effective at inhibiting many cocaine-related behaviors in rodents and may help prevent CIR. Furthermore, the Wu lab at University of Chicago developed a genetically engineered skin-graft designed to express and secrete a given peptide, in this case GLP1, into the bloodstream as an enduring, affordable, and safe therapeutic delivery system ideal for those with unpredictable lifestyles or recovery efforts. To see if skin-derived GLP1 (iGLP1) can prevent CIR to cocaine, mice were trained to nosepoke to obtain cocaine paired with a light cue. Drug and light cues were then withheld until they stopped nosepoking for them, or drug-seeking. After skin-graft surgery and recovery, mice underwent two sessions where the light cue was restored to trigger relapse. Encouragingly, when iGLP1 expression was turned on, relapse was significantly suppressed in all mice, even though they all relapsed strongly without iGLP1. The results demonstrate that iGLP1 can suppress CIR to cocaine in otherwise vulnerable individuals, providing hope for the first effective intervention for both addictions.



INDIANA

Student(s): Ashleigh Doub
Research Institution: Butler University
Lead Student Home Institution: Butler University
Lead Student Home State: Indiana
Faculty Advisers: Mary Gospel | Dacia Charlesworth
Division: Social Sciences

Analyzing Language Coherence Measures in Storytelling Discourse in English and ASL

There is no research studying language coherence in American Sign Language (ASL). Language coherence is crucial to communication and refers to relations between units of language that make the segments of discourse appear to be logical and consistent. The objective of this pilot study was to implement existing measures of language coherence used in English to ASL to assess the appropriateness and feasibility of applying these linguistic measures to a manual language. Participants ($n = 14$; 7 users of ASL, 7 speakers of English) retold a story from a wordless picture book. Responses were recorded, scored, and analyzed using both the global coherence scale of Wright and colleagues (2010)—which examines how an utterance, a segment of the language sample, relates to the theme of the topic being discussed on a scale of 1 to 4—and the local coherence scale of Glosser and Deser (1990)—which investigates how an utterance relates to the prior utterance on a scale of 1 to 5. Low scores on both scales indicate no relation, and high scores indicate a complete relation. Through a quantitative and qualitative analysis, the results of the pilot study indicate the language coherence scales, previously used exclusively for English, could portray ASL language coherence effectively. Additionally, it is necessary to consider the unique grammatical structures of ASL in future investigations of similar discourse. Most important, this study demonstrated how an advanced analysis of ASL could eventually lead to earlier diagnoses of language disorders in an underrepresented clinical population.

INDIANA

Student(s): Hannah Veldhuizen
Research Institution: Indiana State University
Lead Student Home Institution: Indiana State University
Lead Student Home State: Indiana
Faculty Advisers: Jennifer Latimer | Jeffery Stone
Division: Geosciences

Microplastics Ingested by Planktivores in the Wabash River from 1963 to 2010

Funding Agency: Center for Student Research and Creativity, Indiana State University

Microplastics, which are less than 5mm, are abundant in many freshwater ecosystems. Consequently, ingestion of microplastics has been reported in more than 600 aquatic taxa, with fish being the leading microplastic consumer. Previous studies have reported intestinal blockages and inflammatory responses in fish that have directly ingested microplastics. Although present-day microplastic ingestion by organisms is well known, little is known about the historical record of microplastic ingestion. This study seeks to investigate the abundance of microplastics in several species of fish collected from the Wabash River from 1963 to 2010. The University of Illinois's Prairie Research Institute and Indiana State University's Department of Biology fish archive collections include planktivores exclusively. Twenty-nine fish stomach samples were dissected and examined under a stereo microscope (50x–120x). The plastics that were identified were categorized using type (fragment, microfiber, film, pellet, and microbead), color, shape, and size (length or diameter). Microplastics were present in every sample, including 1963, showing that microplastic pollution has been a concern for aquatic life for the last 60 years. The three highest microplastic counts were found in samples collected after 2004, suggesting that microplastic pollution may be increasing. Of the samples analyzed, the most abundant microplastic color ingested was blue (38 percent), and the most abundant microplastic type ingested was microfibers (80 percent). The data obtained from this study will be used to construct a temporal record of microplastic ingestion and to understand how microplastic consumption varies spatially.



IOWA

Student(s): Emma Kelley
Research Institution: Iowa State University
Lead Student Home Institution: Iowa State University
Lead Student Home State: Kansas
Faculty Advisers: Heather Rouse
Division: Education

Head Start and Public School: An Investigation of Collaboration and Disconnection in Early Childhood

*Funding Agency: Office of Child Care, Administration for Children and Families, US
Department of Health and Human Services | Preschool Development Grant
Grant No.: 90TP0030-01-00*

Persistent achievement gaps for low-income children that start before kindergarten entry call attention to the need for quality early childhood experiences. Head Start (HS) is a federally funded preschool program that provides comprehensive services for low-income children and their families (< 185 percent FPL), including health, education, and parenting support. In Iowa, 18 grantees (i.e., agencies) serve approximately 6,500 preschool children across all 99 counties. Given increases in state-funded universal preschool, it is necessary to better understand how HS programs in Iowa collaborate with schools to best serve children. This study used data collected by the Iowa HS State Collaboration Office for a biannual needs assessment to examine collaborations among HS grantees, local education agencies, and other entities. Findings indicate that 70 percent of local school districts have no collaboration, coordination, or communication with HS grantees. Of the HS grantees that do report collaboration, 70 percent say it is “not at all difficult.” These findings provide rich opportunities for improving statewide collaboration and coordination among critical state partners in the provision of high-quality early childhood experiences for vulnerable children. Future research could examine how these relationships relate to later school readiness outcomes to further enhance quality improvement.

IOWA

Student(s): Kathryn Hays
Research Institution: Simpson College
Lead Student Home Institution: Simpson College
Lead Student Home State: Iowa
Faculty Advisers: Eduardo Magalhaes | Sharon Wilkinson
Division: Social Sciences

Effects of Disinformation Campaigns on Varying Electoral Systems

“To give everyone the power to create and share ideas and information instantly, without barriers,” reads Twitter’s mission statement. Social media was created to unite people around the world, promote intercultural communication, and improve access to information. Mark Zuckerberg and Jack Dorsey, among others, were not prepared to see their inventions exploited for political gain. The accessibility of information has created new problems for the future of society. Now, techniques have been developed to weaponize information while laws and policies remain unprepared to handle this technological advancement. This research compares the disinformation campaigns during the 2016 American presidential election and the 2017 French presidential election. After the Democratic National Committee (DNC) phishing attempts and publication of 58,000 emails from John Podesta in 2016, the DNC and the federal government struggled to respond effectively. Widespread distrust in the American media, severe polarization, miscommunication between governmental bodies, and a 1:1 candidate race amplified the effects of the disinformation campaigns. France was able to successfully minimize the impacts of these campaigns through government preparedness and other factors specific to French culture. For instance, a multiparty electoral system with a run-off election hinders information manipulators from effectively disseminating their misinformation. By comparing two democracies with different institutional mechanisms, a better understanding can be achieved on how elections are affected, and mechanisms can be devised to counter these attacks.



KENTUCKY

Student(s): Gloria Huang

Research Institution: Western Kentucky University

Lead Student Home Institution: Western Kentucky University

Lead Student Home State: Kentucky

Faculty Advisers: Richard Schugart

Division: Mathematics and Computer Sciences

Using 3D Geometry to Analyze the Most Influential Factors in the Treatment of Diabetic Foot Ulcers

The treatment of chronic wounds has long been a challenge to wound care professionals and presents a substantial economic burden to health-care systems globally. More than \$50 billion is spent on the treatment of chronic wounds each year, with the annual cost rising as chronic wounds are becoming more prevalent and difficult to treat. To combat this issue, a mathematical model describing the interactions among enzymes (MMPs), their regulators (TIMPs), and the extracellular matrix (ECM), which is the primary measure for the healing response in the wound, was developed and analyzed. Using the model with de-identified patient data, multiple statistical analyses were conducted to determine the most influential factors in the healing process of chronic wounds, specifically diabetic foot ulcers. It was determined that the most influential factors, or parameters, across all patients in the healing process were TIMP and ECM production rates. The three-dimensional geometry (of parameter space) was then visualized to more precisely see how these factors affect individual patients. Knowledge of these factors can, in turn, streamline the treatment of diabetic foot ulcers by allowing the prediction of the optimal data collection times for each patient.

LOUISIANA

Student(s): Ethan Naquin

Research Institution: Nicholls State University

Lead Student Home Institution: Nicholls State University

Lead Student Home State: Louisiana

Faculty Advisers: Ramaraj Boopathy

Division: Biology

Presence of Multi-Drug-Resistant Pathogens and Antibiotic Resistance Genes in Waterways and Seafood Populations of Rural Southeast Louisiana, USA

The spread of antibiotic resistance is a growing global concern in recent years. Improper usage and disposal of antibiotics by consumers, hospitals, and industries has furthered the emergence of antibiotic resistance in the waterways of southeast Louisiana—namely Bayou Lafourche and Bayou Terrebonne, a main source of drinking water for more than 300,000 individuals who live along its banks. Additionally, there are existing reports of exposure to antibiotic-resistant bacteria through direct contact with seafood. In Louisiana, one out of every 70 jobs is related to the seafood industry, and this region exports roughly 1 billion pounds of seafood each year at a value of \$2.4 billion. Although the implications of an increasing presence of antibiotic resistance in the rural environment is alarming, there are no studies dealing with this phenomenon in Louisiana or in the Gulf region. In this study, water samples were collected as well as samples from various species of freshwater fish and shellfish—common seafood caught in the area—and the occurrence of antibiotic-resistant bacteria was monitored. This survey of antibiotic-resistant bacteria and genes was accomplished using a Kirby-Bauer assay as well as PCR techniques for gene display. The results of this study show the presence of multi-drug-resistant bacteria exhibiting resistance to all antibiotics tested. Furthermore, the *su1A*, *su11*, *su12*, and *su13* genes (genes for sulfonamide drug resistance), as well as *tet(A)*, *tet(W)*, and *tet(X)* (genes for tetracycline drug resistance), were identified.



MARYLAND

Student(s): Gabrielle Voithofer
Research Institution: Salisbury University
Lead Student Home Institution: Salisbury University
Lead Student Home State: Maryland
Faculty Advisers: Jessica Clark
Division: Biology

MASSACHUSETTS

Student(s): Cailin Gonyea
Research Institution: Worcester Polytechnic Institute
Lead Student Home Institution: Worcester Polytechnic Institute
Lead Student Home State: Massachusetts
Faculty Advisers: George Pins | Jeannine Coburn
Division: Engineering

Finding Therapeutic Targets to Reverse Nerve Degeneration Associated with Diabetic Peripheral Neuropathy

*Funding Agency: University Student Academic Research Award (USARA) Research Grant
Henson Undergraduate Research Grant*

One of the most common complications associated with diabetes is diabetic peripheral neuropathy (DPN) that afflicts approximately 50 percent of diabetic patients. This progressive degeneration of peripheral nerves can result in a variety of symptoms, including pain, numbness, and muscle weakness. Because the manner in which DPN develops and progresses is unknown, no drug therapies currently exist to treat this disease. To better understand the way this damage occurs in patients that have diabetes, the researcher's lab established a novel model of DPN in zebrafish to explore underlying mechanisms of degeneration. Zebrafish are emerging as an excellent model of metabolic conditions. In the fish studied, the individual components of their nerves are fluorescent, and their skin is translucent; coupled together, the degeneration can be visualized as it occurs in the living fish using time-lapse microscopy. In the present work, a library of FDA-characterized drugs is used in an effort to prevent or reverse the degeneration usually seen. Many of the drugs used have been identified in previous studies for their potential to impact neurodegeneration in other models of nerve damage. Identifying the mechanisms responsible for peripheral nerve degeneration could lead to pharmaceutical therapies that could potentially halt further neurodegenerative effects from occurring and provide a degree of neuroprotection to patients suffering from DPN.

Novel Method of Enzymatically Crosslinking Fibrin Microthread Scaffolds to Tune Degradation Rate and Enhance Functional Skeletal Muscle Regeneration

Over half of all military combat wounds damage skeletal muscle tissue and can result in volumetric muscle loss (VML), when insufficient repair of damaged muscle results in scar tissue formation and loss of function. The current gold standard of treatment for VML is autologous tissue grafts; however, they often result in donor site morbidity, loss of muscle functionality, and infection. Thus, a clinical need exists for an implantable VML therapy that can promote functional skeletal muscle regeneration. Tissue engineered scaffolds are currently being researched as a way to provide mechanical support and direct cell alignment to promote functional muscle regeneration. The lab of the researcher pioneered the development of fibrin microthreads, a bioinspired scaffold shown to promote wound healing as well as cell growth and alignment. When implanted in vivo, however, their degradation rate was rapid and did not match the growth of new muscle tissue. This rapid degradation can be delayed through the use of crosslinking techniques, but existing methods have been unable to produce microthreads with desired mechanical properties, degradation rates, and cell viability. In this study, three novel methods of crosslinking fibrin microthreads were developed using horseradish peroxidase (HRP) and hydrogen peroxide (H₂O₂). After uniaxial tensile tests degradation assays and cell viability assays were conducted, it was demonstrated that HRP crosslinked fibrin microthreads had increased modulus and prolonged degradation rate while supporting cell viability when compared to the uncrosslinked control. In the future, the ability for HRP crosslinked microthreads to promote functional skeletal muscle regeneration can be further validated by conducting in vivo studies.



MICHIGAN

Student(s): Lauren Bergeron
Research Institution: Albion College
Lead Student Home Institution: Albion College
Lead Student Home State: Michigan
Faculty Advisers: Marcy Sacks
Division: Social Sciences

“This Insolent and Inhuman Race”: White Union Soldiers’ Thoughts about White Southerners during the Civil War Era

Funding Agency: Foundation for Undergraduate Research, Scholarship, and Creative Activity at Albion College

The Civil War was the United States’ bloodiest and deadliest war, with intense battles interspersed between long periods of boredom. To preserve the spirit and combat boredom, Union soldiers frequently wrote letters home and kept personal diaries. For many ordinary white Union soldiers, it was their first time in the South and their first time interacting with Southerners, both white and black. From reading scores of letters and diaries written by white Union soldiers located at the Library of Congress, Massachusetts Historical Society, and digitized collections, the researcher found that everyday white Northern soldiers were fascinated by white Southerners, to the point that they commented on the latter’s perceived character and behaviors in their diaries and letters home. Although there was often disdain, there also was frequent sympathy for poor white Southerners with the assumption that they had been duped into supporting secession by rich, slave-owning white Southerners. Research that has been completed regarding white Union soldiers’ understanding of the Civil War only takes into account white Northerners’ attitudes toward slavery and secession. However, this project analyzes comments made by white Union soldiers about white Southerners so as to better understand how white Union soldiers’ perceptions of white Southerners contributed to their overall understanding of the war. Additionally, this analysis helps communicate the depth of the division between the North and the South, revealing that it extended far deeper than politics or commitment to a cause. Rather, white Northerners and Southerners in many ways viewed themselves as culturally incompatible.

MINNESOTA

Student(s): Eryn Zuiker | Lindzy Nelson
Research Institution: Minnesota State University, Mankato
Lead Student Home Institution: Minnesota State University, Mankato
Lead Student Home State: Minnesota
Faculty Advisers: Michael Bentley | Kuldeep Agarwal
Division: Biology

The Interaction between Connective Tissue and Three-Dimensionally-Printed Sintered Cobalt Chrome Alloy

In a biological system, implanted medical devices must be composed of materials that are biocompatible with surrounding tissue. In this study, cobalt chrome (CC) is utilized due to its high biocompatibility and minimal immune reactivity. CC is sintered with Hydroxyapatite (HA), a bioactive material that is an essential component of normal bone and teeth. Alone, HA is highly biodegradable, which can result in clinical implant failure. Examined are the interaction of connective tissue (CT) and a CC/HA alloy, fabricated using a three-dimensional printer. One-by-two-by-four millimeter alloy pieces (50 percent HA, 50 percent CC) are inserted onto rat skulls through a small incision made via aseptic surgery. After six weeks, the implants and surrounding tissue are removed and observed by scanning electron microscopy. The implants are immunohistologically stained with Osteocalcin (Alexa Fluor 488) and Osteopontin (Alexa Fluor 647) and observed using confocal microscopy. The alloys are encapsulated by dense connective tissue continuous with the periosteum, which infiltrates into the spaces between the particles of sintered alloy to form a dense matrix. Osteopontin and Osteocalcin indicate the presence of new bone formation in the implants. These findings contribute to the advances being made in the science of medical implantation and the field of tissue engineering, and furthers understanding of medical device alloys used for dental, hip, femur, and other implantations.



MINNESOTA

Student(s): Ella Graham | Calli Clay
Research Institution: St. Catherine University
Lead Student Home Institution: St. Catherine University
Lead Student Home State: South Dakota
Faculty Advisers: Kristine Pelatt
Division: Mathematics and Computer Sciences

Finding Structure in Texts with Topological Data Analysis

Funding Agency: St. Catherine University Summer Scholars Program

The complex nature of language makes analyzing texts using computer algorithms challenging. Transforming a text into a data set involves changing lines into word count vectors. The number of lines in the text determines the size of the data set, and the number of words determines the dimension. Topological data analysis (TDA) is a subfield of mathematics that combines the study of shapes and analysis of high-dimensional data sets. Persistent homology, a common method from TDA that identifies voids of any dimension in data, has been used to group high-dimensional data points together, but has not been widely applied to text analysis. It was predicted that persistent homology could efficiently detect structure and aid in comparing texts. Texts were analyzed from two categories: 60 highly structured poems (villanelles and sestinas) and 25 rock and pop songs. The words in each line of text were counted via RStudio; these word counts were represented mathematically; and the distance was calculated between the points representing each line of text, based on the shared words in each line. Packages from RStudio were then used to calculate persistent homologies, represent them visually with barcodes, and find the distance between two barcodes. The distances between the barcodes of poems are smaller than that of songs, presumably because these poems have well-defined structures, and song lyrics do not. These results suggest that persistent homology effectively detects structure in forms of poetry and genres of music, laying the foundation for further comparisons between categories of texts.

MISSISSIPPI

Student(s): Clara Ellis
Research Institution: University of Southern Mississippi
Lead Student Home Institution: University of Southern Mississippi
Lead Student Home State: Mississippi
Faculty Advisers: Matthew Donahue
Division: Chemistry

Controlling Prescription Drug Costs through Increased Chemical Reaction Efficiencies

*Funding Agency: National Institute of General Medical Sciences, National Institutes of Health | 2019 Summer Undergraduate Research Fellowship, Division of Organic Chemistry, American Chemical Society | 2019 Ronald E. McNair PostBaccalaureate Achievement Program, University of Southern Mississippi
Grant No.: 1R15GM129751-01*

A major concern in the United States is the increasing costs of pharmaceutical medications in both the development stage and the time when that drug becomes available for dispensation to the public. The Food and Drug Administration (FDA) manages more than 20,000 pharmaceutical drugs approved to be marketed to the American people. A large number of these FDA-approved small molecule-based prescription drug therapies that treat a variety of ailments contain a nitrogen atom embedded within a carbon-based ring. The most common of these rings contains one nitrogen and five carbons called a piperidine that is arranged in a hexagonal structure. The purpose of this research is to efficiently produce a five-step synthetic pathway to creating a piperidine structure and begin investigating a way to polycyclize these piperidine compounds while substituting out different steps of the synthetic pathway. The biomedical research project at the University of Southern Mississippi was performed through a variety of synthetic pathways to form a molecule with the piperidine functional group. The major pathway steps of both an enyne metathesis reaction and a Pauson-Khand reaction were the main focus of the research. An enyne metathesis involves taking a double-bonded carbon-carbon alkene group and a triple-bonded carbon-carbon alkyne group and providing a catalyst to make the two functional groups close into the piperidine ring. The Pauson-Khand reaction also closes the piperidine ring; however, it forms another ring on the piperidine group, forming a polycyclic system. Magnetic resonance imaging was used to characterize the molecular architecture of the products.



MISSOURI

Student(s): Adrienne Skelton
Research Institution: University of Missouri
Lead Student Home Institution: University of Missouri
Lead Student Home State: Missouri
Faculty Advisers: Chad Rose
Division: Education

The Impact of Social and Communication Skill Intervention on Reducing Bullying Involvement

Bullying is a pervasive problem facing the nation's youth that impacts the social, behavioral, and academic functioning of those involved. Two of the most notable predictors of bullying involvement are social and communication skill deficits (Rose et al. 2019). It is critical for schools to implement programs and practices for social and communication skill acquisition to improve the lifelong outcomes of all youth, as well as reduce the likelihood of current and future bullying involvement. The present study was designed to reduce and/or prevent bullying involvement by identifying students in grades K-5 with social and communication skill deficits using a behavioral risk screener (i.e., SAEBRS; Kilgus et al. 2012) and providing them with a 10-week social and communication skill intervention in a small-group setting. Pre/post data were collected from all participants and their teachers with the aim of evaluating their involvement in bullying, as well as social, behavioral, and academic functioning. Initial analyses of pre/post data using a repeated measures MANOVA (i.e., mean level differences) revealed that students reported significant increases in prosocial behaviors, academic self-efficacy, and decreased victimization. Students' teachers reported increased prosocial behaviors, emotion regulation, and academic competence. These findings demonstrate the importance of implementing a skill-based intervention designed to improve the social and communication skill acquisition of school-aged youth as a vehicle for reducing bullying involvement and increasing academic, behavioral, and social functioning. This is especially germane for schools, because all 50 states and Washington, DC, have adopted legislation to address bullying among school-aged youth.

MONTANA

Student(s): Grace Ostermiller
Research Institution: Montana Technological University
Lead Student Home Institution: Montana Technological University
Lead Student Home State: Montana
Faculty Advisers: Peter Lucon
Division: Engineering

Improving the Efficiency of Vacuum Pumps/Air Compressors with Resonant Technology

Funding Agency: Montana Tech Undergraduate Research Program

Power generation devices operate using a variety of systems that must be controlled to maintain optimal efficiency. The purpose of this research was to increase the efficiency of an air compressor/vacuum pump by using resonant technology. A system is operating on mechanical resonance when the oscillation amplitude of the system is at a maximum and the input force, or power, is at a minimum. At resonance, little energy is lost because kinetic and potential energies are matched and out-of-phase, thus requiring minimal additional energy input. The research group purchased a vacuum pump and pulled a vacuum at 100, 200, 300, and 400 mmHg absolute pressures. It determined the average power and efficiency of the commercial system at each absolute pressure. The commercial vacuum pump was then modified to run on alternating current at resonance. The efficiency of the modified vacuum pump was tested by pulling the same pressure values and measuring the average power provided. The average power values from the purchased vacuum pump and the modified vacuum pump were compared. It was found that the alternating current resonant vacuum pump requires less power to achieve the same pressure as the off-the-shelf vacuum pump. The results of this research could bring to market a more efficient air compressor/vacuum pump running on alternating current at resonance.



NEBRASKA

Student(s): Hannah Way

Research Institution: University of Nebraska at Kearney

Lead Student Home Institution: University of Nebraska at Kearney

Lead Student Home State: Nebraska

Faculty Advisers: Allen Thomas

Division: Chemistry

Concentrative Nucleoside Transporter 2 Inhibitors Based on Ribavirin

Funding Agency: Undergraduate Research Experiences at Small Colleges and Universities, Nebraska Established Program to Stimulate Competitive Research (NE EPSCoR) | UNK Summer Student Research Program

Nucleosides have important roles besides their role within DNA, including signaling within biological pathways, and several drugs imitate their activity. To function, certain nucleosides must be transported into cells by the Concentrative Nucleoside Transporter 2 protein (CNT2). Since CNT2 is important in numerous physiological capacities, molecules that can interact with CNT2 could treat a variety of diseases. For example, molecules that block CNT2 (inhibitors), could have anti-inflammatory effects. Whereas, molecules that are transported into the cell by CNT2 (substrates), could treat viruses or cancers. A challenge of discovering nucleoside drugs is the difficulty in assembling the molecules. The research group has applied a highly efficient approach known as Click Chemistry, which involves chemically “clicking” together two different molecules to make a more complex one. The researchers hypothesized that the Hepatitis C drug ribavirin, which is known to bind to CNT2, would be an ideal template for preparing inhibitors using this approach. To test the inhibitors, the researchers engineered cells to exhibit high levels of CNT2 on their surface. It was discovered that modifying the molecular structure of inhibitors based on ribavirin dramatically affected their binding with CNT2. Specifically, larger groups of atoms had a stronger interaction with the transporter, which resulted in an 86 percent inhibition of CNT2 activity. In contrast, smaller ribavirin analogs were much less potent. The hypothesis was confirmed that ribavirin can serve as a template for designing potent CNT2 inhibitors that could be beneficial for treating inflammation related to nucleoside signaling as relevant in liver diseases.

NEW HAMPSHIRE

Student(s): Brianna McGrath

Research Institution: University of New Hampshire

Lead Student Home Institution: University of New Hampshire

Lead Student Home State: Rhode Island

Faculty Advisers: Gene Harkless

Division: Health Sciences

Professional Nurse-Led Unjani Clinics: Empowering the Nurse as a Primary Care Provider

Funding Agency: UNH Summer Undergraduate Research Fellowship (SURF) Abroad

South Africa, burdened by a wide wealth gap, meets the health-care needs of the 16 percent with health insurance but provides unreliable services for the 84 percent who are uninsured. Low-wage workers suffer from long public clinic wait times and poor quality care. In addition to the high cost of private providers, primary health care (PHC) is largely inaccessible (NEJM 2016). In 2013, the Unjani model launched to provide quality, affordable PHC to employed, uninsured families. Developed as a social franchise, Unjani aims to empower black women nurses as entrepreneurs and providers (Unjani Clinic NPC 2019). Although nurses are central to the Unjani model, there is no published research describing their experience. This study aims to identify the role of nurses as PHC providers as well as facilitators and barriers to participating in the Unjani model. A qualitative study, IRB/Unjani approved, using snowball sampling and semi-structured interviews of 10 Unjani nurses was conducted. The following themes were identified: engaging the community in and serving the community with PHC; moving from “employed nurse” to empowered entrepreneur; assuming the risk and benefits of practice autonomy; creating a sustainable PHC service that drives local economic development; and feeling a sense of pride in achieving high-level, autonomous practice as a highly-skilled Unjani nursing network colleague. These results suggest that Unjani nurses are invested, motivated, and proud to serve their community as they grow a profit-generating, high-quality PHC business. Furthermore, the nurse-led Unjani model may be a powerful answer to global challenges in primary-care access and quality.



NEW JERSEY

Student(s): Michael Mitrane | Akash Patel

Research Institution: The College of New Jersey

Lead Student Home Institution: The College of New Jersey

Lead Student Home State: Pennsylvania

Faculty Advisers: Donald Hirsh

Division: Chemistry

Virus-Inspired Gene Delivery to a Marine Microalga

Funding Agency: National Science Foundation | Grant No.: 1923297

Emiliania huxleyi is a single-celled, photosynthetic marine alga that thrives in the global ocean except at the poles. The distribution and abundance of *E. huxleyi* make it an essential part of the marine food web, and its importance makes it critical to understand how it will respond to a changing climate. One way to understand how an organism functions is to modify its DNA. Genes, which are composed of DNA, hold the blueprint to a cell's structure and response to environmental conditions. To date, no scientist has been able to modify the DNA blueprint of *E. huxleyi*. Nature, however, has found a way to accomplish this. Viruses that attack *E. huxleyi* enter the cell and insert their genes in order to replicate. Specific lipids in the membrane that envelops the virus are crucial to the entry of the virus into the cell. Using lipids similar to those found in the viral envelope, the researchers have been successful in delivering and transiently expressing a fluorescence reporter gene within *E. huxleyi*. The goal now is to deliver this gene to the nucleus of these cells so that it will be stably expressed over many generations. This will require a better understanding of how these lipids interact with the plasma and nuclear membranes. Reported here are the initial investigations using confocal microscopy and fluorescence spectroscopy.

NEW JERSEY

Student(s): Danielle Junio | Andrew Diaz

Research Institution: Kean University

Lead Student Home Institution: Kean University

Lead Student Home State: New Jersey

Faculty Advisers: Dongyan Mu

Division: Health Sciences

A Comparative LCA of Bok Choy Growing in Hydroponics vs. Aquaponics in New Jersey

The persistent population growth in urban areas is one of grand challenges of human beings in the twenty-first century. Increasingly, city dwellers live in food deserts where they must travel long distances to obtain fresh and nutritious food. To increase fresh food supply in cities, many community gardens were established and selected the water-based farming facilities such as hydroponics and aquaponics to grow vegetables in favor of their features that can reduce land use and water use. However, those water-based farming facilities have not been well studied in terms of life-cycle environmental impacts and consequences. In particular, there are questions related to water-based food production. Which water-based technique is best in terms of environmental performance? How can the design be improved to reduce resource use and environmental and human health impacts of those facilities? To fill this knowledge gap, project researchers conducted a comparative Life Cycle Assessment (LCA) to quantify resource use, environmental effects, and human health impacts of Bok Choy growing in two water-based community farms (one uses hydroponics, and one uses aquaponics) built in densely populated areas in New Jersey. The study involved both on-site data collection and software modeling with SimaPro 8 for conducting LCA. The scope for analysis covered all the impacts in facility establishment, vegetable production, and their supply chains. The LCA results of hydroponics and aquaponics were compared to determine the suitable technique for Bok Choy production.



NEW MEXICO

Student(s): David Arnot

Research Institution: Sandia National Laboratories

Lead Student Home Institution: University of New Mexico

Lead Student Home State: New Mexico

Faculty Advisers: Kiyoko Simmons | Timothy Lambert

Division: Engineering

Development of Alkaline Zn/MnO₂ Batteries for Grid Energy Storage

Funding Agency: Office of Electricity, US Department of Energy | Sandia National Laboratories | Grant No.: DE-NA0003525

Increasing awareness of climate change and pollution give powerful incentives for the integration of renewable energy onto the electrical grid. However, renewable energy technologies must be coupled with grid-scale energy storage due to their inherently intermittent power generation. Rechargeable Zn/MnO₂ batteries can fulfill this need because of their low-cost, high-energy density and environmental compatibility. Common household single-use batteries use Zn/MnO₂, but researchers have made them rechargeable under limited circumstances. One obstacle to rechargeability is that electrochemically inactive products form when zinc crosses from anode to cathode. Slowing down zinc crossover is key to making the system viable for long-term energy storage applications. Polymeric separators were developed to impede zinc crossover while maintaining low resistance inside the battery. Zinc crosses these separators up to 40x slower than current separator technology by utilizing size and charge screening. Different reactions are enabled when zincate is sequestered to the anode compartment, resulting in increased capacity, energy density, and cycle life. The views expressed in this abstract do not necessarily represent the views of the US Department of Energy or the US government.

NEW YORK

Student(s): Aedan Raleigh | Ivory Moore | Mathew McAuliffe

Research Institution: Siena College

Lead Student Home Institution: Siena College

Lead Student Home State: New York

Faculty Advisers: Ruth Kassel

Division: Social Sciences

Wealth Building and Community Ownership in the South End

The South End neighborhood in Albany, NY, is deeply rooted in structural oppression and lack of food access. Over the past few years, businesses have struggled to implement a sustainable economic model that can address food apartheid, as well as other public health-related issues that stem from being food insecure. Based upon previous research, a cooperative grocery store model was identified by its potential to be most effective in anchoring wealth in the South End. In conjunction with AVillage, a nonprofit based in the South End that is collaborating with individuals and organizations across the Albany area, this study will test which grocery store economic model would be most sustainable for the neighborhood. Using a comparison of successful cooperative grocery store models nationally and preexisting markets in the neighborhood, as well as direct community input on needs and resources, the research will develop a potential framework for the basis of a South End cooperative grocery store. The goal is that this model for a food cooperative will be used for future economic developments not just for food injustices but other concerns in the South End as well.



NORTH CAROLINA

Student(s): Duncan Anderson
Research Institution: Brookhaven National Laboratory
Lead Student Home Institution: North Carolina State University
Lead Student Home State: North Carolina
Faculty Advisers: Angela Burnett
Division: Biology

“Feeling” the Heat: Remotely Sensing Crop Temperature Response to Drought and Fruit Removal Stress

Funding Agency: Office of Workforce Development for Teachers and Scientists (WDTS), Office of Science, US Department of Energy

Given current trends of consumption and waste, it is estimated by the UN Food and Agriculture Organization that global food production will need to increase by 60 percent within the next 30 years. To cultivate crops that are both highly productive and able to withstand stressful environmental conditions, plant physiologists seek successful individuals and their associated traits that improve their survival. Plant spectroscopy and infrared (IR) radiometry are two tools for health monitoring and trait identification that allow for high-throughput testing without using destructive sampling. Plant spectroscopy is the study of examining the energy reflected by plants to determine their traits and health, whereas IR radiometry remotely senses temperature, indicating when crops are expressing higher temperature indicative of drought stress. Both methods were used to evaluate the response of zucchini (*Cucurbita pepo*) to drought stress and continuous fruit removal at the leaf and canopy level in a field setting at Brookhaven National Laboratory. Spectroscopy allowed for the detection of crop drought stress before visual detection by showing reduced crop reflection of infrared light, a key range of the electromagnetic spectrum for plants. IR radiometry detected and quantified drought stress, identifying when crops affected by drought were experiencing water stress significantly different from controls—a useful tool when regions around the world are facing increased average temperatures. The successful deployment of these technologies in a field setting further develops spectroscopy use for agricultural research and thermal remote sensing use for drought detection by farmers.

NORTH DAKOTA

Student(s): Alexandria Hamm
Research Institution: Minot State University
Lead Student Home Institution: Minot State University
Lead Student Home State: North Dakota
Faculty Advisers: Mikhail Bobylev
Division: Chemistry

An Improved Method of Synthesis of a Key Precursor for Multitarget Drugs against Alzheimer’s Disease

Funding Agency: North Dakota IDeA Network of Biomedical Research Excellence (ND INBRE), National Institutes of Health | North Dakota Established Program to Stimulate Competitive Research (ND EPSCoR), National Science Foundation
Grant No.: 8 P20 GM103442-12 | 1355466

Alzheimer’s disease is a neurodegenerative disease that predominately affects the elderly and is characterized by memory loss and cognitive impairment. To date, there are more than 47 million people with dementia worldwide, and the total estimated worldwide cost of dementia is \$818 billion. The number of people affected is estimated to increase to 131.5 million by 2050. Alzheimer’s disease patients experience pathological changes such as amyloid-beta peptide deposits, tau protein aggregation, oxidative stress, and low levels of acetylcholine. Most medications on the market only address the low levels of acetylcholine with acetylcholinesterase inhibitors that block the breakdown of acetylcholine. These medications have been used for decades and do help improve memory and cognitive function; however, they cannot prevent, halt, or reverse the progression of the disease. In the past decade, a variety of new multitarget ligands for the treatment of Alzheimer’s disease was described in the literature. These compounds, while remaining primarily acetylcholinesterase inhibitors, address other aspects of Alzheimer’s disease, including beta-amyloid aggregation. Interestingly, the most active compounds in all of the studies are based on N-ethyl-N-(2-methoxybenzyl)amine, which also serves as the starting material for their synthesis. Currently, N-ethyl-N-(2-methoxybenzyl)amine has a limited availability as a custom made reagent. In this work, an improved method for the synthesis of N-ethyl-N-(2-methoxybenzyl)amine via N-ethyl-N-(2-methoxybenzyl)formamide was developed. The new method is simple, fast, and produces little to no waste. The new method provides an easier access to N-(2-methoxybenzyl)amine and thus can facilitate the synthesis of novel, multitarget drugs for the treatment of Alzheimer’s disease.



OHIO

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Lead Student Home Institution: Wright State University
Lead Student Home State: Ohio
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Division: Physics and Astronomy

Advanced Terahertz Frequency Waveguides

Funding Agency: National Science Foundation | Grant No.: 1742339

Terahertz (THz) frequency radiation spans from 100 GHz to 10 THz on the electromagnetic spectrum in between microwave and infrared light. There are currently only a few uses of THz technology outside of lab settings, including nondestructive imaging and analysis of materials and coatings, sensors in airport security installations, and characterization of pharmaceuticals. This frequency band is particularly useful because it is non-harmful (non-ionizing) due to its low energy. However, there are also a wide variety of materials that exhibit relative transparency at these frequencies, including plastics, coatings, paper, and clothing. Terahertz light can also be used to identify or “fingerprint” materials. Industry and commercial use have been limited due to the challenges of creating, detecting, and controlling the radiation. The focus of this study deals with the last issue. There are few effective ways in guiding terahertz frequency radiation that allows for high throughput over a large bandwidth of frequencies. Traditional fiber optic cables and waveguides that work for other parts of the electromagnetic spectrum do not work at these frequencies. Although lenses and mirrors work, they are incredibly sensitive, fragile, and prone to malfunction. A waveguide’s purpose is to direct emitted light waves in a specific propagation direction and to minimize energy losses. If efficient and effective waveguides were realized, terahertz-based applications could be advanced. This project aims to improve the applicability of THz frequency light by investigating the feasibility of hollow helical metallic waveguides by a combined utilization of simulation, fabrication, and experimental testing.

OKLAHOMA

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Lead Student Home Institution: University of Central Oklahoma
Lead Student Home State: Oklahoma
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James Legge: A Powerful Global Citizen

Funding Agency: RCSA (Research, Creative, and Scholarly Activities) Grant

The origins of the political dissatisfaction in Hong Kong today are rooted in the British occupation of the area that began with the Treaty of Nanking (1842), which gave Hong Kong to the British Empire for trade with Chinese merchants. This treaty allowed merchants and missionaries from Britain to settle in China. Among them, the Scottish missionary James Legge (1815–1897) understood the connection among print, ideas, and social change, and promoted this through his mission printing press in Hong Kong. Legge demonstrates that language is the carrier of culture, as he placed great importance on translating Chinese religious texts and comparing them to Christian works. Although Legge is known best for his translations of Confucian works into English and his appointment as the first chair of Chinese at Oxford University, his activities in Hong Kong are less well understood and clearly illustrate how the growth of English literacy became central to the imperial projects of the past and the state of political and social unrest in Hong Kong today. This research is based on archival documents held at the School of Oriental and African Studies, London and the Bodleian Archives, Oxford.



OREGON

Student(s): Rennie Kendrick
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Lead Student Home State: Oregon
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Division: Psychology

Identification of Learning Conditions That Promote Connections Across Related Information to Derive New Knowledge

Funding Agency: O'Day Fellowship in the Biological Sciences

Innovative thinking requires learning information that is directly taught and then connecting this information to generate new knowledge. This research asks: Which instruction methods encourage students to generate knowledge? In an educational setting, generation of new knowledge is advantageous for both the student and society. For example, a student may learn a formula for sine functions in calculus and then, a week later, learn in physics that light waves are sine waves. While in physics, the student may recall characteristics of sine waves learned in calculus and generate knowledge about properties of light waves that was never directly learned. This process deepens the student's understanding of both physics and calculus. In this study, the experiments measure participants' ability to generate knowledge in two different learning conditions. In one learning condition, participants see several repetitions of one set of information before exposure to a second set of information that is related to the first set. In the second learning condition, participants see alternating repetitions of the two sets. Importantly, participants see the same number of repetitions of information sets in both learning conditions. Participants were tested on their memory for information they directly studied and on their ability to combine related information to derive new knowledge. It was found that participants better learn and generate new knowledge after strongly learning one information set before their exposure to a set of related information. These findings indicate that instruction order can promote connections across material without an increase in instruction time.

PENNSYLVANIA

Student(s): Madison Wojciechowski
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Lead Student Home Institution: The Pennsylvania State University
Lead Student Home State: Pennsylvania
Faculty Advisers: Marietta Scanlon
Division: Engineering

The Use of Advanced Additive Manufacturing Techniques to Design, Optimize, and Characterize an Orthopedic Support

Recent advancements in additive manufacturing technologies have allowed for the customization of medical devices, particularly in the area of orthopedics, with examples such as arm casts. Problems with traditional arm casts include skin irritation, limited breathability, and excessive weight. Additive manufacturing, also known as 3D printing, in tandem with 3D scanning, allows designers to create custom casts based on a patient's specific anatomy. 3D scanning allows the user to create a digital 3D picture that can be modified on the computer, and 3D printing allows a user to build an object by laying plastic layers on top of each other until the final part is created. In this study, the 3D-scanning process was optimized using a low-cost scanner integrated with iPad Pro. The 3D scan was modified in a sculpting-based modeling software called Meshmixer to create a customized arm cast. Design variations were created in the software and printed on multiple 3D printers. The resulting 3D printed cast provided less bulkiness, more breathability, waterproof capabilities, and a custom-fit design. To further optimize the design, different materials will cause an impact in the properties of the cast. Multiple materials were tested in two different strength tests to compare the properties of materials that could be used to 3D print the cast.



PUERTO RICO

Student(s): Gabriel Cruz | Victoria Cotto
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Lead Student Home Institution: University of Puerto Rico at Cayey
Lead Student Home State: Puerto Rico
Faculty Advisers: Patria López de Victoria
Division: Social Sciences

Structural Holes in the Medical Emergency System after Maria

Funding Agency: National Institute on Minority Health and Health Disparities, National Institutes of Health | Grant No.: 1R21MD013701-01

Already facing a crisis in public health, Puerto Rico was struck by Maria, a category 4 hurricane in 2017. Two years after Hurricane Maria, the medical community continues to report deficiencies in the emergency management system and the preparedness for another natural phenomenon. Although Maria disrupted the standard procedures to which medical and governmental officials were accustomed, very little in the way of change in roles has been observed. Analyzing the shift in roles immediately after Maria, health-care professionals located in a mid-sized town in the interior of the island encountered situations in which they were forced to “stretch” their roles and resources as health professionals. This poster analyzes qualitative interviews with 19 health-care professionals two years post-Maria. After Maria, this community served as brokers—or as links among groups, information, and/or resources (Cheung, McColl-Kennedy, and Coote 2017)—during both medical and nonmedical emergency events. The application of a grounded theory framework (Bryant and Charmaz 2017; Charmaz 2015), revealed structural holes in the network of health officials, which this community had to bridge to provide resources and support to the community. These findings shed light on the multiple roles assumed by the participants in the aftermath of the storm and could help identify connections needed in the medical community in light of more recent catastrophic events. The data inform first-year results of a two-year project to understand how the elderly seek help and solve problems related to health and illness in Puerto Rico after Maria.

SOUTH CAROLINA

Student(s): Jeremy Evans | Cassidy Smith
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Lead Student Home Institution: Coastal Carolina University
Lead Student Home State: South Carolina
Faculty Advisers: Sharon Thompson
Division: Health Sciences

Effects of Social Media Browsing on Suicidal Thoughts Among Undergraduate Students

Funding Agency: Kenneth E. Swain Scholarship

Beginning around 2011, there have been increases in mental health issues among teens and young adults. A possible reason for this rise has been the growth of social media through electronic communication; therefore, this study examined social media usage and suicide among undergraduates. An online survey was developed and, after Institutional Review Board approval, was completed by 506 undergraduates (67.9 percent female, 32.1 percent male) at 23 higher education institutions in the Southeast and Midwest. Among these undergraduates, it was found that 24 percent thought about suicide in the past year, and 4.2 percent had actually attempted to kill themselves. Those who considered killing themselves in the past year were significantly more likely to feel the need to compare themselves to others when browsing social media ($p < 0.0001$), felt their life was worse than others based on what they saw on social media ($p < 0.0001$), and had feeling of sadness or suicidal thoughts after browsing social media ($p < 0.0001$) compared to those who had not thought of suicide. Undergraduates who had attempted suicide in the past year were more likely to feel their self-image was negatively affected by interaction with social media websites ($p < 0.05$) and also had feelings of sadness or suicidal thoughts after browsing social media ($p < 0.05$) compared to those who had not attempted suicide. Females were more likely than males to report negative effects of browsing social media ($p < 0.001$). These significant associations between suicidal thoughts and social media usage should be studied further to better devise health education and advocacy campaigns among this population.



SOUTH CAROLINA

Student(s): Piper Powell
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Lead Student Home Institution: Furman University
Lead Student Home State: South Carolina
Faculty Advisers: Erin Wamsley
Division: Psychology

To Listen or Not to Listen: Factors That Influence the Individual Impact of Background Music on Learning

*Funding Agency: National Science Foundation | Furman University Research Fellowship
and Adviser's NSF and BIAL Foundation Grants | Grant No.: 1849026*

College students are often told that listening to music while studying has been definitively shown to hinder their ability to learn effectively. However, methodological concerns in prior studies on this topic may limit their applicability to students. This project sought to correct those methodological concerns in order to determine whether, and for whom, background music is detrimental to learning. Thirty participants read two texts, one in silence and one while listening to their personal study playlist, and then completed immediate and delayed tests on their memory for the texts. Characteristics of the participants and their music, including extraversion, musical background, and the presence of lyrics, were measured to examine their roles in the impact of music on learning. Contrary to prior research, no significant effect of music on learning was found. However, higher extraversion was significantly associated with higher test scores for material studied with music playing. This may indicate that, for extraverted students, music provides an outlet for their natural desire for high-stimulus environments, allowing them an improved focus when studying. Whether lyrics were present in participants' study music, how arousing that music was to them, and whether they had formal music training had no significant influence on the effect of listening to their background music on their learning. This study's findings suggest that the current assumption that music hinders learning may be incorrect or overly simplistic. Further research into individual factors that could determine whether music is a benefit or a detriment to individual students is recommended.

TENNESSEE

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Lead Student Home Institution: Lipscomb University
Lead Student Home State: Tennessee
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Division: Chemistry

Finding Polymer Membranes for Gas Separation with Computational Models

*Funding Agency: Research Experiences for Undergraduates (REU), National Science
Foundation | Grant No.: 1852160*

Gas separation is a valuable process that purifies gases for industrial and medical purposes. Separating pollutant gasses from atmospheric gas also shows potential for reducing carbon emissions. However, current gas separation techniques are costly in regard to energy, financial investment, and the environment. As such, many chemists are studying polymer membranes as a more effective gas separation tool. Polymers are composed of repeating subunits termed monomers. A polymer membrane for separating gases would act as a filter, allowing only one type of gas to pass through. However, there are countless types of polymer membranes and a few ways to determine each polymer's potential utility for gas separation. The objective of this project was to develop a model to predict a polymer membrane's ability to let a specific gas pass through, measured by its permeability coefficient. The model was trained with approximately 70 polymers. Each polymer's monomer structure was introduced to the model along with its known permeability coefficients for nitrogen (the predominant atmospheric gas), oxygen, carbon dioxide, and methane gases. The monomer structures were represented in one of three molecular fingerprinting formats: a persistence image, a bag-of-bonds array, and a Coulomb matrix. In addition, several computational algorithms were tested to optimize the prediction performance. Ultimately, persistence imaging coupled with a neural network algorithm produced an accurate model predicting permeability coefficients. If applied to a larger data set, this model could predict polymer permeabilities, drastically changing future polymeric research and directing scientific advancement toward viable polymer membranes for gas separation.



TEXAS

Student(s): Daniel Quispe
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Lead Student Home Institution: Lamar University
Lead Student Home State: Texas
Faculty Advisers: Cristian Bahrim
Division: Physics and Astronomy

Increasing the Efficiency of Solar Cells in Coastal Areas

Funding Agency: Lamar University's Office of Undergraduate Research and the McNair Scholars Program

The sun is an ideal energy source to generate electric power. Solar energy is scarcely used in coastal areas because weather conditions greatly affect the efficiency of solar farms. To determine the efficiency in energy conversion during certain adverse weather conditions such as heavy cloud coverage or sustained winds and find methods to mitigate the energy loss, weather conditions were simulated in a controlled environment and compared with outdoor measurements. Air blowers were used to simulate sustained winds, and nitro-steam was used to simulate different cloud coverage, to which ashes and colorants were added to mimic various levels of pollution and controlled opacity of clouds. The results showed that sustained winds drop the efficiency of the photo-voltage by 4 percent. The changes in the opacity of the cloud coverage drops the photo-voltage by 20 percent, whereas spreading ashes in simulated clouds with nitro-steam drops the photo-voltage by 27 percent. It was observed that the recovery of solar cells from low temperatures to standard values for improving the efficiency in energy production of photo-power during the daylight is done much faster when the temperature drop is greater. The solar cell stability in electric energy production is analyzed under intense vibrations, using a platform set up to frequencies close to its resonance frequency. This particular study indicates a drop in efficiency by no more than 8 percent. The results provide the solar energy research community with solutions on how to mitigate the effects of weather conditions and how to make solar cells more efficient.

TEXAS

Student(s): Isabella Osuna
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Lead Student Home Institution: Rice University
Lead Student Home State: Texas
Faculty Advisers: Dereth Phillips | Tiphonie Vogel
Division: Biology

Inhibition of Signal Transducer and Activator of Transcription 3 (STAT3) Gain-of-Function (GOF)

Funding Agency: Rice Owl Edge Experience Summer Fund and Sustaining Excellence in Research (SER) Scholars Program

Cytokines are molecules that circulate in blood and provide communication between cells of the immune system to orchestrate responses to infections. Cytokines signal to cells in a step-wise fashion using an intracellular cascade called the JAK-STAT pathway. Cytokines activate receptors on cells that then activate JAK proteins, which then activate STATs. STATs are transcription factors that regulate the expression of immune genes. STAT3 is activated by different cytokines to regulate genes involved in inflammation. There are rare patients with mutations in STAT3 that lead to overactivity of these genes; this leads to an overwhelming autoimmune disease called STAT3 gain-of-function (GOF) syndrome. Patients with STAT3 GOF syndrome are treated with immunosuppression to dampen their overactive immune systems, but this has variable outcomes. JAK inhibitors can block STAT3 activation by upstream inhibition of the signaling cascade. It was hypothesized that JAK inhibitors could be a targeted treatment for patients with STAT3 GOF syndrome. The ability of three JAK inhibitors—tofacitinib, ruxolitinib and baricitinib—to decrease the JAK-STAT cascade in cells from patients with STAT3 GOF syndrome was tested. The cells were stimulated using the cytokine interleukin-21 and inhibited with the different JAK inhibitors. RNA from the cells was then quantitatively analyzed for the STAT3 target gene SOCS3 using real-time PCR. Tofacitinib, baricitinib and ruxolitinib were all effective at inhibiting STAT3, as shown by decreased SOCS3 transcript. Ongoing work is being done to determine if STAT3-specific inhibitors will be similarly effective as JAK inhibitors and therefore offer another new therapeutic option for these patients.



TEXAS

Student(s): Sara Heridia
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Lead Student Home Institution: Trinity University
Lead Student Home State: Texas
Faculty Advisers: David Crockett
Division: Social Sciences

Returning to Normalcy: The Perils of Restoration Politics

*Funding Agency: McNair Scholars Program | Mellon Initiative
Grant No.: P217A170223*

According to the presidential leadership theory of “political time,” presidents face different leadership opportunities depending on the point in a political era when they take power. Regime builders (Franklin Delano Roosevelt, Ronald Reagan) institute a new political era with a new political agenda for the dominant party and for future presidents associated with that regime. Opposition presidents (Dwight D. Eisenhower, Bill Clinton) oppose the dominant party but are forced to play by its rules. Within this schema, a new type of presidential category was identified: the “restoration president.” Restoration presidents come to power after an opposition president, tasked with restoring the political agenda of the regime builder. Previous restoration presidents include James K. Polk, William McKinley, Warren G. Harding, and John F. Kennedy. This analysis focused on the George W. Bush presidency, seeking to understand how it fitted into this restorative pattern. Bush operated as a regime affiliate trying to advance the agenda established by Reagan. However, he came to power after an opposition party interlude (Clinton) and had the task of restoring Reagan’s agenda. It was determined that Bush matched quite closely the pattern set by previous restoration presidents in attempting to further the Reagan agenda yet pushing too far in the process, leading to partisan dilemmas such as those created by Hurricane Katrina and the Iraq War that could result in the eventual collapse of the regime and the rise of a new political order. Understanding Bush as a restoration president helps clarify the present era, including the restoration presidency of Donald Trump.

UTAH

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Lead Student Home State: Michigan
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Division: Mathematics and Computer Sciences

A Mathematical Model of West Nile Virus: The Effects of Passive Immunity in Birds and Vertical Transmission in Mosquitoes

West Nile virus (WNV) is a mosquito-borne illness that has spread across the globe due to circulation among birds. This disease has resulted in thousands of infections and deaths in the United States alone. Several studies suggest that passive immunity in birds and vertical transmission in mosquitoes play a crucial role in the spread of the disease. Passive immunity is the passing of resistance to a disease from the recovered adult population to their young, and vertical transmission is the passing of a disease from an infected adult population to their young. A mathematical model was developed to investigate the effects of passive immunity and vertical transmission within the disease dynamics. Passive immunity is a key factor that has been overlooked in the current literature. The model simulates the real-world phenomena of WNV that can assist mosquito abatement centers nationally. Simulation results suggest that passive immunity increases bird resistivity to WNV and that vertical transmission among mosquitoes increases the spread of WNV. Moreover, it is expected that this model will be used by mosquito abatement centers to estimate the populations of immune birds and to simulate disease outbreaks of humans in the local community. The abatement centers can then utilize the simulation to choose effective strategies to control the spread of the disease in their area.



UTAH

Student(s): Kirsten Barker | Laurana Roderer
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Lead Student Home Institution: Utah State University
Lead Student Home State: Utah
Faculty Advisers: Christopher Scheer
Division: Arts and Humanities

Collaboration and the Environment: Music as a Model for Social Change

Funding Agency: Undergraduate Research and Creative Opportunities Grant | Blue Goes Green Student Sustainability Mini-Grant | Honors Research Fund

The collaborative nature of music, where individual action is essential to the success of the whole, provides a model that can affect viewpoints on climate change. This model has already been utilized in global environmentalist movements such as Greta Thunberg's Fridays for Future. The collaborative approach taken in the creation of new pieces of music can be used to address climate change. A chamber opera for three voices and string quartet was commissioned that addresses the systemic issues surrounding the global climate emergency. The collaborative process involved in this project addressed the reconciliation of the abstract nature of music and the technical jargon associated with scientific concepts. Opera can highlight and expound on the dramatic message of a text and also enhance its emotional undercurrent. For centuries, the powerful and elite considered opera to be a "high art" form because of these communicative abilities. By turning this context on its head, the researchers used the genre to comment on the consumption-based systems that have led to and perpetuated the current climate crisis. This is especially relevant given the traditionally close ties between the fossil fuel industry and the fine arts in the United States (for example, the long sponsorship of New York's Metropolitan Opera by Exxon-Mobil). In focusing on the idea of collaboration, this new piece of music becomes an exemplar of the efforts required to create a sustainable world.

VERMONT

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Lead Student Home Institution: Norwich University
Lead Student Home State: Florida
Faculty Advisers: Thomas Shell
Division: Chemistry

Development of Cobalamin Drug Conjugates as Trojan Horse Molecules for Drug Delivery

Funding Agency: National Institute of General Medical Sciences, National Institutes of Health | Vermont Genetics Network | Grant No.: P20GM103449

Radioactive and fluorescent cobalamin (vitamin B12) derivatives have been demonstrated to target multiple tumor types. In addition, vitamin B12 is a necessary nutrient for cognitive function. Fluorescent vitamin B12 derivatives were shown to be able to cross the blood brain barrier (BBB). Therefore, the cobalamin platform was proved to be versatile. It can be used to target a variety of tumors as well as to ferry drugs into the brain for potential treatment of neurodegenerative disease. Light-activated compounds provide a platform to allow spatiotemporal control of drug delivery, thereby reducing the side effects of traditional chemotherapy. There have been prior examples of light-activated therapy; however, the light required to release these drugs does not effectively penetrate skin or tissue. A cobalamin platform was developed in which the wavelength of release of drugs can be tuned with near infrared wavelengths (NIR), which is known as the region of light that penetrates tissue the most deeply. This platform can selectively target areas of interest, as cobalamin has been shown to be selective for a variety of tumor types as well as to cross the blood brain barrier (BBB), and can release the drug with light to treat various types of cancer and neurodegenerative diseases such as Parkinson's disease. Due to the ability to control the activation of the drugs, side effects should be minimized by reducing off-target interactions of the active drug. This technology would allow for more precise treatments.



VIRGINIA

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Lead Student Home State: Virginia
Faculty Advisers: Elizabeth Ackley
Division: Social Sciences

A Temporal Analysis of Collective Efficacy and BMI-for-Age in Roanoke City Youth

*Funding Agency: Center for Community Health Innovation
Roanoke College Pathways Program*

The social determinants of health reflect the context in which people live (e.g., family income, education attainment, family culture, and access to resources), and have significant implications on health outcomes in the United States. Authors have recently focused their attention on collective efficacy (CE) as an important social determinant of health. A form of social capital that relates to the willingness of community members to work together to reach mutual objectives, CE in low levels of CE has been associated with high rates of obesity in adults and adolescents; this relationship has not yet been explored in children. Given that 42 percent of children in Roanoke, VA, currently classify as overweight or obese, the purpose of this study was to explore the relationship between CE and BMI-for-age in Roanoke city elementary school students using data from the 2017 and 2019 Roanoke Valley Community Healthy Living Index. Geographic Information Systems (GIS) were used to explore spatial patterns between CE and BMI-for-age across Roanoke's diverse neighborhoods. Whereas a significant relationship was found between CE and BMI-for-age in 2017 (indicating that, as CE increased, BMI-for-age declined), the pattern did not persist in 2019. From 2017 to 2019, both CE and BMI-for-age estimates improved. Clear spatial patterns emerged, however, suggesting that neighborhoods with greater CE displayed lower rates of childhood obesity. In this first-known study to explore spatial relationships between CE and health in youth, findings indicate a need for ongoing research.

WASHINGTON

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Lead Student Home State: Washington
Faculty Advisers: Grady Blacken
Division: Biology

Probing the Probiotic Proteome: Biomarkers of Bacterial Survival in Various Compartments of the Human Gut

In recent decades, there has been massive growth in consumer demand for products containing live bacterial cultures or probiotics, driving a \$75 billion market. Yet, even as market share has expanded, the relative effectiveness of different probiotic products is still not fully understood. Such products require further scientific substantiation before manufacturers can claim their health benefits. Few studies have been conducted on how wide-ranging and adverse conditions in the gastro-intestinal tract can influence ingested probiotic culture function and viability. This research attempts to close this knowledge gap, providing a formal method of characterizing bacterial function under various gut conditions through the identification of biomarkers that are indicative of healthy probiotic cultures. *L. Bulgaricus*, *L. Acidophilus*, and *S. thermophilus* cultures were evaluated after exposure to conditions simulating major components of the gastro-intestinal tract, their protein expression analyzed and correlated with growth. Simulated colonic conditions maximized bacterial growth, while simulated gastric conditions minimized it. The validity of the experimental model was thus reinforced, as it accurately reflected previous in-vivo analysis of bacterial growth in different components of the GI tract. By linking growth and protein expression, the gene, *oppa1*, was identified as a possible biomarker of cell growth. This gene, activated in conditions that conferred substandard growth relative to a positive control, seems to present a key to understanding bacterial population health. This research presents a step forward in the evaluation of the quality of various probiotic products by understanding the influence of the human digestive system on live cultures.



WASHINGTON

Student(s): Katriel Sahlstrom
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Lead Student Home State: Alaska
Faculty Advisers: Kraig Wheeler
Division: Chemistry

Overturning Established Amino Acid Crystalline Patterns

Funding Agency: National Science Foundation

Grant No.: DMR 1904651 | CHE 1827313

Medical, biochemical, and material sciences alike depend on the understanding of amino acids, small and seemingly simple structures assembled directly from genetic code. From intricate protein structures folded from amino acid chains to revolutionary chemical materials with advanced functions, the study of these basic molecules is essential for current and future advancements. This study provides a foundational understanding of the assembly of amino acids in chemical structures. Combining pairs of chemically unique amino acids of opposite handedness with a secondary oxalic acid molecule during recrystallization produces a unique crystalline framework. This creates an efficient space to investigate the molecular shape of amino acid assemblies and their impacts on the functionality of neighboring molecules. Analysis of these crystalline materials using single-crystal X-ray crystallography has allowed an intimate view of how these molecules uniquely assemble at the atomic level. Outcomes from this study have opened doors to a deeper understanding of amino acid behavior, including improvements in technological and industrial materials with specific chemical functions as well as biological advances in protein assembly and deformation. This study overturns established hypotheses about the preferences and capabilities of amino acid recognition and leads to shifting perspectives on the structural behavior of biomolecules and chemical materials.

WEST VIRGINIA

Student(s): Megan Lauris
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Lead Student Home Institution: West Virginia University
Lead Student Home State: West Virginia
Faculty Advisers: Samantha Minc
Division: Health Sciences

Understanding Diabetes- and Vascular Disease-Related Amputations in West Virginia

Funding Agency: National Institute of General Medicine Studies,

National Institutes of Health | Grant No.: 5U54GM104942-04

West Virginia has higher rates of diabetes and vascular disease-related amputation than the rest of the country. In addition, there is significant variation in the risk for amputation across the state—for example, the area of residence matters. Using state-level hospital data, high-risk zip codes for amputation were identified, and that information was used to recruit participants for a qualitative study that would explore the barriers faced by both patients and providers in preventing amputation. Focus groups and interviews were conducted with vascular providers, vascular surgeons, and wound care providers as well as with patients who have undergone amputation for diabetes and/or vascular disease. The audio recordings from each session were transcribed and analyzed to identify themes within the focus groups and interviews. The most common theme for both providers and patients was lack of education. Major barriers found in these areas included lack of transportation and rural cultural differences. Patients and providers agreed that health-care costs, access to care, and care coordination were major obstacles. Providers stressed that patient adherence to recommendations was a large barrier for their care. In addition, patients and providers identified three main risk factors relating to patient care: depression, diabetes, and tobacco use. This analysis concludes that amputation prevention should involve improvements in education, improvements in care access and options, as well as culturally sensitive approaches to rural health-care. This information will be used to create a community-based intervention to inform and engage West Virginians in high-risk areas and prevent amputation.



WISCONSIN

Student(s): Emily Finger | Evan Lundeen | Jacob Erickson
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Lead Student Home Institution: University of Wisconsin–Eau Claire
Lead Student Home State: Wisconsin
Faculty Advisers: Sarah Vitale | J. Brian Mahoney
Division: Geosciences

Assessment of the Source and Mobility of Phosphorus in the Hydrologic System in Western Wisconsin

*Funding Agency: University of Wisconsin Groundwater Research and Monitoring Grant
University of Wisconsin Water Resource Fellowship | UW–Eau Claire Kell Container Corporation Scholarship | UW–Eau Claire Student-Faculty Collaborative Research Grant*

Lake eutrophication due to nutrient loading from phosphorus or nitrogen is a growing problem across the upper Midwest. Societal and economic costs are severe, including a loss of recreational tourism, damage to fisheries, a loss of biodiversity, and adverse impacts on human health. Eutrophication is generally blamed on anthropogenic nutrient inputs to the surface water system from agricultural and wastewater sources; however, results from this investigation suggest that the bedrock may also add a significant amount of naturally-sourced phosphorus to the groundwater system. The primary objective of this investigation is to distinguish the source of phosphorus contamination in surface water and groundwater in western Wisconsin and understand the mechanisms behind phosphorus mobility in the regional hydrologic system. The project includes a regional analysis of surface ($n = 45$) and municipal well groundwater ($n = 15$) samples in western Wisconsin to determine a baseline spatial phosphorus distribution and constrain possible phosphorus sources. The samples are measured for phosphorous, iron, manganese, and nitrate, as well as basic water quality parameters, to obtain a more complete understanding of the geochemical environment. Results demonstrate groundwater phosphorus concentrations frequently exceeding the Wisconsin surface water regulatory limit (max 100 ppb) and that phosphorus is highly mobile along flow pathways into lakes and streams. Therefore, this research is important in developing a comprehensive understanding of phosphorus migration in Wisconsin's regional hydrologic systems to implement effective lake and waterway management.

WISCONSIN

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Lead Student Home State: Wisconsin
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Division: Education

Learning the Write Way: Using Writing to Improve Student Conceptual Understanding in Biochemistry

Writing to Learn has been used as reinforcement of conceptual understanding across all grade levels and multiple disciplines. This research is applied to a general biochemistry course to deepen the understanding of three main concepts taught in this course. Four main constructs are embedded into the research: a meaning-making writing task, clear writing expectations, interactive writing practices, and reflections on past work. A meaning-making writing task puts the student in the position of the expert for the course material and presents this to a target audience. The interactive writing practices for this research give the students an opportunity to participate in a peer-review process. After the peer-review process has taken place, the students can reflect on their past work by resubmitting their revised writing assignment. This research was applied over four semesters based on three main concepts taught in general biochemistry. The methods applied rotated three different possible applicable conditions: lecture alone, writing assignment alone, and a lecture followed by a writing assignment. The writing assignments, peer-review comments, and exams were scored based on a standard rubric. The scores given were used to evaluate the comprehension of course material based on the condition applied. Preliminary data shows the application of lecture followed by a writing assignment surpasses the other two conditions. Writing to Learn is an inclusive strategy that can be applied across all disciplines. This strategy enhances retention of students in STEM fields, leading to an increase of STEM graduates.



WYOMING

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Division: Geosciences

Geochemical Analysis of Fossil Oysters as Proxy for Late-Eocene Basin Relationship

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The Tajik and Tarim sedimentary basins in central Asia were once connected as part of the Paratethys Sea, which covered much of central Asia and Europe during the early Cenozoic era. These two basins were connected during the middle Eocene epoch but were then separated by the northward progression of the Pamir Mountains. Sedimentary evidence shows that the Tajik-Tarim connection was severed by approximately 38 million years ago. This separation should be chemically recorded in the shells of invertebrates living within the basins at that time. Since shelled invertebrates incorporate oxygen isotopes into their shells during secretion, they offer a snapshot of the nearby water chemistry. By comparing these oxygen signals from shells found within each basin, the relationship of the basins can be examined. If shells found within both basins share similar oxygen values, it can be inferred that the basins were still connected during at least the lifetime of the organisms. However, if the values differ drastically, there can be no connection inferred. To test this hypothesis, fossilized marine oysters (*Sokolowia buhsii*) were collected from two localities within the Tajik basin and analyzed for their stable oxygen isotope composition. The oxygen isotope results were then compared to a similar study, using the same species and age of fossils, conducted in the neighboring Tarim basin. Preliminary results indicate that the oxygen isotope values from the Tajik basin are much lower than values found within the Tarim basin. These results indicate that the Tajik-Tarim connection had been severed by the late Eocene.



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