Summer Research Symposium

Summer Faculty-Student Collaborative (SCoRe) Research Presentations

FRIDAY, OCT. 6, 2017
3:30–5 p.m.

EDITH KINNEY GAYLORD CORNERSTONE ARTS CENTER

SCHEDULE
Faculty-Student Summer Collaborative Research Symposium

Friday, Oct. 6, 2017
Edith Kinney Gaylord Cornerstone Arts Center

3:30–4:05 P.M. THE SCREENING ROOM

Opening Remarks
Jill Tiefenthaler, President of the College
Sandi Wong, Dean of the College

Student Presentations on their Collaborative Research

Asheton Gilbertson '18
"Burning Transformations: How Fire Impacts Nutrient Cycling Along Rocky Mountain Hillslopes"

Harper Sherwood- Reid '18
"With Senses on Full": Michel Serres and David Foster Wallace

Nathan Goodman '19
"When Forever cComes, We Will Be here": A Policy Perspective on Indigenous Cultural Resource Management in the Pikes Peak Region

CORNERSTONE MAIN SPACE

Poster Presentations

4:10-4:35 P.M.	Poster & Portfolio Session 1	Abstracts P1-P35/T1
4:35-5 P.M.	Poster& Portfolio Session 2	Abstracts P36-P70/T2

Welcome to the fourth annual Summer Faculty-Student Collaborative Research Symposium (SCoRe), bringing our community together to recognize the many hours of research conducted by Colorado College students and their faculty mentors.

The symposium includes short presentations, poster sessions, and conversations across the disciplines, allowing participants a window into the experiential and deep learning that summer research at CC provides. Supporting these student experiences is central to our mission at Colorado College, and many liberal arts skills take root through this opportunity.

Critical thinking; the ability to communicate clearly in writing and speaking; comfort with complexity and ambiguity; and sorting, organizing, and analyzing information are all skills that will create the nimble and adaptable leaders of the future. Studies tell us that students who take part in these sorts of experiences are more likely to thrive in their careers and lives, no matter the discipline they chose to pursue.

This symposium is an opportunity to acknowledge great work, thank the faculty who provide invaluable mentoring, celebrate the impact of our summer research program, and encourage the students whose passion for learning inspires us every day.

I am grateful to the Andrew W. Mellon Foundation for supporting summer research fellowships in the humanities and humanistic social sciences, and the Office of the Dean of the Faculty for supporting our SCoRe program and organizing this special event.

Best regards,

JILL TIEFENTHALER

"The scientific process often functions best as a community process. Teams of scientists brainstorm appropriate scientific questions and the ways to best answer those questions, and teams cooperate to collect, analyze, and interpret scientific data. So much more can be accomplished by several minds and hands than by one. Student/faculty collaborative research is how I build a scientific team. The students begin as trainees, but they become my colleagues. The process simultaneously develops students as scientists and produces a rich intellectual community for me."

LORI DRISCOLL, professor, Psychology

What is SCoRe?

from **EMILY CHAN**
associate dean of academic programs and strategic planning
associate professor, Psychology

During the summer of 2017, over 120 students participated in research under the mentorship and support of Colorado College's dedicated faculty both on and off campus. The goal of the Summer Collaborative Research Program is to provide enriching, engaging, and supportive summer opportunities for student research and co-curricular development. SCoRe supports both students and faculty through academic and community field trips and gatherings, peer-to-peer presentations and discussions, and professional development workshops.

While the block plan structures academics around a compressed schedule, summer research allows both students and faculty to delve deeper into topics and spend extended-time researching- in the classroom, the library, the lab, and the field. We are excited to showcase the work our students have done. The program is one of the numerous opportunities to students to enhance their academic experience at CC.

Visit: **www.coloradocollege.edu/studentfunding/**.

STUDENT PRESENTATIONS

Burning Transformations: How Fire Impacts Nutrient Cycling Along Rocky Mountain Hillslopes

Student Researcher: Asheton Gilbertson '18
Major: Environmental Science: Integrated
Faculty Collaborator: Rebecca Barnes, Environmental Program

Comparing soil samples and water extractable organic matter (WEOM) between burned and unburned sites illustrates the impact of fire: burned soils have ~50% organic matter (OM) content as unburned soils. In addition, while the amount of WEOM in burned soils was smaller, it has a lower C:N ($p<0.02$) than unburned soils. This suggests the available organic matter is more biodegradable by microbes and helps explain previous results that showed that soil organic matter in burn scars was more bioavailable ($p<0.001$) than in reference soils. Further, comparing results from intact soil column experiments to soil extractions and stream samples, suggests that the majority of this soil derived WEOM does not make it to the stream, potentially getting sorbed deeper in the mineral rich, organic poor, portion of the soil column.

"With senses on Full": Michel Serres and David Foster Wallace

Student Researcher: Harper Sherwood-Reid '18
Major: Comparative Literature
Faculty Collaborator: Corinne Scheiner, Comparative Literature

Corinne Scheiner's study in the last several years has largely focused on David Foster Wallace and interpretations of his immense body of work. In recent times, her study has turned towards representations of the sensory beyond the visual in Wallace's work, especially in "Infinite Jest." This sensory consideration of "Jest" ultimately led Scheiner to the texts of Michel Serres, a French philosopher interested in vast swaths of philosophic topics between the metaphysical and technology. This project takes as its object the points of intersection and diversion between Serres' text "Les Cinq Sens" ("The Five Senses") and "Jest." This project seeks to understand both Serres and Wallace by reading critical texts around the works of both authors, investigating the surroundings of the subjects so as to understand the subjects themselves. This project results in two texts that propose that Serres allows for a reading of Wallace beyond the hegemony of vision.

"When forever comes, we will be here": A policy perspective on Indigenous cultural resource management in the Pikes Peak Region

Student Researcher: Nathan Goodman '19
Major: Southwest Studies
Minors: Latin American Studies and Environmental Issues
Faculty Collaborator: Santiago Guerra, Southwest Studies

Indigenous peoples' claims to ancestral lands in the Pikes Peak Region are moderated through a complex, multi-lateral policy network that often fails to account for traditional world views. Research explores tribal consultation – both theoretically and *in praxis* – in depth, along with a comprehensive analysis of problems intrinsic to intergovernmental cultural resource management. Additionally, the projects examine the best methods practices, interrogates notions of 'meaningful consultation' and 'creative mitigation', and explores means of engaging more effectively in a 'bicognizant' worldview. Methodologically, this research is based on over thirty interviews with local, state, federal, and tribal policy actors and extensive fieldwork on the Southern Ute Reservation. Seldom does academic literature consider the implications of Indigenous displacement on cultural resource management in far-away places. This research seeks to break that trend, encourage a more open dialogue, and catalyze attitudinal reform in the Pikes Peak Region.

Modeling NTE Materials Under High Pressure and Temperature

Student Researcher: Sohair Abdullah '19
Major: Physics: Comprehensive Major
Faculty Collaborator: Phillip Cervantes, Physics

Zirconium tungstate has a negative coefficient of thermal expansion under certain increasing temperatures. We study this phenomenon by subjecting the material under high pressure and temperature and measuring the corresponding energy band gaps of the material. We also explore its optical and magnetic properties under high pressures and temperatures. We try to explain our results using lateral modes of vibrations and other possible methods.

Immigration Policy and Activism on the U.S.-Mexico Border

Student Researcher: Audriana Alvarado '18
Major: Anthropology
Minor: Spanish Language
Faculty Collaborator: Christina Leza, Anthropology

Collaborating with professor Christina Leza to assist her in manuscript research, focusing on policies, activism, and Indigenous peoples' identities and rights. We traveled to Tucson, AZ to conduct interviews. While in Tucson I also interned at a non-profit organization that she was studying, so I provided her with weekly updates from the internship while gaining my own experiences. At the organization, I was responsible for office assistant roles, advertisement, grant writing, website updates, and event planning. Along with all of this, I was also focusing on my own research in which professor Christina helped me organize. I was conducting interviews for my senior Anthropology thesis on how distance from the U.S./Mexico border affects the discrimination of Spanish-speaking women workers. It was a collaboration of her work for her manuscript, interning, and conducting research for my thesis.

Colorado's Prison Population 1878-1940

Student Researcher: Samuel Andrew '18
Major: History
Student Collaborator: Eviva Kahne '18
Faculty Collaborator: Carol Neel, History

My research project aimed to explore the demographics of Colorado's prison population in the decades following its founding. I hoped to see how closely the prison population of those years resembled contemporary population figures. Relying primarily on warden's reports, I charted the Religions and birthplace of Colorado's prisoners in two year intervals from 1878-1940, omitting some years due to lack of data. The data that caught my interest was birthplace data. I found there was a large number of foreign inmates in the prison's early years, but that this number dissipated in the early 20th century. This has lead me to further explore the American carceral history of these different foreign populations. I have also looked at how race was represented in the prison, and found that historically Colorado seems to have historically incarcerated black Americans at rates not unlike those seen today.

The Laboratory of Behavioral Neurotoxicology

Student Researchers: Paige Anton '18 and Katelin Teigen '18
Major: Neuroscience
Faculty Collaborator: Lori Driscoll, Psychology

The gut microbiome is a rich population of over 300 trillion bacteria, fungi, and viruses that reside in the gastrointestinal tract and assist in physiological processes such as digestion, secretion, and even neurological function. One route of communication between the gut and the brain is through the vagus nerve; however, the extent to which the gut microbiome depends on the vagus for this communication is unknown. A healthy balance of bacteria in the gut produces beneficial behavioral effects. This healthy balance can be achieved through probiotic supplementation. Specifically, the probiotic *Bifidobacterium infantis 35624* produces the precursors to serotonin in the gut--a neurotransmitter that greatly influences anxiety. To assess the potential anxiolytic effects of *B. infantis 35624*, we severed the vagus nerve in male and female rats, supplemented them with *B. infantis 35624* for three weeks, and then subjected them to the Elevated Plus Maze, Marble Burying Task, and Social Interaction Test to assess anxious behavior. We expect that rats supplemented with *B. infantis 35624* will exhibit significantly fewer anxious behaviors than control rats, and that this effect will be vagally dependent.

Longitudinal Assessments of Educational Programs

Student Researcher: Joann Bandales '19
Majors: Education and Psychology
Faculty Collaborators: Mike Taber, Education, and Emily Chan, Psychology

This study aimed to conduct longitudinal assessments for two educational programs: Colorado Academy's REDI-Lab and Colorado College's Bridge Scholars Program (BSP). The REDI-Lab is a newly implemented program designed for engaging students in design thinking with regards to self-regulated learning. To assess the program, quantitative and qualitative measures were collected from REDI-Lab participants through pre- and post-questionnaires and learning journals, respectively. Analysis of pre- and post-data indicates that the program participants felt less distracted from plans and thought of their work ethic as different from their peers. The four major themes that emerged from their learning journals were a) self-regulation, b) time, c) educational system, and d) unstructured writing. Assessment for the BSP had not officially started, as the primary focus was to design a longitudinal study in order to best holistically examine the program. A two-year study design had been created in order to do this, with results coming in the 2019-20 academic year.

Emotion, Cognition, and Embodiment: Controversies in Interdisciplinary Research

Student Researcher: Kate Barnes '19
Major: Independently Designed Major: Cognitive Science
Faculty Collaborator: Rick Furtak, Philosophy

This summer, I was tasked with making the index for Rick Furtak's forthcoming book. The book, called Knowing Emotions, treats our emotions as an epistemic faculty. In it, Professor Furtak explores the way in which our various moods illuminate various aspects of the world to us. Caringly, he acknowledges that all of these aspects are true to the world, revealed to us through our emotions rather than projected onto the world by us. For me, the picture he paints calls for a new science of sorts, one that isn't limited to examining only the measurable, third-person qualities of our world but also looks at the "value-qualities" we know through our subjective outlook. Simply, it's true that "things" can have "psychical," not just physical, properties. Thus, after finishing the index and assisting Professor Furtak with his presentation at the International Society for Research on Emotions (ISRE) Conference, these topics segued naturally into a project on Panpsychism, the theory that everything has some aspect of mind. Still ongoing, our co-authored paper argues that taking the epistemology of emotions seriously means taking Panpsychism seriously as well.

Teaching Activities for Physics Inclusion Research (T.A.P.I.R.)

Student Researcher: Kobi Bhattacharyya '20
Major: Physics
Faculty Collaborator: Natalie Gosnell and Barbara Whitten, Physics

A persistent problem in the field of physics is the underrepresentation of women and minorities. One factor that significantly affects the number of women that enter the field of physics is the idea of "stereotype threat." Stereotype threat exists in environments where individuals may subconsciously fear conforming to stereotypes about their social group when performing a certain task. In the case of physics, women and minorities may experience stereotype threat, as they stereotypically perform worse in Science, Technology, Engineering and Mathematics (STEM) classes than their white male counterparts. This project focuses on the diversification of traditional physics problems in order to reduce the impact of stereotype threat. This was accomplished by using real world applications, diverse role models, and relatable ideas in the context of each problem.

Time and Temperature Effects on Graphene Oxide's Filtration Capacity with Rhodamine dye

Student Researcher: Marshall Brace '18
Major: Chemistry
Faculty Collaborator: Amanda Bowman, Chemistry and Biochemistry

Carbon-based materials, such as graphene oxide, have recently been discovered to have potential as effective water filters for heavy metal cations and natural dyes. Experiments were performed to test the extent to which the age of the material and temperature of its environment affects the ability of graphene oxide to filter contaminants. In filtration experiments, rhodamine dye was used as a model contaminant, and it was stirred with graphene oxide powder varying in age and temperature conditions (at 0°C, room temperature, and 50°C). UV-VIS spectrophotometry was used to analyze the amount of dye that was filtered out. Over 8 weeks, graphene oxide lost a significant amount of its filtration capability, with a drop of 14% in the amount of dye filtered out after 7 weeks. No such change was observed by varying the temperatures of the filtration environment. This data suggests that even when not in use, graphene oxide will lose functionality over time.

Lesser Bushbaby (Galago moholi) Gum Feeding and Ecological Factors Influencing Fum Exudation from Acacia Trees in the Loskop Dam Nature Reserve, Mpumalanga Province, South Africa

Student Researcher: Claire Bresnan '19
Major: Organismal Biology and Ecology
Faculty Collaborator: Krista Fish, Anthropology

Gum from various species of Acacia trees, particularly *Acacia Karoo*, comprise a significant portion of the winter diet of the Lesser Bushbaby (Galago senegalensis). Sampling was done in Loskop and Leshiba Nature Reserves in the Mpumulanga and Limpopo provinces of South Africa in July and August 2017. Tree density, number and species of Acacia, number of Karoo, and DBH ranges were taken in 25 by 10 meter plots randomly selected in each reserve. Plots containing gum exuding from trees were compared to those without signs of gum feeding using an unpaired t-test. Plots with signs of gum feeding had a significantly greater number of Acacia, particularly Acacia Karoo. The exact mechanisms of gum extraction used by Bushbabies and the ecological factors that impact Bushbaby selection are still largely unknown.

Habitat Use and Cone selection of the North American Red Squirrel (*Tamiasciurus hudsonicus*)

Student Researchers: Beck Brooks '18 and Olivia Frey '18
Majors: Organismal Biology and Ecology
Faculty Collaborator: Marc Snyder, Organismal Biology and Ecology

The North American red squirrel (*Tamiasciurus hudsonicus*) is found throughout North America where mixed conifer forest are present. The red squirrel stores cones in middens, allowing for survival in the winter and spring. Therefore, protection of middens and territory is key in the survival of red squirrels. Middens are comprised of cone species in the squirrel's home range. Understanding cone availability in these forests is an important aspect of examining red squirrel cone selection. It is not known what proportion of *T. hudsonicus*' diet is made up of cones from trees in close proximity to middens. This study focused on identifying middens, their size, and several qualitative environmental conditions. By analyzing the proportion of cone species in middens and respective tree species in the surrounding area more is known about cone preference and selection. Data shows a significant selection Ponderosa and Spruce cones ($p<0.05$). Future research is necessary in determining the cause of the selection seen.

Testing for Tamarix Shade Intolerance in Fountain Creek

Student Researchers: Keirsten Brown '18 and Anna Wermuth '19
Major: Organismal Biology and Ecology
Faculty Collaborator: Shane Heschel, Organismal Biology and Ecology

Invasive plant species pose a serious threat to the health of an ecosystem, as they generally out compete native species for resources, and are resilient to changing environmental conditions. *Tamarix ramosissima* (tamarisk) is an invasive plant species that grows in arid riparian areas throughout the Southwestern United States, where groundwater is scarce. Tamarisk extends a tap root deep into the water table and exhibits very high water use, making it a concern for native plants and humans alike. As chemical and physical removal of tamarisk has either proved ineffective or detrimental to the surrounding ecosystem, other management strategies are needed. Based on the observation that tamarisk produces far fewer flowers in the shade, our study investigates how changes in the plant's light environment can alter its functional traits, and therefore its fitness, providing a potential solution for managing tamarisk population with canopy cover. We measured transpiration, photosystem efficiency, chlorophyll content index, and flower number of a population of tamarisk in both open and shaded light environments along Fountain Creek in Fountain, CO. We speculate that plants in shaded environments will exhibit lower performance and fitness. This study could provide the beginnings of a new strategy for mitigation of *Tamarix ramosissima* populations.

Exploring Flow Hydrogenation for Key Step in Synthesis of Potential New Drug Targets

Student Researcher: Samuel Brown '18
Major: Chemistry
Faculty Collaborator: Amy Dounay, Chemistry and Biochemistry

Cyclic N-aryl hydroxamic acids have few published syntheses accessible to smaller drug-discovery labs, despite strong promise shown by the functional group towards numerous pharmaceutical applications. Recent work in our laboratory has focused on utilizing flow hydrogenation for green, safe preparation of N-aryl hydroxamic acids. Flow hydrogenation is a new, advanced, and safe technique for performing reactions which require hydrogen gas, such as the synthesis of N-aryl hydroxamic acids. However, existing flow methods require the use of additives for optimal results. This research will report on the development of greener processes in the high-yield synthesis of cyclic N-aryl hydroxamic acids. Under our revised reaction conditions, the reactant is designed to facilitate the desired reaction by forcing the spatial orientation of reactive groups closer together. Preliminary results highlighting our improved reaction conditions will be reported.

"No Man Dares to Walk the Earth Alone": African Resistance, War, and the Law on Hispaniola, 1520-1550

Student Researcher: Brittany Camacho '17
Major: Classics/History/Politics
Research Collaborators: Kim D. Butler and Walter C. Rucker (Rutgers, The State University of New Jersey)

Narratives concerning the presence and role of African populations on Hispaniola remain hidden in the contemporary historical tradition. This is due to the historiographical tradition, noted by Erin W. Stone, of the island acting as an "antechamber" to the conquest of modern-day central and Latin America. By treating the Spanish conquest and occupation of Hispaniola as an ultimately inconsequential step in the establishment of the Spanish empire, the flourishing and multi-faceted society that existed on the island in the sixteenth century is lost to history, and its African populations reduced to nonexistence. This project focuses on African *cimmaróns*, runaways from enslavement, on Hispaniola and their greater role as historical agents in the Black Atlantic and Spanish Caribbean. Beginning with the rebellion by Senegambians on Diego Colón's sugar *ingenio* on Christmas Day, 1521, the resulting paper will examine a dichotomous thirty-year period of resistance and attempts at suppression of African *cimarróns* to understand the development of society through established and evolving laws on Hispaniola. Dialogues concerning three *cimarrón* leaders (Sebastian Lemba, Diego de Ocampo, and Diego de Guzman) in particular will shed light on the definitive role that African *cimmarónaje* played in shaping society in sixteenth-century Hispaniola. It is the hope that this project will facilitate further analysis and dedicated scholarship concerning the influential African populations of the Atlantic World.

Electric Field Control of Optically Detected Magnetic Resonance Signals of Charge carriers spin states in organic thin-film capacitors

Student Researcher: Kenneth Crossley '19
Major: Physics: Comprehensive Major
Research Collaborators: Doug Baird, Adnan Nahlawi, Hans Malissa, and Christoph Boehme (Department of Physics and Astronomy, University of Utah)

Organic spintronics is a technology utilizing quantum electron spins (magnetic orientation of electrons) for information processing, rather than the flow of electrons in conventional electronics. The realization of this technology could lead to cheaper, more efficient, flexible electronic devices. This necessitates macroscopic control mechanisms that reproducibly affect quantum mechanical systems. Using optically detected magnetic resonance (ODMR), we studied how spin states involved in spin-dependent processes within the p-conjugated polymer poly(2-methoxy-5-(2-ethylhexyloxy)-p-phenylene vinylene) (MEH-PPV) are affected by the application of electric fields. By constructing MEH-PPV thin-film capacitors with directional transparency, we observed the steady state photoluminescence (PL) and ODMR signals under magnetic resonance conditions with and without a bias. We report a strong quenching of the ODMR signal due to the applied electric field that exceeded a simultaneous quenching of the PL emissions by an order of magnitude. This observation proves that electric fields are capable of controlling spin-dependent recombination rates.

Environmental and Ecological Impacts on Flammulated Owls (Psiloscops flammeolus) in the Pikes Peak Region

Student Researchers: Luke Dorwart '18, Jordan Ellison '19, and Eliza Stein '18
Majors: Organismal Biology and Ecology
Minors: Biochemistry
Faculty Collaborator: Brian Linkhart, Organismal Biology and Ecology

The Flammulated Owl (*Psiloscops flammeolus*) is a nocturnal owl residing in montane forests throughout North America. *P. flammeoulus* provides a model organism for researching the effects of avian migration, territory use, climate change, land management techniques, and forest fires. Avian migration and territory use were determined by affixing GPS backpacks on territorial male *P. flammeoulus* in one study site. Long term environmental data was used in conjunction with prey availability data to determine climactic effects that would hamper breeding success of *P. flammeoulus*. Two control study sites and two manipulated study sites were used to elucidate the effects of forest fires and US Forest land management techniques, specifically with forest thinning.

Quantification of Mating and Mating-Type Switching with Flow Cytometry in *Ogataea polymorpha*

Student Researcher: David Eik '19
Major: Molecular Biology
Minor: Spanish
Faculty Collaborators: Sara Hanson and Olivia Hatton, Molecular Biology

Reproductive mechanisms play an important role in a species' ability to respond to its environment and evolve. Understanding these strategies in yeast offers increased understanding for biotechnological production as well as clinical treatment of yeast-related illness. *Ogataea polymorpha*, like many yeast species, exhibits asexual and sexual reproductive capabilities and can undergo mating-type switching before mating in times of stress. The molecular and evolutionary mechanisms of mating and mating-type switching in methylotrophic yeast are poorly understood and testing protocols are time consuming and inefficient. Here, we attempt to create a high throughput assay to test mating and mating-type switching efficiencies with flow cytometry. We apply three methods to the flow cytometer, including (1) nuclear DNA staining and cell cycle arrest to establish variations in ploidy indicative of mating, (2) bilateral mating with N and C terminus ends of Green Fluorescent Protein (GFP) in mating partners to track mating efficiency, and (3) fluorescent tagging at the MAT locus with Green Fluorescent Protein and Red Fluorescent Protein to observe mating-type switching frequencies. Initial results reveal indistinguishable cell cycle histogram plots in *O. polymorpha*, indicating a need for a novel DNA staining protocol. Transformations for bilateral mating and MAT (mating-type) locus tagging are in progress and we have confirmed that the N-GFP sequence is transformed into the *O. polymorpha* genome. Our complete development of these assays will streamline the process of studying the genetic and environmental conditions in which yeast reproduce. This high throughput method to track mating and mating-type switching frequencies will increase our understanding of pathogenic proliferation and biotechnological manipulation of various yeast species.

Effects of Prescribed Fire on Demographic Performance and Habitat Use in a Ponderosa Pine Ecosystem

Student Researcher: Sam Fason '18
Major: Organismal Biology and Ecology
Minor: Music
Faculty Collaborator: Brian Linkhart, Organismal Biology and Ecology

Ponderosa Pine ecosystems are fire-dependent, and therefore much of the flora and fauna living in these ecosystems have adapted to cope with frequent low to mid-severity burns. However, with decades of fire suppression, rising temperatures globally and increasingly severe droughts, we are now seeing far higher intensity burns across the American West. Our study site, the Hot Creek RNA, has not seen fire in almost 60 years, and the fall of 2017 the USFS will carry out a prescribed burn on the RNA. In order to see if Flammulated Owls habitat usage changes in response to forest fire, we affixed territorial male birds with PinPoint GPS tags. The data from the GPS tags allowed us to get a sense of each territorial male's territorial boundary and the areas within that saw the highest usage, especially when among returning territorial males that were affixed with PinPoint tags in 2016. We are in the early stages of this study, so the findings are preliminary.

Raise Your Black Fists: Race, Track, and Field, and Protest in the 20th Century

Student Researcher: Sam Fesshaie '19
Major: Race, Ethnicity, and Migration Studies
Faculty Collaborator: Jamal Ratchford, History/ Race, Ethnicity, and Migration Studies

In this research project, "Raise Your Black Fists: Race, Track, and Field, and Protest in the 20th Century," we investigated the ways in which black people protested against and reacted to discriminative integration during the 1968 Olympics, and "how white engagement with it, in supportive and oppositional ways, complicated the meaning and manifestations of integration in sport and society." My specific methodology consisted of listening to interviews with various Olympic athletes from the 1968 games. The responses of athletes often varied even amongst those of the same race, but there were some common threads. Many black athletes supported Smith and Carlos's demonstration while some specifically stayed out of the political demonstrations because they were fearful of the potential consequences. Others completely opposed it. Some white athletes supported the protests while others believed that the Olympics were not the right platform to protest discriminative integration.

Nodegoat: Network Data Visualization

Student Researcher: Darryl Filmore '20
Major: Undeclared
Faculty Collaborator: Jane Murphy, History

Nodegoat is a Digital Humanities software created to make modeling and visualization of relationship-based data simple. While attempting to apply Nodegoat's relationship mapping functionality to biographies written by a man named Al-Jabarti (c.1800), Nodegoat's intricate structure and hierarchy was explored. The beginnings of a system which allowed student-teacher relationships, as well as individuals' relation to texts and subjects to be tracked, was successfully set-up. Prioritization for the allowance of various missing data points was critical to the project, and was highly emphasized. Although the Nodegoat portion of the project is still in its very early stages, the its promise to be an excellent framework for network-based data visualization is clear.

Regulation of Mitochondrial Mass Following Stimulation of the B Cell Receptor, CD40 and Their Virial Mimics in Germinal Center-Like B Cells

Student Researcher: Juliet Fink '18
Major: Molecular Biology
Minors: Mathematics and Biochemistry
Faculty Collaborator: Olivia Hatton, Molecular Biology

B lymphocytes generate antigen-specific responses and are activated through the B cell receptor (BCR) and CD40 by interaction of antigen and CD40 ligand, respectively. Following activation, B cells undergo energetically demanding processes of proliferation and differentiation. A relative of B cells - T lymphocytes – require a metabolic change to aerobic glycolysis following activation to support function and memory differentiation. Due to the similarities of these two cells, we hypothesized that a metabolic change must also occur in B cells to allow for their proliferation and differentiation to memory cells. Specifically, we examined alterations in mitochondrial mass to indicate a metabolic transition after activation. We previously demonstrated that mitochondrial mass increased following stimulation through the BCR and CD40 in Ramos cells – a germinal center-like Burkitt's Lymphoma B cell line. We repeated these experiments in BL41, another Burkitt's Lymphoma B cell line. We found no increase in mitochondrial mass in BL41 following stimulation through BCR and CD40. We also asked whether a viral CD40 mimic – the Epstein-Barr Virus (EBV) protein LMP1 – can regulate mitochondrial mass in BL41 cells; LMP1 signaling did not increase mitochondrial mass. These results could motivate future studies investigating the mechanism through which mitochondrial mass increases in Ramos cells in response to BCR and CD40 activation, using BL41 as a negative control.

Our Persistence is Resistance: Incorporating Indigenous Voices and Values in Postsecondary Retention Strategies for American Indian/Alaska Native Students

Student Researcher: Judy Fisher '20
Major: Feminist and Gender Studies
Faculty Collaborator: Dwanna Robertson, Race, Ethnicity, and Migration Studies

This project explores the factors that influence the persistence and retention rates for Native students from the perspective of the scholars and their communities. The National Center for Education Statistics has documented an increase in enrollment for AI/AN students in postsecondary education institutions accompanied by a decrease in retention and persistence rates. This project explores how the inherently assimilative nature of postsecondary education institutions in the US and the refusal of college/university administrators and officials to critically address the problems of retention and persistence are the most insurmountable challenges that AI/AN students face. This project outlines four themes found in the experiences of Native scholars that could be more thoroughly explored by universities to better serve Native students and better understand their perspectives on persisting in higher education. These themes were; a lack of useful mentoring and faculty-student relationships, need for relevant support and environments respectful of cultures, maintaining connections to tribal communities and intergenerational trauma and strength.

A Study of Metrics on Visual Boundaries

Student Researcher: Malcom Gabbard '19 and Sam Kottler '19
Major: Mathematics
Faculty Collaborator: Molly Moran, Mathematics and Computer Science

Certain metrics on the boundary of CAT(0) spaces have been well studied. However, these metrics are not easily extendable to the interior of the CAT(0) space. We propose a new family of metrics on the boundary of CAT(0) spaces which can be extended to metrics on the interior of the space. We explore whether changing the parameters for these metrics is a quasi-symmetric transformation. The advantage of this family of metrics is that it depends on the entire geodesic ray so it captures more of the geometry of the space. This will hopefully help with problems such as generalizing which boundaries of CAT(0) spaces have a finite linearly controlled dimension.

Overcoming Trail Development Challenges on Ring the Peak: A Collaborative Effort

Student Researcher: Wileen Genz '18
Major: Environmental Science: Chemistry
Student Collaborator: Hannah Rider
Faculty Collaborator: Walt Hecox, State of the Rockies Project

The concept of Ring the Peak (RtP) was developed in the 1999 Pikes Peak Multi-Use Plan, which proposed a multi-use loop trail composed primarily of pre-existing trails and roads to encircle Pikes Peak. Two critical gaps remain to close the 63-mile loop, one of which is on the southwest side currently in the planning stage, and the other on the northeast side initiating the construction phase. The progress and challenges of the southwest gap were compared to the experiences of other similar trails around the nation. By evaluating the case studies, the most frequently raised issues and their respective solutions were identified. These strategies, which include publicizing the trail and encouraging collaboration between public and private entities, were compiled into a proposal to address complications impeding the realization of RtP. Once the trail project is complete, Colorado Springs is expected to attract a wider visitor demographic, thereby promoting the recreation economy of the region.

Collecting Concurrency Defect Data from Real World Event Loop Based Applications

Student Researcher: Miguel Guerrero '19
Majors: Mathematics and Computer Science
Student Collaborator: Clara Richter '19
Faculty Collaborators: Janet Burge and Benjamin Ylvisaker, Mathematics and Computer Science

The use of multitasking in software has increased in recent years. A very common model utilized for achieving multitasking is that based on an event-loop and callbacks. The event-based model defines multitasking functionality in a, compared to other existing frameworks, intuitive and effective way. However, we believe that the use of existing event-based frameworks is not without problems. In particular, we believe that the callback abstraction tends to be overused, introducing the possibility for interruption in places where a regular, atomic procedure would be preferred. We speculate that this behavior has made applications susceptible to atomicity violations, a form of concurrency bug. In our project we searched for patterns constituting the necessary preconditions for atomicity violations in event-based runtime environments. Functionality for recording the data required was generally not provided. In order to obtain the data, we had to dig into and modify the core of the environments, including Chromium and Node.js.

Removal of Hexavalent Chromium Ions from Water Using Graphene Materials from Sucrose, Dextrose, and Black Tea Leaves

Student Researcher: Blair Huiyuan Guo '19
Major: Undeclared
Faculty Collaborator: Amanda Bowman, Chemistry and Biochemistry

Hexavalent chromium ion is one of the most toxic water contaminants. The removal of Cr(VI) ions from water using different graphene/graphitized materials produced from sucrose, dextrose, and black tea leaves was investigated in this research. Inductively Coupled Plasma (ICP) was operated to detect chromium concentrations of purified solutions. Stirring the graphenic material and potassium dichromate solution for three hours, and filtering the mixture by gravitational filtration was found to be the most effective way of removing Cr(VI) ions and collecting purified water. The wide adaptability and porous characteristics made graphitized black tea leaves a more competent graphene than sugar-based graphene for water purification. It had promising ability to remove Cr(VI) ions under most conditions, especially in pH 3 solutions. Scanning Electron Microscopy (SEM) was used to capture the surface image of graphitized black tea leaves — a honeycomb-like structure and full of pores with different sizes.

Microwave Assisted, Catalyst Determined Synthesis of Fluorinated Indoles and Pyrroles

Student Researcher: Kaia Harbor '18
Major: Neuroscience
Minor: Biochemistry
Faculty Collaborator: Habiba Vaghoo, Chemistry and Biochemistry

Fluorinated drugs are incredibly important in the treatment of a wide variety of conditions and diseases. This research examined product patterns in the Friedel-Crafts reaction of various indoles and pyrroles with trifluoroacetaldehyde, as these compounds have been shown to have bioactive properties. In the course of this research, several new fluorinated indole and pyrrole compounds were discovered, in the process of diversifying and classifying the reaction by examining the effects of reaction conditions, especially catalyst amount and type. The results suggest that "mono" product (1 equivalence of TFA reacted with 1 equivalence indole) production occurs only in the absence of catalyst, while the "di" product (1 equivalence TFA reacted with 2 equivalences indole) requires the presence of catalyst.

Modeling Wildfire Implications in the Colorado Springs Wildland Urban Interface (WUI)

Student Researchers: Alex Harros '18 and Matthew Valido '18
Major: Environmental Science: Integrated and Environmental Science: Chemistry
Faculty Collaborator: Miro Kummel, Environmental Program

The Hayman wildfire of 2002 and Waldo Canyon wildfire of 2012 were of unprecedented size, intensity, and destructiveness. Furthermore, the post-fire flooding, debris flow, and sedimentation of our valuable water resources demonstrate the extended danger and cost following a wildfire. We used the Hayman and Waldo Canyon wildfires as models to simulate a wildfire event and subsequent post-fire flooding and debris flow. Our area of interest focuses the Ruxton, Bear Creek, Sutherland, and North and South Cheyenne Creek watersheds and their surrounding wildland-urban interface (WUI). Utilizing geographic information systems and remote sensing data, we mapped and correlated key features between the model burn sites and our area of interest. The burn severity model considers three key factors that determined burn severity in the Hayman and Waldo Canyon fires: normalized difference vegetation index (NDVI), slope and aspect. This rendered a burn severity scale for each combination of pixel values on a four-level scale. Stream power index (SPI) and compound topographic index (CTI) were also rendered on a 4- point potential risk scale. To show areas most susceptible to both severe burning and post-fire erosion and flooding, the burn severity and hydrology models were combined to form a single, spatial scale. These combinations accounted for the increased risk of erosion and flooding in areas affected of high predicted burn severity. We hope to use this visualization of risk to assist public services, local communities and other stakeholders in preparation for future wildfire and flooding events.

The Intersections of Race and Gender in 'The Great Outdoors'

Student Researcher: Atiya Harvey '18
Major: Feminist & Gender Studies
Research Collaborator: Jill Bystydzienski (Ohio State)

The secondary research I conducted on the intersectionality of race and gender in 'The Great Outdoors' tries to answer the question of how access to 'The Great Outdoors' is limited for women and people of color through systemic structures and practices? Historical systems of racism and sexism contributed to perceived constraints to the outdoors. Women Studies literature shows that substantial work has been done to allow women into the outdoors despite sexist systems that try to keep them out. Race and Ethnic Studies literature shows that systems of racism played a key role in keeping people of color out of the outdoors. My future research will be intersectional because it will look at different races as well as different genders and how those identities intersect in the outdoors context.

Removing the Rose-Colored Glasses: Contempt and In-Group Bias

Student Researcher: Sarah Quinn Husney '18
Major: Psychology
Student Collaborator: CJ Thompson '18, Eva McKinsey '17, and Maria Cortner '19
Faculty Collaborator: Jason Weaver, Psychology

The present study investigates the link between contempt and mortality salience, exploring their respective effects on partisan stereotyping. We measured 200 mTurk (an online participant recruiting service) users' dispositional contempt, mortality salience, and partisan stereotyping in an online survey. We found that mortality salience and contempt are positively correlated ($p = 0.046$), but that only contempt contributes to partisan stereotyping. We predicted that contemptuous individuals would direct their contempt toward out-group members like political adversaries, amplifying cross-party stereotyping. Contrary to this hypothesis, however, dispositional contempt produced a reduction of positive in-group stereotyping among members of both major political parties (Democrats $p = 0.001$, Republicans $p = 0.030$). This finding suggests that contempt mitigates in-group bias, preventing contemptuous individuals from glorifying their own party.

Analyzing Kamb Ice Stream Flow Line from Grounding Line to Front of Ross Ice Shelf for Evidence of Basal Melt

Student Researcher: Gina Jozef '18
Major: Environmental Science: Physics and Geology
Student Collaborator: Skye Keeshin '18
Faculty Collaborator: Christine Siddoway, Geology
Research Collaborators: Robin E. Bell, Kirsty Tinto, Nick Frearson, S. Isabel Cordero, and Indrani Das (Lamont-Doherty Earth Observatory, Columbia University), and ROSETTA-Ice Team

The stability of the West Antarctic Ice Sheet (WAIS) depends heavily on the buttressing ability of its ice shelves. These ice shelve are threatened by a warming ocean and atmosphere, and if lost as meltwater then WAIS will face accelerated melting, contributing immensely to global sea level rise. The ROSETTA-Ice Project uses the ICEPOD instrument suite to collect shallow ice radar profiles of the Ross Ice Shelf that reveal the extent of ice stream and glacier ice constituents of the shelf. My focus is on the ice flowing from Kamb Ice Stream which can be identified in the shallow ice radar images by a jagged reflector. The value of glacier ice reflectors such as Kamb's is that they provide markers for strain, depth variation, and thickness change between flight line profiles. After accounting for thinning caused by strain, the remainder we attribute to basal melting, freeze-on, or other processes to be determined. For Kamb, we have found that the thinning due to strain is 1 to 6 m over each 10-km increment. The amount of thinning unaccounted for by strain is 0.2 to 1.3 m/yr per increment, which may be attributable to basal melting.

An Excavation of Female Work Environments in 19th-Century Colorado Prison

Student Researcher: Eviva Kahne '18
Major: History
Student Collaborator: Samuel Andrew '18
Faculty Collaborator: Carol Neel, History

My summer research was funded by the Social Issues and Historical Contexts Grant, which aimed to shed light of the histories of American mass incarceration. I focused on female work experiences in nineteenth-century Colorado carceral environments. This research had three foci. I began with how gender shapes the ideology of rehabilitation. I subsequently looked at how race shapes ideologies of gender. Last, how Southern penal labor for women of color influenced the development of Coloradan penal work systems. This project examined postbellum Southern Reconstruction efforts, and how work projects in prison, particularly road building, found their way West in the migrations of freed slaves in the late nineteenth-century. It also looked at the effects of Colorado's State Penitentiary as a repository for federal prisoners west of the Mississippi River, in efforts to track ideological influence regarding female rehabilitation. This research included archival research in Cañon City, oral histories, and relevant secondary sources, utilizing a combination of personal accounts and analytical resources.

Use of Ice Radar records to detect zones of weakening in the Ross Ice Shelf, Antarctica

Student Researcher: Skye Keeshin '18
Major: Geology
Student Collaborator: Gina Jozef '18
Faculty Collaborator: Christine Siddoway, Geology
Research Collaborators: ROSETTA-Ice Team

The Ross Ice Shelf (RIS) in Antarctica is the largest in the world, covering nearly 500,000 km2, an area equivalent to the size of Spain. Ice shelves like the Ross play a role in the regulation of continental ice sheets through ice shelf buttressing. Using shallow and deep ice radar from the ROSETTA-Ice project, ice thickness and internal structure can be examined and used to measure thickening and thinning of the shelf due to basal melting or freeze-on, which may reflect current circulation in the ocean cavity below the shelf. Areas of observed thinning may be more susceptible to weakening and retreat of the ice shelf, with consequences for the stability of the Antarctic Ice Sheet. This method of quantifying ice shelf health may aid in understanding the fate of Antarctic ice in scenarios of climate change.

Observationally Testing the Triple Origin Formation Mechanism for Blue Straggler Star Binaries in the Old Open Cluster NGC188

Student Researcher: Jacob Kohler '18
Major: Physics: Astrophysics Emphasis
Faculty Collaborator: Natalie Gosnell, Physics

Presented are results to constrain blue straggler star (BSS) formation mechanisms in open cluster NGC 188 using the Immersion Grating Infrared Spectrometer (IGRINS) located at the Discovery Channel Telescope (DCT). Under our tested formation mechanism, the progenitors of BSSs are arranged in primordial hierarchical triple stars that dynamically evolve into a binary composed of a BSS and, statistically, an M-type main sequence companion. We present, for the first time, a preliminary detection of a 0.5 solar mass main sequence companion in each of the long period, single-lined binaries WOCS451 and WOCS5671 of NGC 188. Dependent on our telescopes signal to noise ratio, theoretical detection limits are reported assuming a specified set of characteristics of the blue straggler and companion star. Current and future research goals aim for insights into the triple origin formation frequency.

Investigating Mechanisms Impacting Abrupt Alpine Treeline Migration

Student Researchers: Evan Laufman '19, Ali McGarigal '19, and Aiyu Zheng '19
Major: Environmental Science: Integrated
Student Collaborators: Kyle Warner '18, Victoria Cutler '18, Kellen Dreyer '18
Faculty Collaborator: Miro Kummel, Environmental Program

Alpine treelines are important ecotones that are changing due to increasing global temperatures. Due to differences in structure, abrupt treelines are not migrating up slope as quickly as diffuse treelines. To understand the underlying mechanisms driving shifts in abrupt treelines, ecophysiology, spatial patterns in ground temperatures and seedling distribution, as well as atmospheric dynamics were investigated on Pikes Peak. Drone-based photogrammetry revealed that differential cooling traps a cold stagnant air parcel in the old growth forest, possibly impacting seedling growth near the treeline. Tree canopies tended to be warmer on their windward side due to increased heat exchange with night time air. Further analysis is required to understand how these temperature regimes impact the upward migration of this abrupt treeline.

Long-term dendritic and spine changes following repetitive traumatic brain injury: A quantitative Golgi study

Student Researcher: Allysa Warling '19
Major: Neuroscience
Minor: Biochemistry
Faculty Collaborator: Bob Jacobs, Neuroscience

Repetitive traumatic brain injury (TBI) has been linked to long-term consequences, including the neurodegenerative disease chronic traumatic encephalopathy (CTE). The present study quantitatively examined the long-term dendritic and spine changes associated with repetitive TBI across a spectrum of cases: one with a history of repetitive TBI but no neurodegenerative diagnosis, one with early stage CTE, and four with late stage CTE. A total of 240 neurons were reconstructed from two cortical regions: Prefrontal cortex (Brodmann's area, BA, 10), and secondary visual cortex (BA 18). These cells were compared to a non-diseased control cohort (*Jacobs et al.*, 1997). Qualitatively, the repetitive TBI tissue exhibited irregular pial surface vacuoles that were not present in the control cohort. Quantitatively, all dendritic and some spine measures were greater for the control cohort than the repetitive TBI group, even in the case without a CTE diagnosis. These results suggest there may be some extent of microscopic degeneration associated with repetitive TBI.

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Cataloging the Praesepe Cluster: identifying interlopers and binary systems

Student Researcher: Madeline Lucey '18
Major: Physics: Astrophysics Emphasis
Faculty Collaborator: Natalie Gosnell, Physics

We present radial velocity measurements from the WIYN Telescope for 214 cool stars in the Praesepe open cluster. Our target stars are proper motion members and were also observed by the repurposed *Kepler* mission, *K2*. With these findings we provide a more accurate understanding of the cluster, which will allow us to make stronger conclusions with the data from *K2* concerning exoplanet formation and evolution. We find Praesepe to have a mean radial velocity of 34.09 km/s. We derived probability memberships for 87 stars with ≥3 radial velocity measurements, resulting in 77 members. We also identified seven radial velocity variables and four double-lined spectroscopic binaries. We find that 10 stars were incorrectly determined to be members from their proper motion. We plan to obtain more observations to determine orbital solutions, and membership probabilities for more stars.

Computational chemistry across the departmental curriculum

Student Researcher: Amanda Martin '19
Major: Organismal Biology and Ecology
Minor: Linguistics
Faculty Collaborator: Sally Meyer, Chemistry and Biochemistry

The field of chemistry is extensive and seeing the connectivity throughout the courses can often be difficult. Concepts in general chemistry tend to seem irrelevant to concepts in organic chemistry such as nuclear magnetic resonance (NMR) spectroscopy. Creation of process oriented guided inquiry learning (POGIL) activities that link the organic concept, NMR spectroscopy, to general concepts might be the solution to help students comprehend the vital connectedness. Use of the computational software, Marvin, within POGIL activities allows for visual representation of NMR spectrums to help students cue in on specific aspects. Trials of the completed activity for the organic course for effectiveness have yet to be run, and creation of POGIL activity for the general course is the next step in the overall research.

Neuroguidin: A Protein Unique to Neuron Development

Student Researcher: Samuel Mathai '18
Major: Molecular Biology
Student Collaborator: Garrett Manion '18
Faculty Collaborator: Darrell Killian, Molecular Biology

Dendrites are the structures in the nervous system that receive information from outside the neuron itself. Proper dendrite formation is required for many roles of the central nervous system such as cognition, memory, and learning. Dendrite malformation is implicated in neurodevelopmental disorders that affect these areas. Here we investigated the role of *lpd-2/ neuroguidin* in dendrite formation in the PVD neuron of *C. elegans* as model for neuron development. By labeling the PVD neuron of *C. elegans* with a fluorescent tag and knocking down expression of lpd-2 using RNAi, we have identified a neural phenotype caused by the under expression of lpd-2.

Examining the Contribution of Pheromone Signaling Pathways to Mating-Type Switching and Mating in the mMethylotrophic Yeast *Ogataea polymorpha*

Student Researcher: Kate Matlin '19
Major: Molecular Biology
Minor: Biochemistry
Faculty Collaborator: Sara Hanson, Molecular Biology

Pathways regulating sexual reproduction have been mapped in the yeast species *Saccharomyces cerevisiae*, but how these pathways evolved across the diversity of yeast species is largely unknown. The methylotrophic yeast, *Ogataea polymorpha*, is induced to mate through a pheromone signaling response pathway conserved from *S. cerevisiae*, and by nutrient deprivation. In addition to mating, *O. polymorpha* undergo mating-type switching, a mechanism that induces *MATa* and *MATalpha* haploid cells to reversibly switch mating-types in response to stressful conditions. In this study, we investigated the roles of genes (*STE7, FUS3, KSS1, and IME2*) in the mating regulatory pathway in *O. polymorpha*. We constructed and tested gene deletion strains for their ability to undergo mating and mating-type switching. Our results show that in *O. polymorpha*, *FUS3* is only required for mating in *MATa* strains and *STE7* is required for mating in both mating types. KSS1 and IME2 are not required for mating. Preliminary data from mating-type switching assays suggest *KSS1* may be required for switching in *MATalpha* strains and *FUS3* is not required for mating-type switching. This research will be investigated further by determining the role of pheromones in regulating the pathway and identifying any genes that specifically regulate mating in *MATalpha* cells in *O. polymorpha*.

An Environmental History of the Colorado College Ornithological Collection

Student Researcher: Sarah McAuley '17
Major: Environmental Science: Integrated
Minor: Asian Studies
Faculty Collaborator: Amy Kohout, History

Acclaimed zoologist and curator of the Colorado College Museum of Natural History, T.D.A Cockerell, once wrote, "If we do not form a study series, we will have little standing in the scientific world," regarding the College's paltry collection of stuffed birds and mammals in 1903. This project aims to trace the evolution of the Colorado College Ornithological Collection and contextualizes its specimens within the cultural and historical shifts that have shaped the last two hundred years of American scientific practice. Consequently, these birds offer a unique opportunity to explore the relationship between scientific practice and the environmental history of the American West. For example, how has the act of collecting and classifying objects in our physical environment shaped the way we value these birds and 'nature' more broadly? The dismantling of the collection mirrors the transition from specimen collecting to the lab-based practices of the twentieth century as well as the budding environmental consciousness of American naturalists, collectors, and scientists.

Temporal and Spatial Patterns in Home Range Use by Flammulated Owls (*Psiloscops flammeolus*) in Pike National Forest

Student Researcher: Katherine McGinn '18
Major: Organismal Biology and Ecology
Minor: Biochemistry
Faculty Collaborator: Brian Linkhart, Organismal Biology and Ecology

Home range studies provide a unique approach to understanding the complicated ways individuals interact with their environment. The spatial ecology of most mobile fauna indicate the distribution and abundance of interspecific and intraspecific competitors, shed light on predator-prey dynamics, facilitate community structure, and illustrate energetic trade-offs associated with foraging. Avian research has adopted radio telemetry to unpack habitat use by birds to show the diverse ways in which avifauna most efficiently use their environments. Brian Linkhart's research in Pike National Forest demonstrated that Flammulated owls (*Psiloscops flammeolus*) preferentially establish home ranges in Ponderosa pine/Douglas fir overstory. This project seeks to expand on this understanding by implementing pinpoint GPS technology to identify changes in temporal/ spatial habitat usage by male Flammulated owls as the breeding season progresses. During their 2017 summer breeding season, we attached trackers to six breeding males in Pike National Forest which recorded GPS fixes during incubation and nestling period. Results suggest that habitat usage differs between early night foraging and late night foraging and that intensive use areas (IUAs) differ between incubation and the nestling period. These results illustrate how changing energetic demands at different temporal scales alter how territorial males use their available habitat. Further analysis has the potential to reveal what particular aspects differ between IUAs and available but unused habitat.

Becoming the Oppressor: Racist Socialization through Violent Histories

Student Researcher: Kazzandra Medellin '18
Major: Sociology
Minor: Southwest Studies
Faculty Collaborator: Karen Roybal, Southwest Studies

Informed by non-traditional archival research and Post Traumatic Slave Syndrome Theory (PTSS), this research explores how violence between Texas Rangers and Mexicans in the Rio Grande Valley in the early 1900s effected proceeding Mexican and Mexican American generations. Using PTSS as a framework for this research, I analyze how photographs taken by Border photographer Robert Runyon (which include a number of troubling picture postcards), a ride along with two Latino border patrol agents, and Ranger ranger Ramiro "Ray" Martinez's autobiography, embody aspects of PTSS and specifically, racist socialization. This research also speaks to the dangers in limiting archival research to "traditional" materials and is critical of who gets the power to control archives.

Sexual Orientation Disparities in Aspects of Physical Health among U.S. Adolescents: The Roles of Parental Expectations and Peer Behaviors

Student Researcher: Jacob Miller '19
Major: Mathematical Economics
Research Collaborator: Jeremy Luk (National Institute of Child Health and Human Development)

Sexual minority adolescents experience elevated minority stress and disparities in mental health outcomes, but similar disparities in aspects of physical health are understudied. This study examined sexual orientation differences in eating behaviors, physical activity, and perceived weight status relative to BMI. We further tested domain-specific parental and peer influences as moderators of these disparities. Data were drawn from 1926 adolescents who participated in the NEXT Generation Health Study (n = 1926 from Wave 2). Results indicated significant sex differences in eating behaviors, physical activity and weight perception. Parental expectation of physical activity was associated with increased vigorous physical activity among heterosexual adolescents only. Exercising with a same-sex peer was a buffer against sexual orientation disparities in BMI among female adolescents. Sexual orientation differences are not uniform across important aspects of physical health and may be modified by parental expectation and peer behaviors.

Revaluating and Recontextualizing History Through Jazz Musicology

Student Researcher: Callum Neeson '18
Major: Computer Science
Minor: Music
Faculty Collaborator: Ryan Bañagale, Music

This research explores the lives and music of the great jazz musicians of the 20th century, and how musicological studies can re-contextualize common historical notions. In the process of writing numerous historical segments across multiple genres for the musicology podcast, Critical Karaoke, I focused my study on two jazz figure heads of the 1960's – Nina Simone and George Russell. For Nina Simone, I looked at numerous autobiographical documents, live performances, and musicological writings that examine how her interpretation of the Civil Rights Movement differs from mainstream historical notions. Additionally, I looked at the academic writings of George Russell in his book "Lydian Chromatic Concept of Tonal Organization," and how his new conceptualizations of music theory allowed us to look at the jazz cannon and the European classical cannon with the same system. When studying the works of both artists, an observer can reach new conclusions and powerful insights on common historical notions that contradict mainstream opinion.

Computational Chemistry Across the Departmental Curriculum

Student Researcher: Henos Negash '20
Major: Undeclared
Faculty Collaborator: Sally Meyer, Chemistry and Biochemistry

In this research, we designed projects for General and Organic chemistry students that focused on describing the real physics behind the idea of acid strength. Both in General and Organic chemistry courses, we usually implement different mechanisms like bond length (strength), partial charge, resonance stability and induction property to differentiate between strong and weak acids. But in this research, we found out that thermodynamic values are the most important factor to be considered when dealing with acid strength. By drawing trends and comparing enthalpy and entropy values for the dissociation of various acids, we came to a conclusion where entropy values always increase as an acid gets stronger and enthalpy of an acid has no impact on acid strength.

Novel Compound Design and Synthesis for Treatment of Human African Trypanosomiasis

Student Researcher: Norberto Orellana '19
Major: Chemistry
Faculty Collaborator: Amy Dounay, Chemistry and Biochemistry

Human African Trypanosomiasis (HAT, which is also known as African sleeping sickness) is caused by the parasite *Trypanosoma brucei*. Current treatments for the disease present non-negligible side effects that vary from benign symptoms such as drowsiness to far more nefarious issues such as lethality in some cases. Our goal is to design new medicines with improved safety and efficacy. Previous research concerning *Trypanosoma brucei* resulted in the discovery of many compounds with potential for optimization. Among these compounds was NEU-0001101, which was selected as a starting point for this research. Multi-step synthesis was utilized to modify the left portion of the molecule. Preliminary data gathered from calculating properties show that our targeted compounds have desirable properties such as molecular weight and other metrics which are crucial in determining whether a compound is potentially viable as a drug. Data obtained from screening against *Trypanosoma brucei* will further provide insight to the viability of the synthesized compounds. This work resulted in the development of new compounds and opens the way for further study on the left ring of the compound as well as the ring on the bottom right of the compound.

French Literature at the Turn of the 20th Century: Advent of Modernity, Decline of the Aura, and Surrealism

Student Researcher: Maja Orlowska '19
Majors: Comparative Literature and Romance Languages
Faculty Collaborator: Roxanna Curto (University of Iowa)

This research project explores and analyzes the key concepts of French literature of the early twentieth century as a result of the political, infrastructural, and technological changes that began at the end of the nineteenth century. This study analyzes the ways in which these tangible changes influenced the creation of literary works during this shift into modernity, and how they led to the development of new artistic movements such as French Surrealism. This project uses as a point of departure Walter Benjamin's concept of the "aura," which he discusses in the essay "Art in the Age of Mechanical Reproduction." Benjamin's notion of the aura and of its loss during the shift towards modernity can be analyzed in the context of the principal literary works of this time period. The research project focuses on the following works in order to examine the presence of Benjamin's idea of the aura in literary texts: *Les Fleurs du Mal* by Charles Baudelaire, *Du côté de chez Swann* by Marcel Proust, and *Le Paysan* de Paris by Louis Aragon, which allows for an observation of the sequential changes in French literature. Baudelaire and Aragon focus on the cityscape of Paris in their works, including its ongoing transformation, and the changes in the mode of perception of everyday life in modernity. A key component of this question is the emergence of Surrealism, which Benjamin considers a revolutionary force in literature as an institution. The development of Surrealism complicates the idea of the loss of the aura due to the way in which Surrealist works depict the world.

"A Day in the Life"

Student Researcher: Jackson Paine '18
Major: Comparative Literature
Faculty Collaborator: Steven Hayward, English

The goal of this research is to use archival information from turn of the century Colorado Springs in order to rediscover the storied forgotten past of the Pikes Peak region. Focusing on the 1890's to around 1915, the research culminated into nearly a dozen podcasts. These podcasts were modeled after Critical Karaoke's show: *A Day In the Life*, each episode telling a short individual story specific to a day of the year. Using primary documents such as newspaper clippings from the local Colorado Springs newspaper *The Gazette*, transcripts of political speeches, as well as Colorado College's own archives, this research describes the conditions of the changing frontier in the United States and the role Colorado Springs played in its creation.

Experimentally Verifying the Theory of General Relativity by measuring the Angular Diffraction of Starlight

Student Researcher: Benjamin Pitta '18
Major: Physics: Astrophysics Emphasis
Minor: Music
Faculty Collaborator: Shane Burns, Physics

My research this summer was to use the total solar eclipse to repeat the 1919 experiment conducted by Arthur Eddington that was first to experimentally verify the Einstein field equations. The theory of general relativity stated in these equations describes the bending of space-time because of the presence of massive objects. This experiment quantifies that effect by measuring the angular deflection of starlight as it passes near the surface of the sun by taking images during a solar eclipse. Preparation for the experiment revealed that the field of view containing the sun had a lack of bright stars. The images were taken with an SBIG STXL 16200 CCD camera with an 8" aperture Celestron telescope with an exposure time of 2.5 seconds. The location of observation was N 43 23' 44.4 W 109 18' 08.6, just south of Dubois, Wyoming. Analysis of the resultant image revealed an inconclusive result, as there were no visible stars in the field of view. Some procedural error resulted in only one image being taken.

Measuring Dispositions for Culturally Responsive Teaching

Student Researcher: Acelynn Perkins '18
Major: Education
Faculty Collaborator: Tina Valtierra, Education

This summer, I assisted Tina Valtierra and Manya Whitaker in the Colorado College Department of Education with their research aimed at measuring lasting effects of teacher preparation programming and what approaches are most effective in producing effective teachers. Our primary research objective this summer was to examine teacher candidate dispositions- beliefs, values, and attitudes- for culturally responsive teaching practices in comparison to their observed teaching practices. Research methods included conducting and analyzing interviews, focus group sessions, and survey data from outgoing Master of Arts in Teaching (MAT) students. Findings from summer research supported the faculty collaborators' ongoing research project regarding dispositions for culturally responsive teaching.

Diffusion Monte Carlo in Non-Born-Oppenheimer Quantum Chemistry

Student Researcher: Jules Randolph '18
Majors: Mathematics and Physics
Minor: Music
Student Collaborator: Zachary Eberhart '17
Faculty Collaborator: Sally Meyer, Chemistry and Biochemistry

The goal of much of quantum chemistry is to solve the Schrödinger equation for molecules, resulting in a wavefunction describing behavior of the wave-particles (electrons and nuclei) that make up the molecule. Because solving Schrödinger exactly becomes impossible in even small molecules, the Born-Oppenheimer approximation is usually employed, which is often very accurate, however in some cases, such as H_2^+, it leads to noticeable error. One alternative technique to direct calculation is called Diffusion Quantum Monte Carlo (DQMC). The goal of this research is to use DQMC to calculate the ground state wavefunction of H_2^+ without using the Born-Oppenheimer approximation. Last summer, Zachary Eberhart built a Python program which ran DQMC simulations for one-dimensional quantum mechanical systems with external potentials. This summer, working with Zack part of the time, I developed the program to run simulations in two and three dimensions, and attempted to simulate the non-Born-Oppenheimer hydrogen atom and the H_2^+ molecule. The latter attempts are still in progress.

Managing the Masses: Recreation Management on Pikes Peak

Student Researcher: Hannah Rider '18
Major: Environmental Policy
Minor: Philosophy
Faculty Collaborator: Walt Hecox, State of the Rockies Project

Standing at 14,211 ft. above the eastern plains of Colorado, Pikes Peak is a national symbol and the most visited mountain in the United States. Pikes Peak offers a wide variety of recreational experiences and provides accessibility unlike any other mountain of its scale. However, increasing visitation to Pikes Peak and its attractions is threatening the ecological sustainability of this ecosystem. In order to avoid the negative impacts of overuse and capitalize on the possible benefits of the Pikes Peak recreation area, a comprehensive management plan is necessary. The purpose of this study is to estimate future usage of the peak's recreational opportunities, and propose a management plan that will retain accessibility and overall experience for visitors, while maintaining the ecological integrity of this ecosystem.

A Closer Look at the Abundance of Oxygenated VOCs in the Colorado Front Range during Spring and Summer 2015

Student Researcher: Daniel Rodriguez '18
Major: Environmental Science: Chemistry
Faculty Collaborator: Lynne Gratz, Environmental Program
Research Collaborators: A.J. Abeleira, J. Lindaas, I.B. Pollack, D.K. Farmer, and E.V. Fischer

The Northern Front Range Metropolitan Area of Colorado regularly exceeds the National Ambient Air Quality Standards (NAAQS) for ozone. This region has a growing urban population and extensive oil and natural gas production in the nearby Denver-Julesberg Basin. In 2015, a large suite (40+ species) of volatile organic compounds (VOCs) were measured using a custom-built online multichannel gas chromatography system over 8 weeks in spring and 8 weeks in summer at the Boulder Atmospheric Observatory (BAO). We quantified three oxygenated VOCs (OVOCs): acetone, acetaldehyde, and methyl ethyl ketone (MEK). The summer data set was shortened to 5 weeks for the analysis presented here because aged wildfire smoke influenced the site during the last three weeks of the measurement campaign. Previous work found that the OVOCs accounted for almost a quarter of the total calculated OH reactivity yet the sources of these compounds were poorly reconstructed by a Positive Matrix Factorization (PMF) analysis. Here, we take a close look at the abundance of MEK to better understand the relationships between MEK and its known precursors as well as other OVOCs and secondary species. MEK can be directly emitted and it can be produced during the atmospheric oxidation of several different hydrocarbons (e.g. n-butane, 3-methyl hexane, i-pentane). We investigate dominant production pathways using a box model, and characterize local and synoptic meteorological conditions with respect to high and low MEK abundances.

Identifying Mutations That Affect Heterochromatin Boundary Function in *S. pombe*.

Student Researcher: Robert Roth '18
Major: Molecular Biology
Faculty Collaborator: Jennifer Garcia, Molecular Biology

Heterochromatin boundary elements inhibit the spread of repressive histone methylation through gene coding regions, to prevent the silencing of essential genes. Two, relatively unknown, parallel and redundant pathways are responsible for the effective maintenance of heterochromatin boundaries in the fission yeast, *Schizosacchromyces pombe* – a pathway that involves TFIIIC, a transcription factor that associates with specific DNA elements, and a pathway that involves EPE1, a Jmjc domain-containing protein that promotes heterochromatin silencing. To identify other proteins involved in boundary function, a genetic screen was performed to find other proteins implicated in either the TFIIIC or EPE1 pathway with the use of a reporter strain that allows us to phenotypically observe boundary function. To specifically elucidate the proteins involved in the TFIIIC-dependent pathway, chemical mutagenesis was employed in a reporter strain lacking EPE1 function. Mutants that exhibited impaired boundary function were sequenced and analyzed and individual point mutations were discovered in three unique genes, SDA1, COG5, and BYR3. To confirm that these three genes are associated with TFIIIC-dependent boundary function, a CRISPR/Cas9 system was designed to target wildtype genes in the impaired EPE1 reporter strains and reintroduce the identified mutations. These strains can then be used to verify that the mutations do indeed impair boundary function and act within the TFIIIC-dependent pathway of heterochromatin boundary maintenance.

Work and Leisure on the Block Plan

Student Researcher: Isaac Rubinstein '18
Major: History/ Philosophy
Faculty Collaborator: Susan Ashley, History

In the creation of the Block Plan in 1970, Colorado College developed the leisure program as the non-academic half of the CC Plan. Leisure, during the time of the introduction of the Block Plan was the panacea to the ills of the modular schedule. Everything from political action groups, to arts and crafts, to sports and other social organizations were all grouped under the leisure program, which organized these extra-curricular activities, and provided them funding. In the venture towards a holistic, balanced education, Colorado College attempted to fill student's time with productive pursuits that would facilitate learning outside the classroom, forge strong social bonds, and keep students away from drugs and idleness. Did it do this? What were some of the unintended consequences of leisure? What does leisure look like in 2017?

Conspicuousness of Band-winged Grasshoppers Stationary and In Flight

Student Researcher: Brae Salazar '18
Major: Organismal Biology and Ecology
Student Collaborator: Alex Duncan '17
Faculty Collaborator: Nick Brandley, Organismal Biology and Ecology

In band-winged grasshoppers (subfamily Oedipodinae), the variety of hindwing colors—ranging from blue to red—is both striking and unexplained. Hindwing color can vary both within and between species. However, the functional significance of this variation is unknown. Notably, the colorful hindwings are revealed only in flight, and remain hidden in stationary individuals. Although experimental evidence is lacking, this flash of color has been proposed to 1) startle potential predators, 2) to signal the quality of a potential mate, and 3) to enhance species recognition. To elucidate their potential function(s), here we measure the spectral and spatial characteristics of the hindwing patterns in 6 different band-winged species. We then model how an avian predator or potential mate might view grasshopper wings at behaviorally relevant distances. This data suggests that there is a rapid change in conspicuousness as a grasshopper moves from rest to flight regardless of the color vision of the receiver. However, there is little within species variation in coloration or wing patterning. Our results indicate that while hindwings 1) may function as a protean defense against avian predators, 2) it is unlikely that they serve as a signal of mate quality, although, they 3) may deliver enough information for species recognition. This research helps to elucidate evolutionary relationships leading to the diversification of behavior, visual systems, and coloration within band-winged grasshoppers.

Comparison of Incremental Trial Protocols Used to Determine Maximal Oxygen Consumption in Recreationally Trained Competitive Cyclists

Student Researchers: Erica Salhus '18 and Jamie Smith '18
Major: Organismal Biology and Ecology
Faculty Collaborator: Anthony Bull, Human Biology and Kinesiology

The purpose of this study was twofold: 1, to validate a published regression equation to predict maximal oxygen consumption (VO_{2max}) using peak power production (W_{peak}) attained during a short duration, incremental cycling trial to exhaustion; and 2, to compare results from this short trial and a longer duration incremental trial. Protocols: Each cyclist completed both a short and long duration protocol, during which VO_{2max} and W_{peak} were recorded. W_{peak} from the short protocol was also used to predict VO_{2max} based on the equation of Hawley and Noakes (1992). Results: There was a significant difference between actual and predicted mean VO_{2max} values ($p=0.0047$, $r=0.787$). However, there was no significant difference in mean VO_{2max} values from the short and long protocols ($p= 0.0734$, $r=0.984$). This study found that the regression equation of Hawley and Noakes (1992) was not valid for estimating VO_{2max} in our participants, however, the short and long duration protocols yielded similar results and can both be used to determine VO_{2max} in cyclists.

Identification of Active Competence Pili in *Acinetobacter baylyi* Imaged by Atomic Force Microscopy

Student Researchers: Natalie Sarver '20 and Sara Worsham '19
Majors: Neuroscience and Molecular Biology
Minor: Physics and Biochemistry
Faculty Collaborator: Kristine Lang, Physics

Many bacteria are able to take exogenous DNA from the environment and incorporate it into their own genome through the mechanism of transformation. *Acinetobacter baylyi* (ADP1) is a gram-negative bacterium that can acquire DNA this way. This soil bacterium utilizes appendages for the functions of motility, adhesion, and transformation. We are interested in active transformation appendages also known as Type IV Pili (T4P). In order to view T4P, ADP1 is exposed to DNA attached to nanoparticle gold spheres. Thus, appendages attached to gold spheres via the DNA are categorized as T4P because they are in contact with DNA. In our lab, we utilize atomic force microscopy (AFM) to image and analyze appendages with spherical gold nanoparticles attached. In order to conduct further in depth analysis of T4P and gold spheres, preliminary research was conducted to determine the specific parameters of gold balls as well as appropriate sampling populations.

On Computing Slice Genus of Non-alternating Prime Knots

Student Researchers: Hanbo Shao '18 and Lyujiangnan Ye '18
Major: Mathematics and Undeclared
Minor: Music
Faculty Collaborator: Kathryn Bryant, Mathematics and Computer Science

Knot genus, in both the three and four-dimensional settings, is a well-studied knot invariant. In this project, we calculate the smooth slice genus of the last remaining non-alternating prime knots of twelve or fewer crossings for which this invariant is previously unknown - 11 in all. We do this by performing band moves - additions and deletions - on a knot K to produce a torus cobordism in four-ball with another knot J, and the slice genera of two knots are merely differed by one. Regarding different types of knots, we applied various methods to deduce the slice genus of K via analysis of J.

Interaction between chromate(VI) reduced to chromium(III) and DNA

Student Researcher: Shiyen Sinclair '18
Major: Classics
Minor: Chemistry
Research Collaborators: Silas Brown and John B. Vincent (The University of Alabama)

Chromium(VI) compounds are potent mutagens and carcinogens when inhaled, but the potential of these compounds to generate similar effects when taken orally is an area of active investigation. The exact mechanism(s) of this activity is unknown, but potential mechanisms can be grouped into two categories. Virtually no data on the structure of these Cr-DNA complexes exist, in part because the unique magnetic and chemical properties of Cr(III) complexes, which make characterization non-trivial. The current studies have focused on the binding of Cr(III) generated on site by the reduction of Cr(VI) by ascorbate and thiols and other associated changes to the oligonucleotide. The results of 1-D and 2-D NMR spectroscopic studies of a DNA oligonucleotide containing a GG motif and exposed to Cr(VI) in ascorbic acid of dithioltheretol will be presented.

Yuchi (Euchee) Women in Ceremony: Mothers — Past, Present, and Future

Student Researcher: Aubrey Skeeter '19
Major: Education
Faculty Collaborator: Victoria Levine, Music

The Yuchi (Euchee) Indians are a small and irrepressible tribe originally from the Southeastern portion of what is now the United States. They are subsumed under the Muscogee Nation and are currently located in Northeastern Oklahoma, primarily in three communities – Duck Creek, Kellyville, and Sand Creek. The tribe has been studied since 1907 for their history, culture, language, and ceremonial life, particularly the men of the tribe. In an attempt to add more depth to the previous research,

this project has reached out to women of the tribe, and particularly women from Duck Creek Ceremonial Ground, to learn more about their role in traditional life. Women's ceremonial life has changed over time, but has always encompassed sewing ceremonial regalia, cooking traditional foods, childcare, and dancing. These Yuchi (Euchee) women show resiliency and pride in their culture as it continues to grow and adapt to the changing times.

Neocortical Neuronal Morphology in the African Leopard (*Panthera pardus pardus*)

Student Researcher: Lucy Sloan '18
Major: Neuroscience
Minors: Spanish Language and Latin American Studies
Faculty Collaborator: Bob Jacobs, Neuroscience

The present study documented and quantified the somatodendritic morphology of the African leopard (*Panthera pardus pardus*; N = 1) neocortex for the first time, expanding a recent catalogue of non-domestic feline neuromorphology (Johnson et al., 2016). Tissue samples were obtained from the frontal, motor, and visual cortices, stained using a modified rapid Golgi technique, and quantified (N = 259) using computer-assisted morphometry. Qualitatively, a diverse range of spiny neurons and aspiny neurons were observed and appeared similar to those previously observed in the domestic cat, as well as the Siberian tiger and clouded leopard. Quantitatively, the somatodendritic measures of all neurons traced in the African leopard are closer to the clouded leopard than the Siberian tiger. These results reflect the positive correlation between mammalian body size and neuronal sizes (Kaas, 2000) between the three species of Panthera that have been measured to date.

Harmonic Mappings from Generalizations of Hypocycloids

Student Researcher: Lauren Stierman '20
Major: Undeclared
Faculty Collaborator: Jane McDougall, Mathematics and Computer Science

A family of generalized hypocycloids called rosettes display unique mathematical properties. The rosette is a harmonic mapping with canonical decomposition identical to the simple polynomials that generate the harmonic hypocycloid, but with additional factors that are hypergeometric 2F1 series. While the hypocycloid is well-known in the mathematical realm, the rosette was only discovered in 2016. This project explores the intricacies of rosettes and their relationship with hypocycloids, through an analysis of the relationships between relevant formulae and the use of the computer algebra system Mathematica. The graphics of hypocycloids and rosettes that this system generates are of particular significance to this research endeavor. Important findings include the following properties of the rosette – its nested behavior, the mirror image property on the boundary of its mappings, the equal and opposite tangent vectors that produce this property, and the distinct shapes that are generated based on the relative angle rotation of the functions of the canonical decomposition.

Microwave Assisted Solid Super Acid Catalyzed Multicomponent Synthesis of 2-CF3-Tetrahydroquinoline Derivatives via Aza-Diels-Alder (Povarov) Reaction

Student Researcher: Mick Sullivan '18
Major: Biochemistry
Faculty Collaborator: Habiba Vaghoo, Chemistry and Biochemistry

Utilized for their antibacterial properties, fluoroquinolones are among the more common structural scaffolds found in medicinal chemistry. Typically, these compounds are formed in long, multi-step reactions at temperatures as low as -200C. A one-pot, microwave assisted synthesis for precursors of these compounds, tetrahydroquinolines, can be achieved by increasing the temperature and decreasing the time of the reaction, leading to efficient synthesis of the new compounds. Herein describes the process with which different aniline and dienophile derivatives yielded predictable products with varying degrees of reaction completion and purity.

The Role of Mixing on Nitrogen Processing in Tidal Freshwater Zones

Student Researcher: Delaney Tight '18
Major: Independently Designed Major: Environmental Mathematics
Minor: Music
Faculty Collaborator: Rebecca Barnes, Environmental Program

While nitrogen is integral to our survival, nitrogen in excess can be detrimental to the quality of our freshwater resources and the health of our aquatic ecosystems, due to coastal eutrophication and "dead zones." Mass balance studies illustrate that only a fraction of the nitrogen humans add to the ecosystem is exported. However, it is unclear where or how the remaining nitrogen is stored and processed, specifically in the hyporheic and transient storage zones at the surface-groundwater interface in tidal freshwater zones (TFZ's). To better understand how nutrients cycle in TFZ's, measurements of dissolved oxygen, nitrate, ammonium, and dissolved organic carbon were made over the tidal cycle in White Clay Creek, Delaware. To better explain these geochemical observations, we constructed a numerical biogeochemical box model to represent two connected pieces of the riparian aquifer. This model will help decipher the likely mechanisms behind the observations and allow us to determine the sensitivity of the system to a range of parameters, such as incoming oxygen into the system, diffusivity rates, and initial solute concentrations.

Establishing Human B Cell Lines Expressing a Chimeric Epstein-Barr Virus (EBV) Latent Membrane 2a (LMP2a) Protein

Student Researcher: Nora Watkins '19
Major: Molecular Biology and Religion
Faculty Collaborator: Olivia Hatton, Molecular Biology

Epstein-Barr Virus (EBV) is present latently in >95% of adults worldwide. Immunocompromised EBV+ individuals are at risk for EBV-associated cancers which account for ~2% of cancer deaths globally. Latent membrane protein 2a (LMP2a) is an EBV protein present in the membrane of infected human B cells and implicated in establishing and maintaining EBV+ B cell cancers. We aimed to generate EBV- B cell lines that stably express a chimeric LMP2a molecule that permits induction of LMP2a signaling; these lines will be used to examine how LMP2a alters infected-cell biology and drives EBV+ B cell cancers. Initially, optimal DNA transfection and selection media conditions for both EBV- B cell lines were determined. DNA for the chimeric Ly49G.LMP2a protein was synthesized in a bacterial expression vector and *E. coli* were transformed. Ly49G.LMP2a DNA was isolated from bacterial plasmid DNA by restriction enzyme digestion, purified, and subsequently ligated into a mammalian expression vector. Using Sanger sequencing and restriction enzyme digests, we confirmed successful cloning of Ly49G.LMP2 into the expression vector. These vectors were then transfected into two EBV- B cell lines. By creating these cell lines, we aim to determine the role of LMP2a in the development and biology of EBV+ B cell cancers.

The Difficulty Principle: Discrimination Difficulty Modulates Effects of Language on Perception

Student Researcher: Robert Welch '18
Major: Neuroscience
Faculty Collaborator: Kevin Holmes, Psychology

Does the language you speak affect your perception of the world? Previous research has sought a dichotomous yes-or-no answer to this question, yielding evidence on both sides with no clear conclusion. We took a different approach, asking when—not if—language affects perception. We hypothesized that such effects would be proportional to the difficulty of the perceptual discrimination at hand, with difficult discriminations being especially likely to recruit linguistic categories. Across three experiments, we investigated this difficulty principle by systematically varying levels of discrimination difficulty within and across color category boundaries (e.g., green-blue). Consistent with the difficulty principle, participants were faster and more accurate for between--category discriminations than within-category ones, and critically, the magnitude of this effect increased with discrimination difficulty. These findings highlight discrimination difficulty as an important moderator of linguistic effects on perception, providing a potential reconciliation of the mixed body of evidence in this literature.

The Role and Localization of RNY1 Under Nutrient Limiting Conditions in *S. cerevisiae*

Student Researcher: Brandon Wolfe '18
Major: Molecular Biology
Minor: Biochemistry
Faculty Collaborator: Jennifer Garcia, Molecular Biology

Autophagy is a self-degradative process utilized by cells in nutrient limiting conditions. Using S. *cerevisiae*, we investigated the role of autophagy in mRNA degradation. Recent work has shown that autophagy may represent a novel degradation pathway for mRNAs, which results in mRNAs being shuttled to the vacuole for their subsequent degradation. A dysfunction in this pathway has been implicated in the neurodegenerative disease, Amyotrophic Lateral Sclerosis. This led us to further understand the function of RNY1, which is an RNase that catalyzes the degradation of RNA and is suspected to be localized to the vacuole. Furthermore, RNY1 seems to be regulating mitochondrial function under nutrient limiting conditions because our previous work suggests that mRNAs that encode mitochondrial proteins are specifically degraded by RNY1. To test this, we genetically removed RNY1 and observed if the number of functional mitochondria per cell was affected by flow cytometry. The results show a small but insignificant change between wild type and mutant strains lacking *rny1*. Next, we sought to determine the localization of RNY1 as experimental evidence suggests that RNY1 can leave the vacuole to degrade tRNAs. Therefore, we suspect that RNY1 may also have the ability to leave the vacuole to degrade mRNAs. To determine RNY1's localization we used CRISPR-Cas9 and replaced genomic *rny1* with *rny1* containing an internal GFP tag. This will allow us to visualize whether RNY1 localizes to the vacuole or mitochondria to degrade mRNAs that encode for mitochondrial proteins.

The Use of Waste Carbons for Waste Water Treatment

Student Researcher: Keenan Wright '19
Major: Chemistry/Biochemistry
Faculty Collaborator: Amanda Bowman, Chemistry and Biochemistry

This study was done in order to investigate the adsorption potential of heavy metal ions specifically Pb^{2+} using waste products. Egg shells, coffee grounds, fructose-based graphene, and sucrose-based graphene were all activated for the use of adsorbing Pb(II) in waste water. All of the carbon sources were first graphitized by heating in a tube furnace under inert nitrogen gas, then treated with sulfuric acid to activate the carbon. Once activated the adsorbents were tested through stirring (samples were collected at 30 minutes, 1 hour, 2 hours, 3 hours, and 24 hours) and column filtration. Both methods were used to study the effects of contact time between the adsorbent and the contaminated waste water. The stirring method proved to lower the concentration to a detection limit indicating that the more contact time the adsorbent has with the waste-water, the more Pb(II) adsorbed. The adsorbents were also tested with lead (II) nitrate solutions at different pHs to study the correlation between pH and adsorption competency. At basic pHs the concentration of lead was the lowest; however, the egg shells exhibited no pH dependency. The adsorption capacity was determined using an induced coupled plasma machine (ICP) to measure decrease in concentration and intensity of signal. From the calibration curve, the decrease in concentration represented the ability of the adsorbent to remove lead (II) from the solution. This study also used scanning electron microscopy (SEM) in order to retrieve images of the adsorbent's surface area as well as their structure. This information suggests that the larger pour sizes and surface area the higher adsorption capacity.

Construction and Characterization of a Noise Rheostat in Human Embryonic Kidney HEK293 Cells

Student Researcher: Qiu Chang Wu '18
Major: Molecular Biology
Minor: Biochemistry
Research Collaborators: Hana El-Samad, Joao Pedro Fonseca, and Alain Bonny (University of California San Francisco)

Cellular heterogeneity is often overlooked in the study of molecular biology. In isogenic cell populations that are treated uniformly, the distribution of cell behavior varies around the population mean due to molecular noise. While many efforts have been made to measure noise in terms of gene expression, less is known about how to control noise. Here we present our efforts in developing a noise rheostat, which allows for the control of the mean and variance of gene expression in a human embryonic kidney cell line (HEK293). We have prototyped and characterized a small molecule-inducible rheostat in HEK293 lines using flow cytometry, a form of high throughput single cell analysis. The results of the characterization led to a promising linearly inducible two node system that may be able to control gene expression noise. We suggest that the noise rheostat will be an important tool in the efforts of controlling noise in study cellular heterogeneity and particularly, the translational applications in the study of non-genetic variability in cancer may benefit greatly from this tool.

ART PRESENTATIONS

Fissure & Terminus

Student Researcher: Quang Vu '18
Major: Art: Studio Art
Faculty Collaborator: Scott Johnson, Art Studio

This summer, as part of my on-campus summer research, I worked as an assistant for professor Scott Johnson, chair of the Art Department, specifically on his permanent installation in the new Library. Inspired by reusing books that were deemed unusable, professor Johnson collected them from the old library collection and transformed the books into sculptures. Our process involved dipping books into a special mixture of liquid clay several times over, making sure that the clay permeates between pages. We then let them dry out slowly and proceeded to fire them in the kiln. The heat from this process burns away the pages and left us with beautiful stone- like structures that interact perfectly with the site. This research not only provided me with valuable knowledge on different materials such as ceramics, wood, metal, etc., but it also gave me the opportunity to see the artistic process from start to finish.

Exploring the Integration of Digital Media with Reduction Woodcut, Intaglio, and Monoprint

Student Researcher: Abby Wigdale '18
Major: Art: Studio Art
Faculty Collaborator: Jean Gumpper, Art

The basis of this project was to investigate how to incorporate modern technologies into traditional intaglio printmaking. With resources in Colorado Springs, like the 21 C Library and the Pikes Peak Makerspace, I was able to use laser cutters and vinyl cutters to cut out vector images and engrave raster files that were created on Adobe Illustrator. Through studio practice, I observed how using a matrix to make imagery contrasted with the marks produced using traditional techniques of physically drawing and making marks on a copper plates, plexiglas, and wood. Throughout the summer, I assisted professor Gumpper with her work as she experimented with the laser cutter as a way to construct woodblocks. After working with these technologies, I found that the laser cutter created more graphic imagery compared to the delicate lines I cause by drawing on a plate. Overall, there are many ways to integrate technology into traditional printmaking techniques.

NON-PRESENTATION RESEARCH

Deciphering the Relative Contribution of Atmospheric Deposition to Elevated Nitrate Export from Two Colorado Alpine Streams using Stable Isotopes of Nitrogen Species

Student Researcher: Emily Fiona Cerf '18
Major: Environmental Science: Integrated
Faculty Collaborator: Rebecca Barnes, Environmental Program

With an increase in global temperatures and anthropogenic nitrogen deposition in the Colorado Front Range, it is absolutely critical that we deepen our understanding of the biogeochemical responses in order to predict the future of these vulnerable ecosystems. While lower precipitation rates in the Colorado Front Range have resulted in a stabilization of atmospheric nitrate deposition and a slight increase in atmospheric ammonium deposition since their peak in 2000, there has actually been a reported increase in nitrate export in the alpine surface waters at Niwot LTER. This antithetical occurrence is most likely a result of warming temperatures thawing cryospheric features, and thus releasing stored dissolved inorganic nitrogen (DIN), and warming soil, resulting in higher rates of mineralization and thus adding new DIN to the system. It is critical that the relative role of these sources is understood in order to predict the effect of global temperature increases on alpine ecosystems. Using isotopic signatures ($\Delta^{17}O\text{-}NO_3^-$, $\delta^{15}N$- and $\delta^{18}O\text{-}NO_3$) in combination with long term atmospheric deposition and stream chemistry data, we aim to decipher the relative role of these two sources and thus create a more accurate picture of what is driving these dramatic changes in alpine nitrogen cycling in alpine ecosystems of the Front Range.

Secondary Patents in the Pharmaceutical Industry: Extending Exclusivity or Protecting Innovation?

Student Researcher: John Higham '18
Major: Mathematical Economics
Faculty Collaborator: Kristina Lybecker, Economics and Business

The pharmaceutical industry has come under tremendous scrutiny for the practice of secondary patenting. Intellectual property foes term the process "evergreening" and argue that it is both detrimental and anticompetitive. Alternatively, IP advocates insist that secondary patenting is a legitimate, legal means of protecting incremental – later in time – innovation. This study aims to examine secondary patenting, and the associated practice of "product hopping", clarifying that the true issue at the heart of the critics' arguments is not about patents, but rather the means of introducing new products and removing obsolete ones. That is, patents are never ever-greened. Specifically, the protection on a structurally different modification has no impact on "Version 1.0" of the product – its exclusivity and patents expire as scheduled. As such, generic manufacturers are able to bring generic copies of "Version 1.0" to market and generic entry is not delayed.

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