Student Research Symposium

Summer Faculty-Student Collaborative Research (SCoRe) Presentations

TUESDAY, FEB. 8, 2022
3 - 5 p.m.

SCHEDULE
Student Research Symposium

Tuesday, February 8, 2022
Edith Kinney Gaylord Cornerstone Arts Center

3-3:30 P.M. RICHARD F. CELESTE THEATRE

Opening Remarks

Manya Whitaker, Acting Executive Vice President and Chief of Staff, Assistant Professor of Education

Student Oral Presentations on their Collaborative Research

Megan McVeigh '23, "The Effects of Environmental Stressors on Owlet Sex Ratio in Flammulated Owls"

Cheney Hurley '23, "Saved my Life": A Program Evaluation of Colorado's 4th Judicial District Recovery Court Program"

3:30-5 P.M. CORNERSTONE MAIN SPACE

Poster Presentations

3:30-4:15 P.M.	Poster Session 1	Research Abstracts P1-P40
4:15-5 P.M.	Poster Session 2	Research Abstracts P41-P79

DEAR STUDENTS, FACULTY, STAFF, AND PARENTS,

Welcome to the annual Student-Faculty Collaborative Research (SCoRe) Symposium, which brings our community together to recognize the many hours of research Colorado College students have undertaken with the support of their faculty, staff, and alumni mentors, both on and off campus.

The symposium includes short presentations, poster sessions, and conversation across the disciplines, allowing participants a window into the experiential and deep learning that summer research provides. Supporting these student experiences is central to our mission at Colorado College.

This kind of learning cultivates many important skills. 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 are essential for the nimble and adaptable leaders of the future. Studies also tell us that students who take part in these experiences are more likely to thrive in their careers and lives.

This symposium is an opportunity to acknowledge great work, thank the faculty, staff, and alumni who provide invaluable mentoring, celebrate the impact of our summer research experiences, and encourage the students whose passion for learning inspires us every day. Thank you for joining us**!**

Best regards,

L. SONG RICHARDSON
President of the College

The Effects of Environmental Stressors on Owlet Sex Ratio in Flammulated Owls

Student Researcher: Megan McVeigh ’23
Major: Organismal Biology and Ecology
Faculty Collaborator: Brian Linkhart, Organismal Biology and Ecology

For any wild animal, an environmental stressor, such as a drought, may affect the animal in countless ways. In the case of Flammulated Owls (*Psiloscops flammeolus)*, low precipitation (especially from the months of January to June) greatly affects the quantity and nutritional quality of available prey for this small insectivorous raptor. Limited prey puts stress on both adult owls, who need to catch prey for their offspring and to sustain themselves, as well as newly hatched owlets who need food to grow and develop. After working on Dr. Brian Linkhart’s field crew over the summer of 2021, I questioned whether the environmental stress of low precipitation might affect the ratio of female to male owlets hatched in a particular year- in some bird species, one sex will be favored over the other in times of stress. As part of the data sets collected over 41 years in Dr. Brian Linkhart’s long-term research study on Flammulated Owls, field crews have been collecting blood samples from owlets since 2003 to determine their DNA sex, since the plumage of male and female owlets is identical. After participating in a field season in the Manitou Experimental Forest in Teller County, Colorado, I analyzed this data set documenting the DNA sex of owlets. My goal was to determine if there was any significant difference in sex ratios of owlets amongst the years, and if that difference was correlated to precipitation levels. In my analysis, I did find that the sex ratios were different for every year; however, the difference had no significant correlation to changes in precipitation, so the difference in ratios may be due to chance rather than as a response to a stress. However, continued data collection and analysis for both DNA sexes of owlets and precipitation levels is important, as a pattern may emerge over a longer period of time than the 16 years I was able to analyze. In addition, across all owlets and all years, I found that there were 47% females hatched to 53% males. Although this difference might seem insignificant, if this trend were supported with more years and a larger data set it could suggest that some factor, precipitation or not, is favoring males over females in this population of Flammulated Owls, which could have several important demographic consequences.

“Saved my Life”: A Program Evaluation of Colorado’s 4th Judicial District Recovery Court Program

Student Researcher: Cheney Hurley ’23
Major: Sociology
Faculty Collaborator: Gail Murphy-Geiss, Sociology

In partnership with Colorado College’s Sociology Department and Colorado’s 4th Judicial District Recovery Court, this evaluation intends to understand the effectiveness of the Recovery Court Program and what strengths and weaknesses are associated with it. Qualitative data was collected by the Recovery Court in 2019 using an anonymous and voluntary paper survey distributed to every participant in the Recovery Court Program. Participants were asked a series of demographic questions followed by more substantive questions regarding their satisfaction with the Recovery Court Program. Through qualitative coding and analysis, I found that respondents reported the program to be effective and transformative, particularly noting the value of weekly treatment groups and the structure provided in the recovery process. Difficulties reported by respondents include adjusting to the program, the demanding schedule, and urinalysis drug tests, and many suggested improvements to address these and other challenges. This report will be used by the Recovery Court to evaluate and improve the program so they can continue to help individuals overcome substance abuse and addiction.

from **PEDRO DE ARAUJO**
Dean of the College
Associate Professor, Economics

What is SCoRe?

During the summer of 2021, over 150 students participated in research under the mentorship and support of Colorado College's dedicated faculty both on and off campus. While the Block Plan structures academics around a condensed timeline, summer research allows students and faculty collaboratively to explore deeper into topics, by spending extended time researching in the classroom, the library, the lab, and the field.

The Student Collaborative Research (SCoRe) Program supports both students and faculty through academic and community field trips and gatherings, peer-to-peer presentations and discussions, and professional development workshops. We are excited to showcase the work CC faculty and students have done this summer.

Visit: **www.coloradocollege.edu/other/advising-hub/research-opportunities/**

"The SCoRe program provides an excellent opportunity for students to experience both the excitement and struggle of research. Many students have done short research projects in their courses at CC, but for most students, the SCoRe program is their first chance to fully immerse themselves in a full-time, long-term research project. Through this longer exposure to a research problem, students not only hone their technical skills and learn to become independent problem-solvers. Students also learn how to navigate the highs and lows that come with the rare breakthroughs and frequent failures of research. Learning about both the technical and human aspects of research are crucial in preparing students for graduate school and beyond."

AMY DOUNAY, Associate Professor, Chemistry and Biochemistry

P1 Synthesizing Inorganic Thin Film Solid Electrolyte from Aqueous Precursors

Student Researcher: Abigail Mercier ’22
Major: Biology
Faculty Collaborator: Donald Clayton, Chemistry and Biochemistry
Research Collaborator: Judy Wang ’21

Solid-state electrolytes are useful in electrical energy storage systems including rechargeable batteries, high-energy capacitors, and other electrochemical devices. While research studies of these materials are abundant in the literature, more environmentally sustainable approaches to their synthesis are of great interest. Offering a more sustainable approach for solid-state electrolyte synthesis situates battery chemistry in the expanding field of green chemistry. The focus of this work is to utilize aqueous precursors of simple inorganic salts to create industry-competitive solid-state films. Previously, the Clayton Lab has demonstrated the utility of this approach to produce high quality solid films of the ionic conductors $Li_5Al_2O(PO_4)_3$ (LiAlPO) and $Li_2O—Al_2O_3$ (LiAlO). The next phase of this research aims to expand the synthetic method to more conductive and competitive synthetic targets. In this research, both $Li_5Al_2O(PO_4)_3$ and $Al_2O(PO_4)_3$ precursors solutions were successfully replicated and tested with TGA analysis; this establishes the baseline for later relative experiments.

P2 Caste, Race, and Capitalism: An Exploration of the Development and Maintenance of Racial Capitalism in the Caribbean

Student Researcher: David-Elijah Brown’22
Major: English, Creative Writing
Faculty Collaborator: Najnin Islam, English

This past summer, I worked with Professor Islam to research comparative studies of caste and race on a global context. Using archival newspaper documents from the mid-nineteenth century to the early twentieth century from Port of Spain, Trinidad, we searched for and interrogated articles reflecting the nature and language used in reference to caste and race during post emancipation life in the Caribbean. Focusing on caste and race comparisons as they relate to power and racial capitalism, this research functioned as an entryway to a developing, nuanced understanding of global labor migrations during the nineteenth century. What is it to call caste race? What does the language suggest about the lived experience of the caste system? What is the role of power? Perhaps there is something to learn about the role of radical love. This research invites a rethink of capitalism and its insidious tendencies. While I will allow this research to inform my creative practice and creative writing thesis, Professor Islam will be using this research to further develop a book exploring Indian indentured servants in the Caribbean.

P3 True *dpy*-19 null allele reveals gene's importance in neuroblast migration in *C. elegans*

Student Researcher: Ana Musto '22
Major: Molecular Biology
Faculty Collaborator: Darrell Killian, Molecular Biology

During nervous system development, undifferentiated cells known as neuroblasts, migrate to specific locations where they differentiate into neurons. In *Caenorhabditis elegans,* it has been suggested that the *dpy-19* gene plays a role in Q neuroblast lineage polarization and migration, and an unrelated role in regulating body length. However, past studies have only examined mutations in the *dpy-19* gene that only partly eliminate its function and a true null allele of *dpy-19* has yet to be studied. With a true null allele created by genome editing, here, we aim to determine the extent to which *dpy-19* impacts Q cell neuroblast migration, as well as animal length. First, we scored multiple *dpy-19* mutations to determine their effects on body length. These same *dpy-19* mutant strains were scored for neuroblast migration defects using GFP markers for the neuron identities: A/PQR, A/PVM and SDQL/R. Finally, the direction of movement of the Q cell lineage ancestors – QR and QL – was analyzed for all mutants. Our results suggest the true null allele of *dpy-19* causes significant reduction in body length compared to the other mutants studied, however missense mutations *e1314* and *e1259* are more likely to affect the migration of PQR, PVM and SDQL neurons. These results suggest the role of *dpy-19* might be multifaceted and draws attention to the importance of specific amino acids within DPY-19.

P4 Water Issues in the West: Castle Rock Water Management

Student Researchers: Anna Sofia Vera'22; Diellza Muriqi '22
Majors: Environmental Science; Economics
Faculty Collaborator: Kat-Miller Stevens, Economics and Business and State of the Rockies
Research Collaborator: Cyndy Hynes, State of the Rockies

Castle Rock has a population of 75,285 people and is rapidly expanding. While the town's population continues to grow, water shortage has become an important concern. In the last decade, the town has implemented programs to increase supply and decrease demand. One of their main goals is to supply the town with 75% renewable water by 2050, which includes water from surface streams, tributary groundwater, and reused water. However, renewable water has two issues (1) it is more costly (2) it is subject to high variability and vulnerability because of an increasingly hotter and drier climate. One section of our research focused on finding ways that the city can provide water in an equitable and accessible way while maintaining their goal of 75% renewable water, given that water rates are projected to significantly increase. The other section of our research was investigating Aquifer Storage and Recovery programs as an alternative storage strategy (to surface reservoirs) as a means to secure water during times of drought and wildfires and decrease the strain on overallocated surface streams in the Front Range.

P5 Redistricting

Student Researcher: Josemary Fernandez '23
Major: Mathematics
Faculty Collaborator: Beth Malmskog, Mathematics and Computer Science
Research Collaborators: Sam Caro '22; Joshua Kalenga '22; Lilly Davis '22; Dominic Altamura '22; Casmali Lopez '23; Bright Throngprasertchai '22

Our research this summer was focused on redistricting, which is a process that happens frequently to draw new precincts, districts and to accommodate for a growing or changing population. There were many parts to this project, which included working with GIS program to draw new maps, creating code to produce a plethora of acceptable maps, and outreach to encourage community involvement. We worked specifically with data from Colorado to create new and justifiable maps. This work is really important because it is crucial that the redistricting process is not unfair. Unfair redistricting can be seen through phenomenon such as gerrymandering, which can influence elections and distributions of funds to be unjust.

P6 Enclosure, Commodification, and the Dispossession of Roma Communities in Contemporary Slovakia

Student Researcher: Filip Carnogursky'23
Major: Environmental Science
Faculty Collaborator: John Gould, Political Science, Russian and Eurasian Studies

This research examines mechanisms by which marginalized Roma people in Slovakia have been evicted, moved to different towns, and dispossessed. Attempts to control the movement of Roma people -whether by prevention or by forced removals- go back several centuries, all the way to the reign of Maria-Theresa. The practice of moving whole communities away from economically or socially desirable places has been very common in modern-day Slovakia too. By investigating a recent removal of several hundred Roma people from Banícka street, located in the developed city of Poprad, this research tries to shine a light on current practices which allow such removals elsewhere in Slovakia. The remaining local Roma and non-Roma people have been interviewed as well as the moved Roma people who now live without water, gas or electricity in the small town of Nizna Slana. Interviews with officials and local people from both towns produced diverse responses on how the move was carried out. Whether the removal was arranged by profit-seeking "investors" or "city officials" every informant but the Poprad city officials said that the Roma people "have been moved", thus implying that someone has overseen the process and that it has not been spontaneous. The removal of several hundred Roma people from the city center of Poprad -completed in a few weeks- to backwater Nizna Slana seems to be in line with past instances of organized dispossessing of Roma people for capital accumulation. The research will be finalized into a podcast episode.

P7 Effects of a Warming Climate on Plant-pollinator Interactions in the Alaskan Tundra

Student Researcher: Alex Jennings '22
Major: Environmental Science
Faculty Collaborator: Roxaneh Khorsand, Organismal Biology and Ecology

Climate change is altering arctic ecosystems and plant communities. While there has been abundant research investigating abiotic changes and shrubification of the tundra, the specific effects of warming on plant-pollinator interactions remains understudied. Our research intends to establish a pollination network on Alaska's North Slope and determine how warming impacts the historically synchronous relationship between plants and their pollinators. Since 2019, we have simulated warming by using open top chambers in dry heath and moist acidic plant communities. Our methodology seeks to answer four central questions: 1) How does experimental warming affect the timing and duration of flowering? 2) How does experimental warming affect the quantity and quality of floral nectar? 3) Which insect types are the most effective pollinators? 4) Is pollinator exclusion detrimental to plant reproductive output? Our 2021 data are still being analyzed, although data from 2019 and 2020 suggest that: (1) flowering lasts longer in warmed plots, (2) Dipterans (flies and mosquitoes) are the most abundant visitors, although Hymenopterans (bees) are more effective at transporting pollen, and (3) warming increases nectar volume but does not alter sugar concentration.

P8 Identifying MAT Locus Sequences and Structures in *Ogatea methanolica*, *Ogataea pilisensis*, *Ogataea haglerorum*, *Ogataea angusta*, and *Candida arabinofermentans* Using MinION Sequencing and Hi-C

Student Researchers: Lindsay Smith ’23; Amanda Yoo ’23
Majors: Molecular Biology; Molecular Biology
Faculty Collaborator: Sara Hanson, Molecular Biology

Yeast species can have different cell types determined by the sequence present at the mating-type (MAT) locus with sexual species requiring two cells of different mating types to reproduce. Sexual yeasts can be categorized based on their mating systems as homothallic (have no distinct mating types or can switch mating types) or heterothallic (stable and static mating types). Our primary goal of this project was to determine the three-dimensional configuration of yeast species’ chromosomes and how particular configurations facilitate mating-type switching. We performed Hi-C on *Ogatea methanolica*, *Ogataea pilisensis*, *Ogataea haglerorum*, *Ogataea angusta*, and *Candida arabinofermentans* to locate spatial DNA and chromosomal interactions. Using MinION sequencing, we obtained long-read sequences of *Ogatea methanolica*, *Ogataea pilisensis*, and *Ogataea angusta* which provided more complete and accurate assemblies of the MAT loci. With this information, we will be able to determine how the MAT locus is arranged in relation to the rest of the genome in each species and how this relates to each species’ mating systems.

P9 Together Means More: An Analysis of Conjunctive Water Management for the Edwards Aquifer

Student Researcher: Olivia Coutre ’23
Major: Southwest Studies and Environmental Studies
Faculty Collaborator: Eric Perramond, Southwest Studies, Environmental Program

Conjunctive water management, defined as management that acknowledges surface water and groundwater to be interconnected, is a formal system in many states for accounting for and assuring water supply. Most western states are experiencing rising temperatures, longer droughts, and population growth, which makes a challenging combination of decreased water supply yet increased demand. Many states have adopted conjunctive management strategies to address these challenges, but Texas faces unique legal and cultural obstacles. The Edwards, a karst aquifer in south-central Texas, is a prime example of how bifurcated law, limiting judicial processes, decentralization, and the underfunding of Texas water regulation hinders conjunctive management. Despite this, many water-using entities in the Edwards have successfully implemented projects such as aquifer storage and recovery, recharge enhancing infrastructure, voluntary irrigation suspension programs, drought contingency plans, and outsourced water. These initiatives increase water supply for the aquifer’s in-stream flows for endangered species and growing municipal demand.

P10 In Vitro Culture of Bovine Fibroblasts using Select Serum-Free Media Supplemented with Chlorella vulgaris Extract

Student Researcher: Galileo Defendi-Cho ’24
Major: Undeclared
Faculty Collaborator: Timm Gould, Chemistry and Biochemistry

Standard cell culture practices require addition of animal-derived serum to culture media to achieve adequate cell growth. Typically, 5-10% by volume of fetal bovine serum (FBS) is used, which accounts for a vast majority of the cost of media and imposes environmental and ethical problems associated with the production of animal serum. Here we tested the efficacy of culturing cells by replacing serum in the media with algae extract and select additives. Using LC-MS, we compared molecular signatures of FBS to extracts derived from two different strains of Chlorella and identified common features in their characteristic profiles. Bovine fibroblasts, cultured in serum-free media supplemented with C. vulgaris extract and just two growth factors plus insulin, showed significant growth with enhanced viability compared to control cells cultured without serum, albeit still lower than that of controls cultured with 10% FBS. Furthermore, C. vulgaris extract enhanced cell viability beyond that of cells cultured with the two growth factors and insulin alone. These results suggest that key components in serum that are essential for cell growth may also be present in C. vulgaris extract and demonstrate that it may be used at least as a partial alternative to serum for cell culture applications.

P11 Environmental Influence on Seismic noise in the Alaskan Arctic

Student Researcher: Cade Quigley ’23
Major: Geology
Research Collaborators: Alaska Earthquake Center- Michael West, Stephen Holtkamp, Kasey Aderhold, Alex Farrell

Seismic stations in the Alaska Geophysics Arctic Observation Network (AON) offer a unique opportunity to use seismic noise to better understand environmental change because of 1) the remoteness of the stations and 2) co-located meteorologic, infrasound, and seismic sensors. We use multiple years of meteorologic, seismic, infrasound, and geologic data from the AON to assess the controls rivers, sea-ice, surface ocean waves, and wind have on background seismic noise. We find that wind and river noise have the strongest control on high frequency seismic background noise, while ocean waves and sea ice have a strong influence on low-frequency seismic noise. Stations that are near high-energy rivers show high frequency seasonality (>6 Hz) that correlates with seasonal freezing and breakup of the rivers. Low-frequency seismic noise is dampened with the generation of sea-ice, suggesting a strong influence of ocean surface waves on low-frequency microseisms. Wind speed has a strong positive correlation with seismic power (dB) in frequencies above 1 Hz, with the greatest influence in higher frequencies (>10 Hz). In addition, AON stations show variable sensitivity to wind, which we hypothesize to be a result of local variabilities at stations, such as vegetation, surface topography, and enclosure design. Seismic noise records provide an additional long-term dataset in remote areas, such as the arctic, that are experiencing rapid environmental alteration as a result of global climate change.

P12 Electric Field Crystallization

Student Researchers: Mir Qi ’23; Adam Keim ’23
Majors: Undeclared; Physics and Chemistry
Faculty Collaborator: Eli Fahrenkrug, Chemistry and Biochemistry

Crystal molecules are able to arrange themselves in various geometries, known as polymorphs. The different polymorphs of API’s (Active Pharmaceutical Ingredients) are able to affect various biological parameters such as absorption rate and consequently the effectiveness of the drug. Previous research has shown that by growing crystals in strong electric fields on the order of 10^9 V/m, we can establish selectivity for certain polymorphs of these crystals. We developed a cell where we are able to apply these electric fields at the interface between a dielectric and an electrolyte and grow crystals on our dielectric -- Essentially a capacitor that can be opened to analyze the crystals we’ve grown. In the lab, we utilized rapid prototyping techniques including parametric CAD modeling and 3D printing to develop cells that are resistant to leaking over >12hr crystal growth trials. After extensively iterating on our cells, we grew crystals in them, and analyzed our crystal samples using XRD (X-ray diffraction) as well as DSC (Differential scanning calorimetry), the latter of which showed that we possibly achieved selectivity for Form II of paracetamol in our crystal growth trials.

P13 TDA and Oil Market Crash Predicting

Student Researcher: Marston Xue ’22
Major: Mathematics
Faculty Collaborator: Molly Moran, Mathematics and Computer Science

Topological data analysis (TDA) is a newly developed branch of mathematics developed to understand data using topological tools. Starting with a point cloud, we connect points whose distance is smaller than a certain number R to build a topological object we can study. As R increases, this object we build becomes more complex. We use topological tools to study this object and its transformation and then identify features that persist in each iteration. In this research, we use TDA to explore the future product market for oil. We analyze the time series of prices for four correlated energy futures: crude oil, Brent oil, natural gas, and gasoline. We show that the persistence landscape Lambda_1 for the first homology group exhibits strong growth before a crash happens.

P14 Denial of Indigenous Rights on Public Land; Barriers to Co-Management at Bears Ears National Monument

Student Researcher: Rosalee Bayer ’22
Major: Political Science
Faculty Collaborator: Kat-Miller Stevens, Economics and Business and State of the Rockies
Research Collaborator: Drew Cavin, Global Education and Field Study

The United States has long excluded, often through violent removal, Indigenous nations from their ancestral land. In southern Utah, a coalition of representatives from the Hopi Tribe, Navajo Nation, Ute Mountain Ute Tribe, Pueblo of Zuni, and Uintah Ouray Ute is pursuing collaborative decision-making authority (“co-management”) for part of their sacred land: Bears Ears National Monument (BENM). This research aims to identify what is preventing the realization of co-management at BENM through analyzing (1) what co-management means (2) what direct precedent exists and (3) the history and political realities of the region. I determined that there is no direct precedent by using Goodman’s (2000) six principles of co-management to analyze the management arrangements at three national monuments commonly referenced in co-management literature: Canyon de Chelly National Monument, Kasha-Katuwe National Monument, and Santa Rosa and San Jacinto Mountains National Monument. Other significant barriers appear to be the strong political opposition to the existence of BENM, the lack of consensus about how co-management should function, and the lack of recognition from the federal government that a more just management arrangement is needed. These substantial and complex barriers indicate that co-management will be challenging to achieve.

P15 Suja, louca, e sem moral: Re-imagining Trans Narratives Through Art and Fantasy

Student Researcher: Manuel Uribe ’22
Major: Romance Languages: Spanish and Portuguese
Faculty Collaborator: Naomi Wood, Spanish and Portuguese

Due to the global expansion and exportation of the popular reality TV competition show *RuPaul’s Drag Race*, queer, gay, and transgender artists all over the world are reaching new heights of fame as professional singers, actors, entertainers, and entrepreneurs—especially in Brazil. However, *Drag Race* promotes queer art that is often sanitized and palatable for White, cis-het audiences. It rarely considers monstrosity and other deviant forms of queer expression as legitimate or profitable. This project focuses on the lyrics and music video for Urias’ song “Diaba.” A transgender woman and self-proclaimed she-devil, Urias sings about the transphobia that she has suffered throughout her life and converts this pain into art, and subsequently into financial capital, in order to continue resisting everyday transphobia. In “Diaba,” Urias monsters herself as a means of exorcising the demons of her past and creating pleasure for herself through demonic fantasies of power and domination.

P16 Dynamics of a DC-driven atmospheric pressure plasma jet

Student Researcher: Džafer Čamdžič ’22
Major: Environmental Physics
Faculty Collaborator: Adam Light, Physics
Research Collaborator: Logan Henning ’22

The dynamical regimes of atmospheric pressure plasma jets remain relatively unexplored. While a small number of studies have observed chaotic behavior in jets, very little is known about dynamical transitions in these systems. Better understanding of the possible dynamical regimes will help constrain the large parameter space available for applications. We measure the temporal behavior of the electrode current in a DC-driven, coaxial dielectric barrier jet using argon. Analysis of recurrence rates in a time series provides a quantitative means to classify dynamics and identify transitions in a complex system. We use recurrence quantification analysis (RQA) to explore dynamical variations in the discharge current for a simple jet system.

P17 State of the Rockies Project 2021: Senate Testimony Analysis

Student Researchers: Greta Forseth ’23; Izzie Hicks ’22
Majors: Environmental Science; Environmental Studies
Faculty Collaborator: Kat-Miller Stevens, Economics and Business and State of the Rockies
Research Collaborator: Saigopal Rangaraj ’22

The 2021 State of the Rockies project examined policy debates around regulating oil and gas development in Colorado, specifically looking at SB 19-181, a bill that passed the state legislature and was signed into law by Governor Polis in 2019. Our research involved qualitative coding of written and verbal testimonies about the bill given in the Finance and Transportation & Energy committees of the Colorado Senate. We coded the statements made by different stakeholders in the sessions to determine patterns of arguments; emotions and characters used; focusing events mentioned; and various political, economic, and social impacts of fracking in Colorado as discussed by different proponents and opponents of the bill. We seek to answer the question of why the proponents won the fight for SB 19-181 and determine the factors that influenced the outcome, as well as their replicability in different settings.

P18 Mapping Critical Skills of Environmental Educators

Student Researcher: Vanessah Klaers ’23
Major: Environmental Science
Faculty Collaborator: Howard Drossman, Education

As aspiring educators shape the art and science of their teaching practice, they sometimes struggle to apply developmental psychology principles appropriately. The Lectical Developmental Pedagogy Assessment (LDPA), a developmental assessment designed by Theo Dawson that evaluates students' responses to five open-ended questions, was issued to 17 college students participating in the Teaching and Researching Environmental Education (TREE) Semester. I qualitatively coded the assessment responses to nine existing aspects related to developmental pedagogy: Developmental Psychology, Developmental Dynamics, Developmental Pedagogy, Psychological Structures, Curriculum, Learning, Assessment, Theory and Practice, and Methodology. Based on the codes related to each of the nine aspects, I created skill maps to explore under-theorized components of the TREE participants' understanding of each aspect. The skill maps were then expanded with the help of the TREE Semester Program Director to more effectively guide TREE Semester participants' learning. By testing how this can improve TREE Semester students' learning in fall 2021, we hope that our research will inform other teacher educators to develop a more robust curriculum in the field of developmental pedagogy.

P19 Revealing the Potential of Fingerprints as Sources for Biomarker Discovery Through MS Data Normalization

Student Researcher: Aleesa Chua ’22
Major: Chemistry
Faculty Collaborator: Heather Desaire, University of Kansas
Research Collaborator: Leah Pfeifer, University of Kansas

The utility of fingerprint samples for health diagnosis is largely unexplored, despite its ubiquity and ease of access. However, fingerprint compositions are complex, which challenges the identification of potential biomarkers. The integration of mass spectrometry (MS) and machine learning (ML) enables the study of thousands of signals at once, which can facilitate the identification of the most biologically relevant signals. However, there are challenges to data reproducibility inherent in MS data acquisition, like instrumental fluctuations, that hinder effective ML outcomes. This study’s aim was to address such issues of reproducibility through the identification of a normalization strategy that best minimizes the effects of systematic variation in pooled MS data sets. A total of 202 fingerprint lipid samples, collected in seven batches, from two different biological conditions were used for the study. Prior to normalization, the variation in MS signal intensity between batches accounted for the greatest source of variability. To mitigate this, four different approaches of data processing were selected and investigated in R. Normalization effectiveness was qualitatively assessed through the reduced sample clustering by batch on a principal component analysis. EigenMS outperformed in eliminating the effects of systematic variation, while also providing improved classification outcomes. This study’s results enable the use of fingerprint samples for future biomarker discovery and prompt further investigations into their utility as measures for various biological conditions.

P20 Patents and Innovation in the Medical Device Industry

Student Researcher: Sam Caro ’22
Major: Economics
Faculty Collaborator: Kristina Acri, Economics and Business

The healthcare industry is one of the most lucrative industries globally. Patents are an important tool to incentivize innovation in the healthcare industry. Patients, doctors, and hospitals continue to demand life-saving medications, surgeries, and devices. The innovation of firms and individuals is therefore crucial to the health and well-being of the public. The U.S. patent system incentivizes this innovation and offers firms compensation for the resources invested in new medications. However, research shows that the legal environment of the pharmaceutical industry effectively shortens the patent life of new drugs and decreases the incentives that drive innovation in the industry (Acri & Lietzan, 2020). This is problematic in that our legal system skews innovation incentives away from breakthrough discoveries and towards marginal improvements of existing drugs or devices. The focus of our research this summer analyzed the economic effects of patent distortion in the medical devices industry. While the research is still ongoing, the legal analytical framework points towards patent distortion of medical device patents.

P21 Finding Fairness in Redistricting

Student Researchers: Lily Davis ’22; Sam Caro ’22; Dominic Altamura ’22
Majors: Political Science and Mathematics; Economics; Mathematics
Faculty Collaborator: Beth Malmskog, Mathematics and Computer Science
Research Collaborators: Josmary Fernandez ‘23; Joshua Kalenga ’23; Casmali Lopez ’23; Bright Throngprasertchai ’23

In this research, we set out to develop a cheaper alternative to detecting a common contaminant in beer, diacetyl. Diacetyl is a contaminant that develops naturally in the fermentation process, and in very small concentrations ruins the taste of beer. With the recent increase in popularity of microbreweries, finding cheap and effective methods in quality control has become more important. We devised a technique that uses a UV-vis spectrometer to detect the presence and quantity of diacetyl. Through heating the beer and trapping the contaminant on a thin layer of poly vinyl alcohol (PVA), we can measure the change in absorbance of the PVA membrane, and then calculate the concentration of diacetyl. This method shows promise to be reliable and accurate when compared to an already accepted method of testing (Liquid Chromatography Mass Spectrometry) but is much cheaper and more accessible to smaller breweries.

P22 Colorado Redistricting: Recombination and Parallel Processing

Student Researchers: Joshua Kalenga ’23; Bright Throngprasertchai ’23; Casmali Lopez ’23
Majors: Computer Science; Mathematical Economics; Mathematics
Faculty Collaborator: Beth Malmskog, Mathematics and Computer Science

Given the political importance of redistricting and gerrymandering in the ‘swing state’ of Colorado, Markov-Chain-Monty-Carlo (MCMC) analysis of possible district layouts allows us to help identify fair and competitive redistricting. An integral part of MCMC analysis is the recombination algorithm that is used to move from one possible district layout to another. This process is repeated many times to generate statistically significant distribution plots for the possible districting layouts of Colorado within a certain set of legal requirements and desirable traits. This project implements existing Gerrychain and Multiprocessing python libraries in an attempt to reduce run time of the recombination algorithm. Initial runs of the team’s algorithm with congressional districts show the limitations of parallel processing, while more promising perspectives exist with the state house districts of Colorado.

P23 Analysis of Floral Volatiles and Nectar from Flowers of *Pleurothallis* Subgenus *Ancipitia* to Determine if *P. Crocodiliceps* Group Species are Pollinated by Deception

Student Researcher: Anusha Vajrala ’23
Major: Biochemistry
Faculty Collaborators: Murphy Brasuel, Chemistry and Biochemistry; Mark Wilson, Organismal Biology and Ecology
Research Collaborators: Izzy Hensley ’21; Raven Ward ’21

Previous research on orchids in the genus *Pleurothallis* suggests that flowers reproduce by reward or deceit pollination depending on their floral micromorphology. Specifically, flowers utilizing deceit pollination pollinate by pseudocopulation. Our research focuses on orchids from the subgenus *Ancipitia,* and we hypothesize that putative deceptive species group separately from putative rewarding species based on their floral volatile profiles and that putative deceptive species release significantly less sugar than rewarding species. Through GC-MS analysis, dendrogram grouping patterns among putative deceptive species *P. acinaciformis*, *P. renieana*, and *P. wielli* were identified. Analysis of chemical standards led to the confirmation of 14 floral volatiles which are also known insect semiochemicals. These volatiles include: (Z)-9-tricosene, eicosane, tricosane, docosane, heneicosane, hexadecane, octadecane, benzothiazole, benzaldehyde, 2-methoxy-4-vinylphenol, 2-(1-phenylethyl)-phenol, 2,4-di-tert-butylphenol, ethyl stearate, and bis(2-ethylhexyl) phthalate. LC-MS analysis revealed that sucrose was the predominant sugar in rewarding species, whereas two sugars were most abundant in deceptive species. Further examination of nectar data suggests that putative deceptive species do not produce a significantly less amount of sugar in comparison to rewarding species, rejecting the hypothesis that putative deceptive species release significantly less sugar than rewarding species.

P24 An Exploration into the Efficacy of Addition Reactions in Benzyne Photochemistry

Student Researcher: Will Abbey ’22
Major: Biochemistry
Faculty Collaborator: Jessica Kisunzu, Chemistry and Biochemistry
Research Collaborators: Mir Qi ’22; Adam Keim ’23; Ben Sokol ’22

Benzynes are cyclic 6-carbon molecules with an unstable triple-bond, and prior to the 1970s, they saw limited use in organic synthesis due to the harsh conditions necessary to generate them. In 1983, mild methods and precursors, specifically silyl-triflate compounds, opened the door for benzyne to become applicable for the synthesis of polycyclic molecules. Another method discovered in 1978 used UV-sensitive precursor molecules to effect benzyne generation. While the photochemical process to generate this molecule has been studied, the applications of this UV effected benzyne generation have only been documented in one reaction type to date. “Click” chemistry reactions of photogenerated benzynes and nitrogen-containing compounds have been shown to occur on greatly reduced time scales when compared with non photochemically-generated benzynes. This reduction in time demonstrates significant promise for other reactions with photo-benzynes and the method could see use in pharmaceutical and commercial settings. In the research presented herein, the synthesis of AMTBA, the aforementioned photo-benzyne precursor, has been improved; furthermore, a series of novel reactions was conducted to provide the groundwork for future studies of photo-benzyne chemistry.

P25 An Investigation into Reactivity of Monothiomalonamides and Benzyne

Student Researchers: Anh Do ’23; Izzy Nagle ’23
Majors: Chemistry; Biochemistry
Faculty Collaborator: Jessica Kisunzu, Chemistry and Biochemistry

Benzyne is a six-carbon, cyclic and aromatic compound that contains a triple bond, resulting in a high level of molecular strain and reactivity. Based on previously reported work in which B-dicarbonyl compounds have been observed to react with benzyne to form various insertion products, the Kisunzu lab is investigating the reactivity of monothiomalonamides (MTMAs) with benzyne. MTMAs are dicarbonyl compounds containing an amine group and a thioester group, contributing to the novelty of this reaction. Due to MTMA’s uninvestigated reactivity with benzyne, a variety of reaction conditions were used to determine which ones favor the desired insertion products. Reactions were run at 60 or 80°C, for times ranging from 0.5 hours-6 hours. Additionally, computational analysis was performed using Spartan to determine the lowest energy conformers of the compounds and intermediates involved in the synthesis. The mass of the desired insertion product was detected after a reaction time of 0.5 hours, at 80°C, however the product was not able to be isolated and characterized. Further investigation is needed to replicate these results and fully characterize the products of the benzyne reaction.

P26 Teach and Thrive Learning Circles

Student Researcher: Doré Young ’23
Major: Environmental Science and Chemistry
Faculty Collaborator: Tina Valtierra, Education
Research Collaborator: Danny Zamudio MAT ’23

This project was designed to explore the factors influencing outcomes like burnout, turnover, and thrival in early career teachers. Part of this research is working to understand all the problems and pressures teachers may face and how those relate to their particular school environments. This research was done through the Teach and Thrive Learning Circles (TTLCs), focus groups, in-depth interviews, and literature review. TTLCs were community meetings with Colorado College’s MAT (Masters of Arts in Teaching) students and recent graduates of the program where they could share stories, struggles, advice, and support. Every week, participants interacted with educational presentations and engaged in check-ins, mindfulness activities, reflections, and discussions. Teachers need as much support as possible and we found that developing teacher identity is crucial to keeping teachers teaching effectively. It is known that teacher identity is important to teacher and student success, but examining these TTLCs can offer insight into how this identity is best cultivated and maintained.

P27 Effects of Short-Chain Fatty Acid Supplementation on The Behavior and Gut Microbiota of Maternally Separated Rats

Student Researchers: Emma O’Leary ’22; Tia Vierling ’22; Ethan Grant ’23
Majors: Neuroscience; Neuroscience; Neuroscience
Faculty Collaborator: Lori Driscoll, Psychology

Early life adversity (ELA), a broad category of trauma including childhood abuse and neglect, is associated with a propensity for drug addiction, increased anxiety, and memory difficulties even into adulthood. Prior research has established that gut microbiota may impact mental health and wellbeing, therefor interventions in this pathway of communication between gut and brain (known as the microbiome gut-brain axis) are of therapeutic interest for their potential to address the effects of ELA. Short-chain fatty acids (SCFAs), which are microbial metabolites, are known mediators by which gut microbiota communicate with the brain, yet the potential of SCFAs to alleviate the effects of ELA on behavior remains relatively uninvestigated. Following a period of maternal separation, a rodent model of ELA, rats were supplemented with SCFA or control solutions. Subsequently, rats underwent a battery of established behavioral tests to assess anxiety, depressive and addictive behavior, as well as long- and short-term memory. Rat brains were analyzed for hippocampal volume posthumously. Cecal samples were also collected to analyze the effects of ELA and SCFA supplementation on gut microbiome composition. Groups showed no significant differences in performance on tests designed to assess addictive behavior and anhedonia; results for other tests are forthcoming.

P28 **UV Triggered Spark Gap for Repeatable Discharges**

Student Researcher: Logan Henning ’22
Major: Computational Physics
Faculty Collaborator: Adam Light, Physics

We present progress towards a UV (275nm) LED triggered spark gap as a cheap solution for a repeatable discharge in high voltage ns pulsed power sources. While spark gaps are the simplest high voltage switches, the discharges can have several microseconds of timing uncertainty. Alternative switches that hold off 10kV or more and provide less jitter can be cost prohibitive and difficult to obtain. By using variable-time-length pulsed emission from a UV LED, we hope to show a correlation between discharge timing uncertainty and UV emission. Preliminary results of the jitter and rise times are presented. We present progress to date and details of the switching characteristics of the triggered gap.

P29 **Design of an Interferometer to Measure Electron Density in Atmospheric Pressure Plasma**

Student Researcher: Benjamin Modlin ’23
Major: Physics
Faculty Collaborator: Adam Light, Physics

As a cost-effective way to measure electron density in atmospheric pressure plasmas, we explore optical interferometry using a continuous wave laser and lock-in detection, a form of detection for amplification of signals at specific frequencies. We present a Nomarski-type geometry designed to minimize sensitivity to inter-path vibrations and allow for future measurements with pulsed light. Typical electron densities of atmospheric pressure plasma jets range down to approximately 10^{12}/cc, which corresponds to a phase shift of only a few microradians in 632.8nm light. In order to increase our sensitivity to this small change, we drive the plasma with oscillating high voltage at 42 kHz and use that as our reference signal for phase-sensitive detection. We present the current design, preliminary results, and plans for upgrading the diagnostic in the future.

P30 **Dr. Justina Ford Documentary**

Student Researchers: Brian DeLong ’23; Sabrina Brewer ’21
Majors: History and Film and Media Studies; History
Faculty Collaborator: Jane Murphy, History

Our research focused on the life of Dr. Justina Ford (1871-1952), a woman largely recognized for her role as the first licensed Black female doctor in Colorado. Her relationships with patients, leadership in the Denver community, and investment in local industries reveal a woman dedicated to the well-being of others. While we used archives to better understand Dr. Ford’s personal struggles, accomplishments and acts of generosity, we also looked into the larger context of racial and economic disparities in healthcare, the history of marriage, and Colorado’s medical history. As researchers, we are proud to have learned more about the life of a woman with a tremendous impact on her community as well as Colorado’s medical and social community. Our hope is that our work, culminating in a Rocky Mountain PBS documentary, will continue to expand the story of Dr. Ford’s life and legacy.

P31 Developing an accessible, open-source sensor for PFAS contamination

Student Researchers: Ryan Freedman ’22; Elias Mondaca ’22
Majors: Environmental Science; Chemistry
Faculty Collaborator: Eli Fahrenkrug, Chemistry and Biochemistry

Per- and polyfluoroalkyl substances (PFAS) are a family of notoriously stable and harmful compounds that have become ubiquitous as water contaminants of great concern across the globe. PFAS detection is a major challenge since current methods require technical and costly laboratory equipment, which translates to hundreds or thousands of dollars per individual test. Our work aims to develop a cheap, simple-to-manufacture sensor for immediate and on-site detection of perfluorooctanesulfonic acid (PFOS), a particularly potent compound in the PFAS family. This presentation will demonstrate the use of conventional gold electrodes coated with thin molecular imprint polymers (MIPs) for selective and sensitive PFOS detection in the biologically relevant low part-per-trillion range. This work focused on developing a method to repeatably electropolymerize and characterize the critical MIP layer, while also understanding how MIP stability is impacted by exposure, re-use, and time. Finally, this presentation will describe how this MIP platform will be adapted to bipolar electrodes (BPEs) to further decrease sensor size and simplify device readout using a simple smartphone camera.

P32 Affirming Indigenous Sovereignty: Limitations and Potential of the Bears Ears Model

Student Researcher: Sophie Pelletier ’22
Major: Environmental Studies
Faculty Collaborator: Eric Perramond, Southwest Studies, Environmental Program

The history of conservation in the United States has been marked by land dispossession, oppression, and violence against Native Sovereigns. To rectify this history, co-management, or the sharing of responsibility between two government entities, emerged as a powerful strategy in strengthening Indigenous involvement in conservation to respect Native sovereignty. In 2016, a coalition of the Hopi Tribe, Navajo Nation, Ute Mountain Ute Tribe, Pueblo of Zuni, and Ute Indian Tribe proposed the creation of Bears Ears National Monument. In their proposal, the coalition delineated the necessity for the co-management of the Monument with the United States government. This paper assesses the limitations and potential of the National Monument’s model of co-management. Bears Ears National Monument offers a promising and just model for conservation in the United States, but is insufficient in meaningfully respecting tribal sovereignty because it is still trapped within colonial structures and exclusionary approaches to land management.

P33 Summertime Ozone Behavior along a Vertical Transect near the Denver, Colorado Metropolitan Area

Student Researcher: Tiantian Zhu ’22
Major: Environmental Science
Faculty Collaborator: Lynne Gratz, Environmental Program

Denver, Colorado in the Northern Front Range of the Rocky Mountains is a nonattainment area for surface ozone. Summertime ozone levels are influenced by local precursor emissions such as heavy motor vehicle usage and an active oil and natural gas industry, as well as western U.S. wildfires and complex terrain-driven wind patterns. Persistent high levels of summertime ozone emphasize the ongoing need for monitoring and mitigation for the protection of public health. In summer 2017, the Colorado Department of Public Health & Environment measured hourly ozone at seven sites along a vertical transect on the eastern slope of the Rocky Mountains, from Golden, CO (1839m ASL) to Mines Peak (3683m ASL) to determine the vertical extent and temporal variability of the Denver ozone plume. Mean ozone increased by 1.0ppb per 100m for the four lowest elevation sites (up to Black Hawk, 2627m ASL). At these same four sites, diurnal amplitudes in hourly mean ozone generally decreased with increasing elevation and the effects of mountain-valley wind patterns on diurnal ozone levels were evident. In contrast, two higher elevation sites, Jim Creek (3104 m ASL) and St Mary (3163 m ASL), showed weaker associations with diurnal mountain winds, significantly lower mean ozone concentrations than adjacent lower elevation sites, while Mines Peak appeared to serve as a regional background site. Multiple high ozone events, including those impacted by regional wildfires, were also assessed using a combination of local criteria pollutant measurements, synoptic meteorological maps, satellite imagery and air mass back-trajectories.

P34 Analyzing the role of the rbm-39 gene in C. elegans neuronal morphology

Student Researcher: Cade Thumann ’22
Major: Molecular Biology
Faculty Collaborator: Darrell Killian, Molecular Biology
Research Collaborator: Duffy Doyle ’22

Neuronal function depends on dendritic and axonal processes that create a network of connections between neurons in which their morphology is critical for proper nervous system function. Recent studies have identified genes that regulate dendrite morphogenesis in model systems including *Drosophila melanogaster* (fruit fly) and *Caenorhabditis elegans* (worm). *rbm-39*, which encodes an RNA-binding motif protein, has been shown to play a role in dendrite development in worms, while the fruit fly homolog is important for various aspects of nervous system development and function. The extent of the role of *rbm-39* in nervous system development is still unknown. Using a strain of *C. elegans* with the *rbm-39* gene removed by genome-editing technology, we examined the role of *rbm-39* in various neuron and glia subtypes. Specific neurons were analyzed and compared between the *rbm-39* mutant and control. Our results suggest that *rbm-39* has surprisingly minimal impacts on nervous system development unlike the role of its homolog in the fruit fly. To learn more about the molecular role of the RBM-39 protein, we isolated and sequenced mRNA from *rbm-39* mutants and compared the results to controls. The results strongly suggest that RBM-39 plays a role in the regulation of alternative splicing and we are analyzing the data to learn if genes that are important for nervous system development have altered splicing patterns.

P35 A New Phase of Urban Climate Action: The Intersections of Environmental Justice and Urban Greening in the Rocky Mountain West

Student Researcher: Clara Stein ’22
Major: Environmental Studies
Faculty Collaborator: Corina McKendry, Political Science, Environmental Studies Program

Cities have been important actors in environmental action and greenhouse gas reduction for years. Yet urban greening has often exacerbated social injustices, spawning green gentrification in low-income communities where local governments neglect the long-term impacts of capital investments. Now, some cities are reimagining what urban infrastructure and planning must look like to meet the needs for climate change mitigation, resiliency, and environmental justice. These local governments are restructuring institutions to work collectively in a polycentric system, to not only build a more sustainable urban environment, but to reimagine sustainability through a holistic lens, one intertwined with housing, transportation, urban planning, and the injustices that have plagued cities for generations. Through a cross-case comparison between Denver, CO, and Salt Lake City, UT, two cities committed to climate action while facing severe housing crises, this study argues that cities are entering a new phase of urban climate action, one rooted in righting systemic injustices to build a more sustainable and equitable urban environment for all.

P36 Transgender Studies in India: What’s in the “Field”?

Student Researcher: Eileen Huang ’22
Major: Feminist and Gender Studies
Faculty Collaborator: Rushaan Kumar, Feminist and Gender Studies

As a literature review, this summer research project explored how situated knowledge is produced about transgender experiences, politics, and theorizing in the context of the Indian empire. It aimed to ascertain if and what might comprise transgender studies as a "field of study" in Indian empire. In the 10 weeks, we studied themes and rationales behind content organizations of the two Transgender Studies Readers Vol 1&2, published in the US, and compared their structure and contents with writings by Indian trans activists and organizations on trans issues. We were driven by the question of how the specificity of the geopolitical location of India can help us theorize, reconfigure, and decolonize what we supposedly already know about queer and trans people. Taking seriously the histories of the violence in colonial knowledge production, we centered works by Indian trans writers in and outside of academia. I conducted weekly reports and literature reviews to identify universalizing discourse about trans people. Grappling with the impact of globalization on gender and sexual politics so to understand geopolitical formations in the Global South, I contended with what and who the language of “trans” includes, and which local embodiments and politics of gender would be left out.

P37 The effect of excess UV light on Arabidopsis thaliana's germination frequency and anthocyanin production

Student Researcher: Eileen Miller '23
Major: Organismal Biology and Ecology
Faculty Collaborator: Shane Heschel, Organismal Biology and Ecology

Due to the depletion of the ozone layer, more UV light is reaching earth, and this increase in UV light has proven harmful to plants, affecting life-history traits such as germination rate. One of the primary motivators for germination is the photosensor phytochrome. Seeds use phytochrome to sense their seasonal light environment and to decide when to germinate. Using Arabidopsis thaliana, we examined whether seeds with different phytochrome mutations tolerate excess UV in terms of germination success. We also investigated whether these phytochrome mutants have differences in anthocyanin content; anthocyanin is a pigment that plants produce as a UV protectant. For this experiment, seeds from wild-type (non-mutated background) and phytochrome mutant lines (phyA, phyB, and phyE) were grown on agar plates in a growth chamber and were exposed to either 60 minutes, 30 minutes, or no UV light. Germination data indicated that seeds from this species can tolerate slightly higher UV levels; however, Arabidopsis thaliana with either phytochrome E or phytochrome A gene mutations suffered when exposed to excess UV. This indicates that Arabidopsis thaliana is equipped to handle excess UV light however certain mutants of the plant will be negatively affected. In particular, phytochrome A and E genes might have a role in UV sensitivity. We also found that phytochrome B and E mutants produced more anthocyanin than phytochrome A mutants or wild-type, indicating that B and E might have roles regulating anthocyanin production.

P38 Analyzing Design Meetings

Student Researchers: Emily Evans '22; Liz Seero '23; Gwen Hardwick '23
Majors: Computer Science; Computer Science; Computer Science
Faculty Collaborator: Janet Burge, Mathematics and Computer Science

Meetings are a critical part of our work and academic life, both in person and remotely. This summer our team, along with another research team at the University of California, Irvine, analyzed the videos and transcripts of ten distributed design meetings from a major healthcare software development company. Our goal was the understand the issues that arise with such meetings that may inhibit efficiency of the team or the ability to produce a quality product. We began by creating a coding taxonomy to classify and organize our data. Our two primary areas of interest were to understand the types and frequency of tool use, and to understand the role of information both present and missing from meetings. After analyzing our coded data, we found that when designers were missing information they went ahead and made decisions anyway 44.2% of the time. Moving ahead while missing critical information could result in decisions that could impact the quality of the software. The goal of this research is to understand what happens in meetings and use that information to support development of tools intended to aid designers in making better decisions by capturing and presenting critical information.

P39 Cinema as Philosophical Exercise

Student Researcher: Daniel Teplow '22
Major: Philosophy: Philosophical Psychology
Faculty Collaborator: Jonathan Lee, Philosophy

This summer I collaborated with Professor of Philosophy, Jonathan Lee on his philosophical writing projects on prominent film directors Terrence Malick and Andrei Tarkovsky. The projects sought to illuminate the philosophical reflection posed by these films and the potential transformative aspect of these reflective experiences on the viewer. The philosophical aspects of the films span many dimensions of philosophy including ethics, metaphysics, phenomenology, aesthetics, and existentialism. In engaging with these films, viewers are brought to confront some of today's most pressing moral dilemmas, cultural issues, and to challenge dominant conceptions of the self. Film is the art medium of Professor Lee's choice as it lends itself to particularly immersive aesthetic experiences in addition to standing as today's prominent art medium. My work involved bibliographic research on the films and their philosophical aspects, synthesizing information from sources and evaluating its relevance to the project, and engaging in regular dialogue with Professor Lee with the aim of developing the thrust of his writing pieces.

P40 **Iceberg-rafted rocks and what they reveal about climate-warming in Antarctica: Evidence from uranium-lead isotopes and Antarctica's rock record**

Student Researchers: Amanda Yoo '22; Tiantian Zhu '22; Lindsey Smith '22; Denise Benitez '24; Emory Pollatsek '24; Ella Konrath '24; Anjolie Konrath '24; Casmali Lopez '23, Ben Roche '24
Majors: Molecular Biology; Environmental Science; Human Biology and Kinesiology; Undeclared; Geology; Undeclared; Undeclared; Undeclared; Geology
Faculty Collaborator: Christine Siddoway, Geology

A valuable record of the effects of climate warming in Antarctica is contained within ocean sediments that accumulated offshore from the Southern Continent. The sediment contains a timeline of the geological past, including intervals when warming caused the Antarctic icesheet to retreat inland rapidly, by releasing icebergs. This geological record can be used to forecast the consequences of anthropogenic global warming and icesheet contributions to future sea level. Our group of nine CC students, guided by four graduate student collaborators and one faculty, joined in a course-based research experience (CURE) that investigated material obtained by International Ocean Discovery Program (IODP) drilling in the Amundsen Sea in 2019. To determine whether sand-sized sediment had been shaped by glacier ice, we used CC's scanning electron microscope (SEM) to investigate surface textures of sand grains at very high magnification. To address the question of icesheet retreat, we selected rock fragments that had been entrained in flowing glacier ice on land, then carried to sea within icebergs that broke out from the Antarctic ice sheet. We acquired U-Pb isotopic data for the mineral *zircon* that is a constituent of each rock, using mass spectrometers in laboratories at University of Arizona. The isotope values served as a 'fingerprint,' that we could compare to onland geology databases in order to match each ice-rafted rock to its likely place of origin on Antarctica.
From SEM investigation, we discovered V-shaped percussion cracks, subparallel linear fractures, and conchoidal fractures, of the types documented to form in a high pressure subglacial environment where grains impact each other. Because such materials only form on continent, not in the deep ocean, they provide evidence of iceberg-rafting of the sand and coarser rock fragments to the IODP drill sites.
From the 17 rock samples we characterized petrographically and using U-Pb isotopes, we determined a majority to be granite derived from West Antarctica, under ice sheet conditions much like the present day. We traced one notable sample to the Antarctic Peninsula, signifying transport over a distance of 2600 km along coastal currents, and reduced ice sheet extent. Two very distinctive samples of quartzite, obtained from a sediment interval ~5 million years old, have signatures that uniquely match rock formations on the Vinson Massif in the continental interior. Those require a much-diminished West Antarctic ice sheet and an open interior seaway that would allow icebergs released from alpine glaciers to float a distance of 1400 km, from these highest mountains of Antarctica northward to the Pacific Ocean. Three igneous samples appear to match sources in the Central Transantarctic Mountains. If verified by further research, this group will substantiate the 'interior seaway' scenario indicated by the quartzite samples. The melting of the West Antarctic ice sheet at that time of warm climate (late Miocene) would have caused global sea level rise of 7 meters or more.

P41 Moderate Ideological Identity Formation and Type Identification

Student Researcher: Kat Gruschow ’22
Major: Political Science
Faculty Collaborator: Elizabeth Coggins, Political Science

Significant political science literature considers the antecedents and political effects of ideological identification. Yet, the overwhelming bulk of this literature systematically overlooks a significant portion of American voters: those who select “moderate.” Meanwhile, the “moderate” identification consistently garners between 35-45% of survey respondents—a substantial portion of the U.S. electorate, and often the “swing vote” constituency. The prevailing narrative assumes “moderate” is a catch-all category for voters with too little political knowledge to place themselves at the ideological poles. This research challenges that notion. We apply and extend an existing model of ideological identity formation to moderates, which focuses on policy preferences and symbols, and add personality and cognitive dispositions as critical factors. Our preliminary results reveal three distinct types of moderates who select the label for discrete reasons, and demonstrate that for many, the label choice is more intentional than haphazard.

P42 Diasporic Arab Writing in The Contemporary Arab World

Student Researcher: Kenza Zakarya ’24
Major: Mathematical Economics
Faculty Collaborator: Ammar Naji, Comparative Literature, Arabic, Islamic and Middle Eastern Studies

Professor Danielle Sanchez is working on a monograph regarding World War II in Africa. Her project is thematically oriented, shedding light on the effects the conflict had on military campaigns, labor, culture and consumption, politics, and education. The project builds off her dissertation and additional research she has been conducting in recent years. She is pulling from case studies, oral histories, and in-person and digital archival research for her project. Over the summer, I especially helped digitize and flag relevant content from the Kenyan National Archives at Syracuse University as well as looked through and annotated national health reports from various cities in South Africa. I also read books written and published during and in the aftermath of the war regarding race relations and American and British imperialism in the continent. This research was put in constellation with contemporary historiography (drawing especially from the volume *Africa and World War II*). The broader goal of Professor Sanchez's work is the accessible illumination of the important yet commonly overlooked role that Africa played in World War II.

P43 Constructing and Resisting Models of Pop Music in the Neoliberal Era

Student Researcher: Mason Castle ’23
Major: Music and Sociology
Faculty Collaborator: Stephanie Doktor, Music

How could the most pervasive philosophy of the last half century remain hidden in plain sight? In our contemporary phase of global capitalism, the hegemony of neoliberal rationality is at the forefront of everything from global finance and public infrastructure to cultural operations and our fundamental relationships to others. This summer, Dr. Stephanie Doktor and I sought out to further our understanding of the neoliberal ontology and identify how its economicazation of non economic spheres intersects with the world of popular music. Through the writings of Cedric Robinson, Wendy Brown, Michel Foucault, and David Harvey (to name a few), we first came to terms with the structural and personalized manifestations of neoliberalism. What stood out most in the context of our research was the notion of individual self enterprise. This principle of which demands a severe assumption of precarity in the name of the development of human capital and without social infrastructure to fall back on. The cultural ubiquity of this dynamic paints a grim portrait of creativity within the production of pop music as well as its ability to subvert dominant social discourses. However, in reading the respective works of Lester Spence, Robin James, and Dale Chapman, we saw that through methods such as blue notes, choreosonics, and demonic calculus, artists are able to resist white supremacisty heteropatriarchy within the traditional framework of pop music production.

P44 Capitalism and Anarchy: Research on the Counterculture of Switzerland in 1968 to 2000

Student Researcher: Jolie Curran ’22
Major: History/ Political Science
Faculty Collaborator: Jake Smith, History

Capitalism and Anarchy: Research on the Counterculture of Switzerland in 1968 to 2000 is a project created to aid the research process of Professor Jake Smith in a literary endeavor of the same subject. This project sought to explore the history of countercultural movements in Switzerland from 1968-2000 through the translation and categorization of formal and informal Francophone news sources of Switzerland. In this research, over two-hundred alternative and anarchist articles, leaflets and posters were translated and catalogued to create an overarching timeline of political dissent and alternative lifestyles in over five major cities in Switzerland (Zurich, Lausanne, Geneva, Berne, Basel, etc.). This research ultimately led to the analysis and discovery of two notions that implicate each other in the grand scheme of non-conformity in Switzerland: the importance to youth groups of having an autonomous youth center free of capitalistic and traditional authority and the financial strain autonomy inflicts on these spaces. This research aims to reveal the interplay and mutual destruction of capitalism and anarchy utilizing Swiss cities as a foundation of information.

P45 Archival Storytelling: Understanding Hmong Diasporic Experiences through the Father Yves Bertrais Collection

Student Researcher: Min Pan ’22
Major: IDM: Asian American Studies
Faculty Collaborator: Aline Lo, English

Literacy and literature have shaped how Hmong engage with each other. This research was a particular exploration on how Hmong communities around the world kept in touch with each other by using the Hmong Romanized Popular Alphabet (RPA) during and after their displacement from Laos. The main objective was to look at Father Bertrais’ archival materials at the University of Wisconsin, Madison, to gain a better sense of how literacy helped (re)shape the day-to-day lives of the Hmong. The contents (i.e. letters, photos, book orders, stories) of Bertrais’ archive allowed for the tracing of Hmong resettlement across America, Australia, Europe, Philippine, and French Guiana. This exploratory beginning both enriched and complicated how literacy and literature has impacted Hmong communities; Bertrais’ collection revealed that Hmong RPA was used to document and preserve Hmong traditions and stories, while current Hmong (American) literature reclaims spaces and voices of representation.

P46 Extension of McDougall’s Circle Theorem

Student Researcher: Olivia Bouthot ’23
Major: Mathematics
Faculty Collaborator: Jane McDougall, Mathematics and Computer Science

Ptolemy’s Theorem states that for a cyclic quadrilateral, the sum of the products of opposite side lengths is equal to the product of the diagonal lengths. A ratio form of this property extended to McDougall’s Circle Theorem, which shows that a similar property is true for all cyclic polygons with an even number of sides. McDougall’s Circle Theorem extends further to weigh each term in the identity whilst maintaining equality. Arbitrary point(s) w_n are added within the circle, and their distances from the vertices of the cyclic polygon are used as weights. This project aims to use elementary methods to prove this further extension of McDougall’s Circle Theorem. We found that the arguments between cyclically ordered points in evenly sided cyclic shapes fall in a balanced alignment in which they are collinear on a line through the origin. Additionally, we describe an alternate elementary proof of McDougall’s Circle Theorem using the complex terms found from the Lagrange Interpolation formula. The complex terms in this expression form our newly defined balanced alignment.

P47 **The Narrative: The Instrument for Personal and Societal Development**

Student Researcher: Psalm Delaney ’24
Major: Education and Classics
Faculty Collaborator: Manya Whitaker, Education
Research Collaborator: William Anderson

This project is an extension of my work as an intern at the One Tribe Freedom School where I assisted and collaborated with Denver Public School and University of Denver educators and administrators in curriculum development. In the format of a multimedia web source, my project aims to utilize literature as an instrument to empower and teach individuals and communities that they are the author of their own narrative. The web source holds pre-kindergarten through adult classroom lesson plans, a book gallery with literary reviews for featured works, as well as multimedia resources from professionals including authors, artists, and teachers. Through literature, individuals will learn about and acknowledge where they came from, who they are, who they can be, and how they can and will take personal initiative to achieve their goals. It intends to dismantle dominant narratives that hinder the growth of individuals and communities. Individuals of all ages will use literature to define the term ‘dominant narrative’ and identify how the dominant narrative affects their perception of others, others’ perception of them, and their perception of themselves. Furthermore, students will identify how they will break away from the dominant narrative in order to embrace themselves and their identities to write a narrative that is completely their own.

P48 **Replicating PLATYPUS Findings & Analyzing MUNGE Encryptions**

Student Researcher: Jessica Hannebert ’23
Major: Computer Science and Environmental Science
Faculty Collaborator: Dan Ellsworth, Mathematics and Computer Science

PLATYPUS attacks use power measurements to steal cryptographic keys (such as the ones we use in e-commerce). We set out to replicate the findings from the original PLATYPUS paper in a less controlled environment and find out whether the attack could be applied to a High-Performance Computing network. We found that, as the paper reported, different instructions in the x86 assembly language can easily be distinguished by their power consumption. Along the way, we also discovered some peculiar behavior in Intel RAPL counters. However, we were unable to replicate the paper’s findings on distinguishing between operands of assembly instructions based on Hamming weight. Based on our experiments so far, using this attack against an HPC system would be difficult and fairly easy to prevent.

P49 **Insecticidal Activities of Silphium Integrifolium Leaves**

Student Researcher: Elaine Zhang ’22
Major: Biochemistry
Faculty Collaborator: Murphy Brasuel, Chemistry and Biochemistry
Research Collaborator: Kansas Land Institute

Silphium Integrifolium, known as rosinweed, are belongs to the sunflower family. They are easily grown to most kinds of the soil and are known to be good natural insecticides. Terpenes are a large class of organic hydrocarbon compounds exist in various of plants, and some of them are known to be good insecticidal compounds. Sesquiterpene lactones, a diverse group of terpenoids, are hypothesized by David Van Tassel to be the main insecticidal compounds in *Silphium Integrifolium* leaves. The goal of this paper is to identify the possible compounds, especially sesquiterpene lactones, that may help to induce natural insecticidal activity in over 90 different genotypes of *Silphium Integrifolium* leaves. The result shows that higher amounts of insecticidal compounds that being presented in *Silphium Integrifolium* leaves may cause a decrease in their response to trigger the insecticidal activity. Besides, the amounts of insecticidal compounds presented in over 90 genotypes varies by their regions: either they are from east, west or center of the Midwest regions in the states. Further goals may be directed to breed the *Silphium Integrifolium* plants that will give stronger insect defenses.

P50 Database of 'Ulama' Intellectual and Social Networks in 18th-Century Egypt and Syria

Student Researcher: Kenza Zakarya '24
Major: Mathematical Economics
Faculty Collaborator: Jane Murphy, History

The research focuses on expanding a database of 'Ulama' Intellectual and Social Networks in 18th-Century Egypt and Syria. This network includes practitioners, teachers, students, and patrons of "the sciences", in period terms, in 18th and early 19th-c. To identify these social networks, we referred to Jabarti's manuscripts and biographies, and to analyze them we use Nodegoat, a data modeling platform. We also looked at intellectual relationships of students of particular manuscripts and subjects and used Francis Robinson's "*OTTOMANS-SAFAVIDS-MUGHALS: SHARED KNOWLEDGE AND CONNECTIVE SYSTEMS*" to expand the existing network. To better understand the factor of space, we used ArcGIS to georeferenced historical maps of this region. We are still at an early stage of this project, and modifications on the components and organization of the data can be brought.

P51 Examining Claims About the Economic Impact of Fracking Made by Colorado's Oil and Gas Industry and Environmentalists

Student Researchers: Evan Rao '23; Dova Castaneda Zilly '23
Majors: Environmental Studies; Economics and Environmental Studies
Faculty Collaborators: Kat-Miller Stevens, Economics and Business and State of the Rockies; Jonothan Pierce, Economics and Business
Research Collaborators: Izzie Hicks '22; Saigopal Rangaraj '22; Greta Forseth '23

This year, the State of the Rockies Project focused on the recent passing of Senate bill 19-181 in the CO General Assembly, which provided an unprecedentedly robust regulatory framework for fracking in the state. Research fellows specifically focused on what people were saying in public testimonies regarding the bill, coding variables such as whether fracking helps/ hurts the economy and what emotions the speaker used in their testimony. Throughout the testimonies, it was abundantly clear that the oil and gas industry and environmentalists had very different conceptions over what the economic impacts of fracking are for the state of Colorado. For example, representatives of oil and gas emphasised that severance taxes from fracking benefit social services such as schools and fire departments, and that their industry supports local economies through well paying jobs. They also argued that money from oil and gas operations helps to fund watershed projects and Colorado open spaces, all of which theoretically mitigate any negative impacts their industry has on the state of Colorado. Environmentalists took a very different stance, arguing that oil and gas operations often negatively impact local economies by lowering home values, harming the local environment, and forcing the public to pay for abandoned wells. Overall, environmentalists felt that the oil and gas industry was over exaggerating their impact on Colorado's economy to push a pro-fracking agenda. We intend to research the validity of these claims as they relate to the economic impacts of oil and gas in Colorado.

P52 Landscape Evolution of DeVicq Region, West Antarctica from Low-Temperature Thermochronology and Thermo-Kinetic Modeling

Student Researcher: Fiona Swope '22
Major: Geology
Faculty Collaborator: Christine Siddoway, Geology
Research Collaborator: Jennifer Talyor, PhD student University of Minnesota

Mounting evidence through recent airborne, satellite, and marine surveys support the hypothesis that a deep linear valley, DeVicq Trough, is a tectonic feature within the Marie Byrd Land (MBL) dome, West Antarctica. Beneath the West Antarctic ice sheet lies rugged bedrock topography and a high geothermal gradient. Its landscape evolution can be studied using the Apatite Helium (AHe) dating method, which captures the movement of the uppermost crust, in response to glacial incision and consequential isostatic rebound over the history of Antarctic glaciation. In the MBL region, AHe records the timing of upward motion of bedrock, as glaciers erode into bedrock. A 3D numerical model, Pecube, uses AHe data to investigate interactions between the icesheet and bedrock. Pecube finds insights into the development of subglacial topography and onset of glaciation that help to determine whether erosion into geological faults or downcutting by fast flowing ice streams are likely to have controlled the formation of the linear DeVicq Trough.

P53 Identifying Greener Reagent Alternatives for the Distributed Drug Discovery Program

Student Researcher: Justin Tee ’22
Major: Biochemistry
Faculty Collaborator: Amy Dounay, Chemistry and Biochemistry

The goal of the Distributed Drug Discovery (D3) Program is to develop an accessible, internationally collaborative, and efficient educational lab protocol that tasks students with synthesizing antimicrobial dipeptides. Students will benefit from the D3 program by learning industry-relevant techniques, instrumentation, and in the contribution towards tackling the antibiotic resistant microbe (AMRs) problem. The “older” D3 protocol has successfully identified anti-microbial lead compounds, but many of the reagents utilized are hazardous or inaccessible. A primary concern to widely implement the D3 Program is to find greener reagents that are just as effective as the ones already in use. The optimizing reagents of interest are piperidine, the precursor to the illicit drug phenylcyclohexyl piperidine (PCP); the explosive hydroxybenzotriazole (HOBt); the reprotoxic dimethylformamide (DMF); the corrosive trifluoroacetic acid (TFA); and the toxic dichloromethane (DCM). Viable green alternatives were identified for piperidine, HOBt, and DMF: piperidine was replaced with 4-methylpiperidine, HOBt was replaced with propanephosphonic anhydride (T3P), and DMF was replaced with ethyl acetate (EtOAc). Identification of alternative reagents for TFA and DCM were unsuccessful. Optimizations to the proposed “greener” protocol also include a reduction of solvent-use in washing steps, and cutting the acylation step from overnight to one hour. The “greener” D3 protocol successfully achieved high purities and acceptable yields for biological-screening purposes across multiple dipeptide products. Confirmation of the efficacy of the proposed protocol in the classroom is still necessary; nonetheless, preliminary results suggest that the optimized protocol is a greener alternative at no cost to performance.

P54 Investigating lifts of simple algebraic varieties

Student Researcher: Tim Somerset ’23
Major: Mathematics
Faculty Collaborator: Shishir Agrawal, Mathematics and Computer Science

This project explored algebraic varieties and the conditions for generating a smooth lift of a singular variety. The problem was simplified to look only at ideals generated by only one polynomial in two variables, and lift with a specific form. Expository work was done on the condition of flatness, relating flatness to torsion-free and free conditions of lifts. The smoothness condition was investigated with respect to the lift of a single, square-free polynomial. We showed that given a polynomial in two variables, this polynomial will not only share no common irreducible factors with its partial derivatives, its partial derivatives will also share no common irreducible with one another. Additionally, it was determined by counterexample that a square-free polynomial will not always have a smooth lift.

P55 Predicting Molecular Passage Across the Blood Brain Barrier

Student Researcher: Victoria Rosa ’24
Major: Neuroscience
Faculty Collaborator: Sally Meyer, Chemistry and Biochemistry

The blood-brain barrier (BBB) is a highly selective, semi-permeable membrane separating the brain from the circulatory system. Knowledge of a compound's ability to permeate the BBB is an essential factor in drug development. For drugs targeting diseases within the central nervous system (CNS), permeation of the BBB is necessary; furthermore, it is desirable that compounds designed to treat diseases outside the CNS do not cross the BBB to avoid consequences resulting from off-target interactions. In this study, a literature review was conducted to determine which molecular descriptors (e.g. molecular mass, charge, number of rotatable bonds) influence passage across the BBB. Using these descriptors, a user-friendly artificial neural network was built, trained, and tested using a data set of 2,304 molecules. This model predicts molecular passage across the BBB with an accuracy of 92.5%. In the future, teaching modules will be developed using this neural network to create course content that is engaging for general chemistry students.

P56 Identifying and Cataloging Ancient Coins

Student Researcher: Finlay Roberts ’22
Major: Classics
Faculty Collaborator: Richard Fernando Buxton, Classics

The purpose of this ongoing project is to catalog in as much detail as possible the ancient coins that belong to the Money Museum situated by Colorado College. This summer, Professor Richard Fernando Buxton and I focused on ancient Roman imperial coins. During the week, we went over to the museum and photographed coins from the collection, labeling information as we went along. Outside of the museum, we were able to use online and print databases to identify exactly which Roman Imperial Coinage specimens the museum had in its possession. Our data is collected in two spreadsheets, each one accounting for a set period of time and listed in the order that the coins are kept in the museum. We handled coins from the reigns of Augustus until Nero, meticulously deciphering obverse and reverse inscriptions and images until we were certain of which coin we held. The coin preservation and collection fields are larger than I had anticipated and contain a detailed approach that I could not have imagined before this project. Part of the historical value of coins comes in the vast quantity of them that we can obtain. Through seeing and identifying such a great amount, the study of coinage has been illuminated for me.

P57 DFT and QTAIM Methods Applied to Binding of DOXO to PEG-PSMF Functionalized Zig-zag SWCNT

Student Researcher: Gregory Thompson ’22
Major: Chemistry
Faculty Collaborators: Sally Meyer, Chemistry and Biochemistry; Dan Ellsworth, Mathematics and Computer Science

Our goal was to obtain a quantitative understanding of bonding between PEG-PSMF functionalized zig-zag single walled carbon nanotube (SWCNT) and doxorubicin (DOXO) through the Quantum Theory of Atoms in Molecules (QTAIM). It is important to learn more about the bonding of a drug delivery functionalized carbon nanotube that can reduce adverse side effects of chemotherapeutics. The lowest energy geometry of each molecule and complex was obtained through Gaussian16. Topological and energetic values pertaining to bonding were obtained through AIMALL. The validity of method was proved through low percent error values between calculated QTAIM parameters of a gaseous water dimer and those in previous studies. The present study proceeded to apply theory and methods to a PEG-PSMF functionalized zig-zag SWCNT and DOXO to obtain QTAIM parameters.

P58 Social Ecologies of Resiliency: Religious and Spiritual Community Responses to Climate Turmoil in Colorado Springs/Manitou Springs

Student Researcher: Emma Ulbrich ’22
Major: Anthropology
Faculty Collaborator: Sarah Hautzinger, Anthropology

As scholarship about climate change quickly grows, less attention has been paid to the psychological, moral and emotional dimensions of the crisis. This project explores the efforts of local religious groups and organizations, in the Colorado Springs and Manitou Springs area, to build resiliency in practical terms, and also to take in the enormous implications of climate change and other facets of global ecological challenges. Our goals included drawing together scaled representations of this activity, from finely grained, ethnographic case studies, to how these become integrated into regional, national, and global coordination. Our participation in the group resulted in a better understanding of how communities can form through similar experiences of climate disaster, and how “spiritual” practice plays a critical role in grappling, combatting, and taking environmental action. Our conclusions bring to the surface the underlying contradictions within the Earth Church community (our main location of participant observation), questions of the role of individuality in climate change, role of “belief” in a spiritual group, and also racial dynamics of cultural appropriation versus cultural appreciation within ideas of “spirituality.” Our research ended with starting a group now called, Eco-Spiritual Climate Justice Network in Southern Colorado, to build a network of different spiritualities and religions around one common concern.

P59 **Exploring Rny1-Dependent Clearance of RNA Decay Fragments**

Student Researcher: Hayden Low ’22
Major: Molecular Biology
Faculty Collaborator: Jennifer Garcia, Molecular Biology

Tight control over the amount of mRNA, the chemical messenger of genetic information, is important in regulating many essential cellular processes. Recently, evidence suggests that in the yeast *Saccharomyces cerevisiae*, certain mRNAs are degraded by targeting to a membrane-bound region called the vacuole and subsequent RNA-cleavage by a protein called Rny1. Our research examines if Rny1 clears persistent molecules called RNA decay fragments that are produced by incomplete degradation of full-length mRNAs. Using a procedure called northern blotting to detect specific RNAs, the amounts of these decay fragments were monitored in yeast strains with and without Rny1 activity. Results suggest that active Rny1 is required to clear decay fragments consisting of an often-studied RNA sequence called the MS2 array as well as decay fragments originating from genomic yeast sequences. In both cases, the lack of Rny1 activity appears to cause the accumulation of decay fragments, suggesting that Rny1 is involved in the degradation of persistent byproducts of incomplete RNA decay. The apparent Rny1-dependent clearance of the chosen MS2 and genomic RNA decay fragments demands the investigation of additional types of RNA and the elucidation of potential connections to gene regulation and pathology in mammals.

P60 **Investigating the Possibility of Mass Transfer in Sub-subgiant Stars**

Student Researcher: Tiffany McBride ’22
Major: Physics: Astronomy
Faculty Collaborator: Natalie Gosnell, Physics

Sub-subgiant stars (SSGs) are a type of star whose evolution that we cannot explain with standard single-star stellar evolution. For their age, SSGs are under-luminous with an unusually low surface temperature. SSGs’ unique combination of properties-- such as strong magnetic activity, unusual position on the HR diagram, binary companions, and short rotational periods-- give us some footing to draw conclusions about the evolutionary path of these stars. The edge of the region that SSGs occupy on the HR diagram is a continuous boundary. One dynamical encounter that can abruptly change the path of evolution is mass transfer. Once stars in a binary system reach a certain radius, the Roche Lobe radius, their mass will be transferred to their companion star via the companion star’s gravitational pull. Some of the conditions common in SSG systems are also found in systems that can reach a large enough radius to conduce transfer mass. Therefore, we theorize that the boundary of the SSG region is shaped by mass transfer. To investigate this, we must analyze if typical SSG properties- specifically those that affect the probability of mass transfer- create an environment where mass transfer is not only possible, but likely, around and before the SSG region of the HR diagram. By running MESA models, or stellar models, similar to SSG star properties, we were able to vary the properties of interest and evolve them to the SSG region of the HR diagram. Then, we were able to isolate which properties varied the possibility of mass transfer enough to *cause* mass transfer in SSG systems. Upon analysis, we were able to conclude that SSG systems require a rotational period of, at most, 5 days. Parallel to our studies of the Roche lobe, we analyzed the known composition of SSG systems. In a histogram of known rotational periods for the observed SSG sources, the most frequent rotational periods were around 3 to 5 days. Though SSG systems have been observed to have periods from less than a day to over 30 days, there is a clear bell curve in the rotational period histogram that peaks at 3 and 5 days.

P61 **BIRCHES/THE NEW FRONT RANGE**

Student Researcher: Henry Freedman ’23
Major: English: Creative Writing
Faculty Collaborator: Rachel Paupeck, Art

BIRCHES:
Birches is founded in the understanding that due to the simple fact that most cemeteries across the U.S. are reaching capacity a new, more space efficient, burial practice is needed. This concept incorporates mixing cremains into concrete, and through a series of pours, striated columns are cast. Each pour, due to the inherent properties of concrete, will lend a different character of color and texture to the surface of the column resembling birch bark. The mourners, through a calculated set of experiential sequences are taken to and through, below and above a grove of birches; some real and some abstract burial markers.
THE NEW FRONT RANGE:
The idea of The New Front Range is to take ideas set forth in the 1960s by Adolfo Natalini in the concept Superstudio and the first produced American track housing Levitt Town and make the future of domestic living and agriculture approachable and relatable but still a clear (and realistic) evolution of how we exist today. The key to the success of our project is the simplification of living. The future will be rife with new inventions and innovations, but the key to surviving a world that the human race is actively destroying is simplifying life, and going back to the routes of what makes a home a home, and what makes a community a community.

P62 **Women and Gender in the Anthropology of Hinduism**

Student Researcher: Lucy Meigs ’23
Major: Philosophy
Faculty Collaborator: Yogesh Chandrani, Asian Studies, Religion

The main focus of my research is the way women in Hindu communities in postcolonial India create power through their positions in kinship relationships. Firstly, I will review sources on gender and caste discourse in India. This provides background information for others to understand the caste of Dalit women in India. I will present on two authors, Lucinda Ramberg and Gloria Goodwin Raheja. Ramberg focuses on a group of Dalit women who marry the Hindu goddess Yellamma. This marriage places them as the breadwinner of the household. Through this, they are the landowner of the family and take on the position of the son. Ramberg discusses how gender is understood in these communities, and the way in which Dalit women restructure the western idea of women. Raheja focuses on another community of Hindu women who write songs and use oral traditions to tell stories of female solidarity. They find community through their shared position in society. She also discusses the role of kinship in female relationships in these communities, and how Indian women negotiate their space in their marriage and natal family. My presentation will provide an understanding of the way Hindu women negotiate their gender and place in relationships.

P63 **Using Propylphosphonic Anhydride (T3P) to Achieve a Green, Accessible Protocol for Distributed Drug Discovery (D3)**

Student Researcher: Markus Bergstrom ’23
Major: Chemistry
Faculty Collaborator: Amy Dounay, Chemistry and Biochemistry
Research Collaborator: Justin Tee ’22

Over one billion people worldwide are infected with neglected diseases, which primarily impact low-income populations, leaving pharmaceutical corporations without incentives to invest in drugs to treat them. The Distributed Drug Discovery (D3) program creates procedures for Organic Chemistry II classes that synthesize drug candidates to be screened for activity against pathogens causing neglected diseases. Institutions around the world participate, speeding up the drug discovery process and promoting social responsibility in young scientists. D3’s vision of socially responsible chemistry aligns well with the practice of green chemistry, which prioritizes sustainability and safety. One method D3 currently uses is solid phase peptide synthesis (SPPS). Traditionally, SPPS uses hazardous and hard-to-access materials, so this study optimizes conditions using propylphosphonic anhydride (T3P) as a coupling reagent. This new protocol is 28% less expensive than the original, uses safer solvents and more accessible reagents, and is effective across a wide variety of compounds.

P64 Limitations of the Antiquities Act: A Story of Bears Ears National Monument

Student Researcher: Natasha Yskamp Long '22
Major: Environmental Studies
Faculty Collaborator: Eric Perramond, Southwest Studies, Environmental Program

The Antiquities Act of 1906 grants the President the authority to designate Federal lands national monuments. Throughout the last century, controversy has followed the Act as Presidents exercise their authority in designating tracts of land of different types and sizes. One of the most controversial uses of the Antiquities Act was President Obama's 2016 designation of, and President Trump's subsequent reduction of Bears Ears National Monument. This research looks at the limitations of the Antiquities Act in the designation of Bears Ears National Monument and throughout history. The brief language and Congressional definition of terms within the Act has given the President a broad power for designating and, arguably, reducing areas of protected lands which has had an impact on conservation, cultural protection, land management, and local livelihoods. The limitations and shortcomings of the Antiquities Act have historically encouraged colonial possession of Indigenous cultural objects, sparked controversy surrounding federal land management plans, created debates about the discretion of the President under the act, and excluded Indigenous voices in the decision-making process of managing lands that they have cultural connection to. These limitations may result in a Congressional amendment to the Antiquities Act to make it stronger, permanent, and inclusive.

P65 Environmental Norm Circulation Through South American Mining Legal Cases

Student Researcher: Saul Mendez Villalpando '22
Major: Environmental Studies
Faculty Collaborator: Mike Angstadt, Environmental Program

Global environmental governance is fragmented by diverse national challenges, priorities, and institutional competencies, yet simultaneously given greater order by international environmental law (IEL) norms, which can provide shared understandings of appropriate responses, actors, and institutions. In this pilot study, I explored whether and how domestic judges contribute to environmental norm circulation in mining and extractives issues. I analyzed court decisions from judges in Chile, Bolivia, and Argentina, qualitatively coding them for evidence of IEL norms to understand which norms are most commonly incorporated into opinions, and whether there is evidence of transnational legal borrowing. While I found few examples of direct references to other judges' ideas, I observed the presence of IEL norms, most frequently examples of the "duty not to cause environmental harm" and "prior informed consent" IEL norms, along with common examples of "common concern" and "extractives transparency". These findings suggest that judges are aware of the concerns from those that can be and have been affected by mining practices. Additionally, these observations suggest that judges from the involved countries do in fact participate in IEL norm circulation in mining and extractive issues, though not necessarily in a direct, explicit manner.

P66 Producing Audioscore videos to Accompany the Compositions of Professor Ofer Ben-Amots

Student Researcher: Max Lavinsky '22
Major: Music
Faculty Collaborator: Ofer Ben-Amots, Music

Research in the music department is defined, among others, as creativity and the publication of creative projects. For my research work, I created AudioScore Videos to accompany the musical compositions of professor Ofer Ben-Amots. AudioScores are video files that combine the sound recording of the performance with the images of the notated score, allowing the listener to follow the score while listening to the music. These videos are a useful asset for the composer, and serve as an easy and comprehensive medium to share the music with audiences and musicians around the world via major social networks online. Producing such videos requires several specific skills such as a solid sight-reading of notation, advanced level ear-training, and a thorough knowledge of the relevant computer applications. This project allowed me to develop and improve upon my video and audio editing skills, while simultaneously allowing me to expand my knowledge of musical notations and score formatting. It also provided a new and invigorating way for me to interact with the incredible compositions of my academic advisor, Ofer Ben-Amots.

P67 Selective Synthesis of Monomeric and Dimeric Mo(VI) Perfluoropinacolate Complexes

Student Researcher: Rana Abdu ’22
Major: Biochemistry
Faculty Collaborator: Thor B. Mdalel, Boston University; Dr. Linda H. Doerrer, Boston University

High valent 4d transition metals are of interest due their reactivity in oxidative chemical processes. The Doerrer Group has synthesized a variety of 3d transition metal complexes using perfluorinated alkoxide ligands due to their increased tolerance to protonation in water and their reluctance to form dinuclear bridging interactions. These characteristics are attributed to a decrease in pi-donor ability of the alkoxides. In this work, the use of perfluoropinacol, H_2pin^F, in the selective formation of monomeric and dimeric Mo(VI) oxo- complexes demonstrates the group’s first examples of 4d, perfluoropinacolate complexes. The hypothesis is that the presence of acidic protons from protic cation leads to formation of a dimer via a dehydration/ condensation reaction. Altering the cation by removing the potential for hydrogen bonding allowed for the selective synthesis of the monomer species and is confirmed by x-ray crystallography to be $X_2MoO_3(pin^F)$ where $X=NMe_4^+$ or $(K\{18C6\})^+$. Addition of weak acid allowed for the selective formation of the dimer complex. This was confirmed by x-ray crystallography to be $X_2Mo_2O_4(\mu\text{-}O)(pin^F)_2$ where X = NMe_4^+ or $HNEt_3^+$.This suggests that pH plays a significant role in the formation of monomeric and dimeric Mo(VI) oxo- complexes. Lastly, initial studies to reduce the Mo(VI) complexes to Mo(V) suggest that the dimer has a lower reduction potential than the monomer. Additional studies into the reactivity of these complexes are needed to better characterize them.

P68 Exploring mRNA Autophagic Decay Fluorescently Tagged Proteins in *S. cerevisiae*

Student Researcher: Megan Koch ’22
Major: Molecular Biology
Faculty Collaborator: Jennifer Garcia, Molecular Biology

Under stress, some organisms breakdown certain complex cell components in a process called autophagy. Cells repurpose the building blocks of less critical molecules and alternatively synthesize cell products necessary for survival. mRNA, the molecule that codes for protein synthesis, has been hypothesized by our lab to undergo autophagy in yeast during nutrient deprivation. To compare mRNA degradation under various cellular conditions, our lab created a way to visualize where mRNA fragments were accumulating by constructing a bacterial plasmid with a genetic sequence which marks densities of mRNA with fluorescent green proteins. This tracking system functions regardless of stress states because the promoter gene sequence (pADH1 instead of pMET17) allows for constant production of a protein connected to a green fluorescent protein. The fluorescently tagged protein binds special regions on certain mRNA decay fragments called MS2 loops. Visualization by laser microscopy of our plasmid within wild-type *S. cerevisiae* yeast confirmed the gene modification achieved more consistent green tagging of mRNA accumulations. Visualizing the quantity and location of mRNA decay can contribute to a broader understanding of mechanisms for RNA decay by autophagy under stress. This mechanism is relevant to understanding certain neurodegenerative diseases where RNA accumulations can result in neuron death.

P69 Characterizing Ciliary Localization of Type 3 Adenylyl Cyclase Mutations in a Novel Obese Mouse Model

Student Researcher: Madeleine Ross ’22
Major: Neuroscience
Faculty Collaborator: Lori Driscoll, Psychology
Research Collaborators: Dr. Jeremy McIntyre; Thomas Everett; Chang-Hung Wu; University of Florida

Mutations in type 3 adenylyl cyclase (ADCY3), a downstream GPCR effector that localizes to neuronal primary cilia, have been linked to obesity in patients and mouse models. However, the mechanisms by which ADCY3 contributes to obese phenotypes remain unknown. This project sought to characterize the localization of a mutant ADCY3 protein in a novel mouse model (ADCY3DGFP) using immunohistochemistry. While an antibody targeting the C-terminal epitope detected ADCY3 in wildtype (WT) mice, no signal was detected in mutants, confirming efficient deletion of that region. Using a secondary antibody to an intracellular epitope, no ADCY3 labeling was detected in WT or mutant mice. Previous studies have shown that specifically inhibiting ADCY3 in the paraventricular nucleus (PVN) is sufficient to produce obesity. We sought to determine if restoring ADCY3 in the PVN would reverse the obese phenotype present in ADCY3DGFP mice. WT and mutant mice were injected with adeno-associated viruses (AAV) expressing either a gain-of-function ADCY3 (ADCY3M297I) or a predicted non-ciliary localizing ADCY3 (ADCY3K465R). We then sought to confirm successful AAV targeting and ADCY3 localization in mutant mice. ADCY3M297I was found to localize to neuronal cilia; however, expression was largely outside the PVN. Interestingly, the ADCY3K465R protein exhibited strong membrane and axonal localization, but also was present in cilia, suggesting that the mutant protein can still be trafficked to cilia when overexpressed. Further experiments are necessary to identify the presence and location of mutated ADCY3 in ADCY3DGFP mice and to improve targeting for expression of AAVs in the PVN.

P70 Characterizing the effect of the *rbm-39* gene in C. elegans germline development

Student Researcher: Duffy Doyle ’22
Major: Molecular Biology
Faculty Collaborator: Darrell Killian, Molecular Biology

The *rbm*-39 family of genes encode RNA-binding proteins that are predicted to regulate alternative RNA splicing. However, the exact biological and molecular roles of *rbm-39* remain largely unexplored. To learn more, we explored the role of *rbm-39* in *C. elegans* (a worm used for genetic studies). Loss of *rbm-39* leads to sterility, but the cause has not yet been explored. Using staining and microscopy techniques we found that *rbm-39* knockout worms have reduced germline development and a smaller pool of germline stem cells. In addition, we used RNA-sequencing to implicate *rbm-39* in regulating a large group of genes via alternative splicing. Alternative splicing analysis revealed a significant number of alternative 3’ splice sites, which gene ontology (GO) enrichment revealed to be highly associated with a reduction in the downregulation of the Notch signaling pathway, as well as the cell’s ability to respond to amino acid stimuli, aminoacylase activity, and the NuRD and CHD-type complexes. *rbm*-39 was found to cause 3’ alternative splicing in other 3’ UTRs that are primary regulators of gene expression, such as germline progenitor *nos-3,* oocyte gene *pal-1,* and mixed genes *cye-1* and *mex-3*. Overall, misregulation of these genes may explain why *rbm-39* mutants are sterile.

P71 Autophagy is Induced under Stressed Conditions in Yeast

Student Researcher: Sally Miran '22
Major: Molecular Biology
Faculty Collaborator: Jennifer Garcia, Molecular Biology

When cells are under stressed conditions where they cannot optimally function, they must work to conserve materials to survive. In order to conserve materials and have the necessary tools to survive, through a process known as autophagy, they break down "extra" components to their own smaller building blocks that can be used for processes they do need. There is also an association of dysfunctioning autophagy and ALS, so knowing more about what induces autophagy can potentially have applications in the clinical settings. To study autophagy better, we looked at the yeast, *Saccharomyces cerevisiae,* which have a complex metabolism where glucose is used as the main source of nutrients and when these nutrients are depleted the yeast are considered under stressed conditions. When glucose is depleted, that is when the yeast enter a metabolic phase, known as post-diauxic, where they must use other sources of energy that are non-ideal. The goal of our project was to find whether or not autophagy is occurring in the post-diauxic phase which may provide greater insight as to the exact conditions autophagy is induced. We used an assay that detects proteins only associated with autophagy and found that in this post-diauxic phase, yeast are inducing autophagy to some degree.

P72 Exploring biosignatures in stromatolites using a modified Bligh and Dyer Lipid Extraction method

Student Researcher: Fer Juárez Duran '23
Major: IDM: Astrobiology
Faculty Collaborator: Amy Williams, University of Florida

Currently, there are many ways we can attempt to detect microbial life in outer space. Due to the current capabilities of space flight instruments on Mars, lipids have become a topic of interest among the astrobiology community. Studies have shown that lipids may withstand and preserve their structure through significant time periods and radiation while still being detectable by mass spectroscopy. Previously derived data of samples from the El Tatio Geyser region, suggests that organics detection of Martian proxies (due to hyperaridity and high UV radiation) is possible using pyrolysis. In our experiment, we compared pyrolysis to the efficacy of the widely accepted, effective Bligh and Dyer Lipid extraction (BD) method on the samples previously mentioned. Because these types of pyrolysis analyses are currently reproducible by spaceflight instruments on board the Curiosity Mars-rover, comparative analysis of the detection methods is necessary in the field of Astrobiology. By using organic solvents with differing polarities, we extracted and trans-esterified lipids from the mineral matrix of the rock samples for GC-MS analysis. Our data shows similarities between pyrolysis-derived data and BD derived data suggesting that pyrolysis serves as a comprehensive approach to organics detection in an extraterrestrial context.

P73 Judges and Norm Diffusion in Climate Governance

Student Researcher: Claire McCallum '22
Major: Environmental Studies and German Studies
Faculty Collaborator: Michael Angstadt, Environmental Program
Research Collaborator: Hyeyoon Park, Lund University, Sweden

In recent years, there has been a noteworthy increase in domestic court cases worldwide pertaining to environmental issues. This research explores norm diffusion and judicial dialogue in international climate governance, seeking to understand the role that judges worldwide play in advancing environmental judgement in a variety of issue areas. To do so, we conducted qualitative coding of domestic court opinions concerning climate change to look for which types of cases most readily incorporated certain norms and which norms were most readily incorporated. As the field of environmental law is still relatively new, there is not yet robust evidence of explicit legal borrowing among domestic courts within the sphere of climate litigation. Despite this, coding environmental court cases concluded that certain international environmental law norms are being widely implemented in domestic climate litigation broadly throughout environmental law worldwide, including ideas of "a right to a healthy environment", "common but differentiated responsibilities," "sense of urgency," and the "precautionary principle." The types of rulings which proved most favorable to incorporating norms of environmental law were those in which potential human rights violations were involved, and the norms most frequently referenced by judges can be linked to ideas outlined in international agreements such as the Paris Climate Agreement or the United Nations Framework Convention on Climate Change. Ultimately, we suggest that these initial findings indicate that norm diffusion and some degree of judicial dialogue is occurring on an international scale among mostly human rights climate cases.

P74 Exploring Magnetic Saturation of Sub-subgiant Stars

Student Researcher: Jessie Lyons ’22
Major: Computational Physics
Faculty Collaborator: Natalie Gosnell, Physics
Research Collaborators: Emily Leiner, University of Wisconsin- Madison; Katy Omizo ’22; Tiffany McBride ’22; Will Taylor ’22

Sub-subgiant stars , or SSGs, are a classification of stars that defy single-star evolution, being both under luminous for the subgiant branch and overly red for the main sequence. Prior research indicates these abnormalities are due to high magnetic activity arising from tidal locking with a companion star (Leiner et al. 2017). Short periods cause greater mixing within the star, strengthening the resulting magnetic fields, so we would expect the shorter the period the further the star will deviate from the single star evolution path. However, for SSGs with periods below twenty days this is no longer true. Instead, the expected trend plateau and those with periods below twenty days populate the same area of the HR diagram rather than continuing to aberrate. Our work explored the possibility that this plateau results from magnetic saturation. Using the stellar evolution code MESA, we calculated the Rossby numbers for theoretical SSGs and found that the values aligned with the magnetic saturation point at the subgiant branch. Our findings give strong evidence that SSGs falling below twenty days are magnetically saturated.

P75 Detection of Hydrated Electrons at Liquid-Plasma Surface Using Total Internal Reflection Absorption Spectroscopy

Student Researcher: Shalese Lovell ’21
Major: Physical (Environmental)
Faculty Collaborator: Adam Light, Physics
Research Collaborator: Quinna Phillips ’22

Polyfluoroalkyl substances (PFAS) are highly stable compounds used in a multitude of commercial applications. Increasing amounts of evidence point to ubiquitous contamination in nature and negative health effects of PFAS bioaccumulation. Removal of PFAS contamination remains difficult due to the strength of the carbon-fluorine bonds. One promising method for their bond destabilization is through the introduction of free electrons in the liquid vicinity, or dissolved (hydrated) electrons. Low-temperature plasma is capable of producing hydrated electrons with greater energy efficiency, making it a strong candidate for PFAS remediation. Hydrated electrons absorb red light strongly, so that even very small absorbance can be detected using a helium-neon laser and lock-in detection. This study uses an established total internal reflection absorption spectroscopy (TIRAS) technique to explore whether atmospheric pressure plasma jets can effectively produce hydrated electrons at the liquid surface.

P76 Studying Africa in the Second World War

Student Researcher: Star Goudriaan ’23
Major: History
Faculty Collaborator: Danielle Sanchez, History

Over the summer, I assisted Professor Sanchez on research in preparation for their monograph regarding the Second World War in Africa. Her project is thematically oriented, shedding light on the effects the conflict had on military campaigns, labor, culture and consumption, politics, and education in an accessible manner. The project builds off her dissertation and additional research she has been engaged in during recent years. She is pulling from case studies, oral histories, and in-person and digital archival research for her monograph. Over the summer, I especially helped digitize and flag relevant content from the Kenyan National Archives at Syracuse University as well as looked through and annotated national health reports from various different cities in South Africa. I also read a few books written and published during and in lieu of the war regarding race relations and American and British imperialism in the continent. I will be putting some of the findings from these three project entry points in context with contemporary historiography (especially drawing from the volume *Africa and World War II*) and Professor Sanchez’ monograph proposal. The goal is to shed some light on the important yet commonly overlooked role that Africa played in World War II.

P77 3D Printing Minimal Surfaces

Student Researcher: Nate Hohner ’24
Major: Physics
Faculty Collaborator: Jane McDougall, Mathematics and Computer Science

Minimal surfaces are surfaces that locally minimize their area. We used Mathematica and Cura to 3d model minimal surfaces, and then used a 3d printer to create those surfaces in the physical world in order to better understand their physical properties. Through previous research on this topic, a new family of minimal surfaces was discovered, called the Rosette Minimal Surfaces. Through 3d printing, we brought them to the physical world for the first time. An important property of one particular surface known as $RS_4^{(\pi/2)}$ is that it tiles 3d space, allowing it to be used for many important material science applications, such as 3d printing other objects using minimal surfaces as infill in order to minimize material use while maximizing strength. There will be another demonstration of this concept through 3d printing the boundary of a surface and then realizing its minimal surface as a soap film.

P78 Evaluating spatio-temporal trends in infrasound propagation using seismo-acoustic arrivals from repeating explosions

Student Researcher: Nora Wynn ’22
Major: Geology
Research Collaborators: Fransiska Dannemann Dugick, Sandia National Laboratories, Geophysical Detection Programs; Joshua Carmichael, Los Alamos National Laboratory, Geophysics Group; Andrew Theil, Oklahoma Geological Survey

We analyze seismo-acoustic arrivals originating from weekly controlled munition disposals at the McAlester Army Ammunitions Plant (McAAP) in Oklahoma over a period of seven months during 2019. These arrivals were recorded across a combination of 121 temporary and permanently installed seismic stations across Oklahoma and the surrounding states. Arrivals were identified by a human analyst team as well as an automated noise-adaptive STA/LTA detector. Because of its consistency and duration, the McAAP dataset provides an opportunity to study the spatial and temporal variability of infrasound propagation as it relates to seasonally variable atmospheric conditions. Here, we present findings based on both the empirical waveform data as well as infrasound propagation modeling through Ground to Space (G2S) atmospheric specifications utilizing acoustic ray-tracing. We evaluate the utility of using acoustic arrivals recorded on seismic stations to characterize infrasound propagation. We study the discrepancies and similarities between the seismo-acoustic arrivals and the predicted ray tracing arrivals with the intention of evaluating spatio-temporal trends related to atmospheric dynamics. *SNL is managed and operated by NTESS under DOE NNSA contract DE-NA0003525*

P79 Making Language More Inclusive: Open-Source Academic Resources and Gender Neutrality in Italian Language

Student Researcher: Chidera Ikpeamarom ’22
Major: Computer Science
Faculty Collaborator: Amanda Minervini, Italian
Research Collaborators: Chloe Brooks-Kistler ’23; Emmaline Hawley ‘24

What are the steps we can take to make language learning and language itself more inclusive? Students at Colorado College need to complete two blocks of language to graduate. Though language learning is an important part of one’s academic journey, and can lead to increased interaction with other cultures, there can be financial barriers. Many language courses at CC, and likely at other institutions, are known to require the purchase of relatively expensive online text/workbook codes that eliminate the more cost-effective options students may be able to find. In hopes of increasing the use of free/open-source language materials, our team began creating animated videos that could be used to introduce early Italian grammar topics to language students. Like most Romance languages, Italian is a gendered language with grammatical rules that rely heavily on the masculine/feminine gender binary. This reliance on the gender binary can be harmful to individuals who identify as non-binary or gender non-conforming. P pulling inspiration from genderneutral additions in other languages and suggestions made previously made in the field, our team proposed using a new 3rd person pronoun “loi” and replacing gendered endings with an asterisk when wishing to make gender-neutral sentences. These proposals and our reasoning for were demonstrated in a final animated video titled “Beyond Binaries”.

NON-PRESENTATION RESEARCH

Jesuits, Hispanos, and the Oldest Church in Colorado: A forgotten tale of settlement in the American Southwest

Student Researcher: Javier Cantu ’22
Majors: History and Southwest Studies
Faculty Collaborator: Jane Murphy, History; Santiago Guerra, Southwest Studies

The history of Hispanos and their attempts to colonize the San Luis Valley region during New Mexico's and Colorado's territorial periods is documented in this study. Cultural, political, and economic institutions that materialized on the west side of the valley, the site of the Guadalupe-Conejos land grant, and the first church in Colorado, Our Lady of Guadalupe Parish are illustrated. I suggest these are forgotten components of the story of American westward expansion. Lastly, a selection of academic literature is evaluated to understand how the subject’s discourse has changed over time. Original source material on early Hispanic village life such as *Diary of the Jesuit Residence of Our Lady of Guadalupe Parish, Conejos, Colorado, December 1871 – December 1875,* and other archival material such as unpublished volumes of the Jesuits’ day-to-day activities, individual letters, documents, et al., provide a glimpse of the lived experience of these little-known American settlements.

Investigations in Postcolonial Literature: Subversive Postcolonial Temporalities

Student Researcher: Isa Hussain ’21
Major: Middle Eastern and South Asian Studies
Faculty Collaborator: Pallavi Sriram, Theatre and Dance

In Western traditions of knowledge, civilization, and organization, a temporal economy has been created and maintained, where time itself is made into a commodity, or scarce resource that all humans must compete for. Death, then, is set up as an ending point, the terminus of both life and the self. While this research does not and cannot provide comprehensive answers to the questions it poses, it does offer a foundation for understanding time, life-death, and the self differently through a postcolonial lens. Grounded in an Afro-Asian collection of literary, poetic, performance, and visual arts texts, this research situates a paracolonial belonging to the world in conversation with hegemonic Western relationships to time and the body. The collection of creatives from all over Afro-Asia and its diasporas provides alternate understandings of time and humanness that interrogate and, in some cases, challenge Eurohegemonic knowledges characterized by colonial rigidity, commodification, and rationality. In this process, the categories of past, present, and future become less substantial, and other ways to organize life and humanness are implicated. These markers of a postcolonial temporal tradition include spirituality, magic, and perhaps most importantly, intimacy.

The Liegnitz Plot

Student Researchers: Pema Baldwin ’22; Maya Rajan’22
Majors: Film and Media Studies; Film and Media Studies
Faculty Collaborator: Dylan Nelson, Film and Media Studies

Our primary responsibility for this research position was to go through the USC Shoah Foundation’s Visual History Archive, which is an archive of over 50,000 video testimonies from Holocaust survivors. We transcribed these testimonies and kept a log documenting their relevance to the project and our thoughts on them, so that the filmmakers could easily sort through and find material that could fit into the film. We also went through footage from the film and transcribed those portions for the editors, director, and producer. Additionally, we put together paper edits for the video editors to reference when putting together the cuts. Lastly, we watched cuts and gave feedback to the team.

Thermodynamic Analysis of SL1 1x2 internal loop in SARS-CoV-2

Student Researcher: Quinn Eaheart ’23
Major: Biochemistry
Faculty Collaborator: Neena Grover, Chemistry and Biochemistry

SARS-CoV-2 utilizes a positive-sense single stranded RNA as its genomic material. This single stranded mRNA hijacks the host cell’s ribosome to translate its own proteins. Upon infection of a host cell, SARS-CoV-2 produces polyprotein 1ab which is then cleaved into 16 non-structural proteins. Non-structural protein 1 (Nsp1) inhibits host cell translation by binding to the 40S ribosomal subunit. Stem loop 1(SL1) in the 5’-UTR of the mRNA mediates the binding of Nsp1 to the ribosome. SARS-CoV-2 specifically contains a 1x2 internal loop within the SL1 that is not seen in other coronaviruses. In this study, we are examining the thermodynamic properties of the 1x2 internal loop of SL1. UV-visible thermal melts and isothermal titration calorimetry (ITC) were performed on various DNA and RNA constructs containing the 1x2 internal loop in SL1 in the presence of 1 M KCl or 10 mM magnesium chloride at two different pHs. Initial results show additional base pairing at lower pH in 1 M KCl buffer, indicating the formation of an A+•C base pair.

Tracking sediment mixing and transport in an alpine creek

Student Researcher: Kira Ratcliffe ’23
Major: Geology
Faculty Collaborator: Sarah Schanz, Geology

For this project, we studied sediment transport and mixing in the West Elk Creek drainage, near Gunnison, Colorado. Current geomorphological understandings of sediment transport in alpine creeks are limited and simplified. Here, we used measurements of grain size, angularity, and lithology to investigate a more nuanced understanding of sediment mixing and transport. We performed pebble counts at ten different sites in the main channel of West Elk Creek and at inflow sites in the drainage. We found that grain size in the main channel was, on average, greater than the influx sites we had identified. We also found that grain size and angularity both increase moving downstream in the main channel. This is counter to the theory that grain size decreases rapidly moving downstream in headwater reaches of stream systems. These results indicate that sediment mixing and transport in alpine streams is much more complex than reflected in traditional modeling systems. Further investigation into the West Elk Creek drainage would allow us to create a more nuanced mixing model which could, in turn, be applied and tested in other drainages. Sediment transport reflects broader hydrologic patterns and geologic trends in a system. Better understandings of sediment transport can help guide land management practices as well as how we build sustainable infrastructure in a changing climate.

Women of Color in Colorado State Legislature

Student Researcher: Soumya Keefe ’23
Major: Environmental Studies
Faculty Collaborator: Dana Wolfe, Political Science

The overall research question that Dr. Wolfe is trying to answer is, why/how have women been successful in navigating the political pipeline of Colorado state politics? The smaller question I focused on this summer was to look at women of color specifically. Why/how have women of color been successful in getting elected to the Colorado General Assembly. My main research methods were reading and interviews. I read political science journal articles and a book that go into theory of electability and who chooses to run and why as well as how race and gender effect decisions to run and campaigns. I also read newspaper articles written during these campaigns to better understand how the media was viewing these women. I found that women of color are elected exclusively in the Denver metropolitan area, have strong ties to community, were not necessarily planning to run, focus on nontraditional voters, and utilize training programs before starting their campaigns, and by holding office create circumstances in which other women of color are more likely to get elected in the future.

Reevaluating the IDEA / Campus Collection

Student Researcher: Will Bates ’22
Major: Theatre
Faculty Collaborator: Rebecca Tucker, Art

Professor Rebecca Tucker serves as administrator for the Campus Collection. Currently, Professor Tucker is focusing on the creation and implementation of a campus-wide loan program, one which would give students the opportunity to borrow art; this is an opportunity which has so far been reserved for staff and their offices. I believe that Professor Tucker’s work fulfills the spirit of the IDEA / Campus Collection’s mission statement in that it “provid[es] access to works of art for the campus community”. Currently, the only members of the Colorado College community who have access to the works making up the Campus Collection are administrators and professors. Giving students access is essential to carrying out the mission of the IDEA / Campus Collection. Despite being called the Campus Collection, few students in recent years have interacted with its works, let alone known of its existence. Due to the shifting circumstances of the IDEA / Campus Collection, the current condition and inventory of the collection needs serious attention. Our work this summer was to propose this: the reinvigoration of the Colorado College IDEA / Campus Collection, this time centering students. A rotating committee of interested students could be formed to maintain the collection, deaccession the collection’s most damaged or least relevant objects, and accession the works of students, alumni, and other contemporary local artists.

Optimization of Ratio Metric Signal from Carbon Quantum Dots (CQDs) Linked with Coumarin 343

Student Researcher: Fernando M. Gomez ’22
Major: Biochemistry
Faculty Collaborator: Murphy Brasuel, Chemistry and Biochemistry
Research Collaborator: Rosa Mallorson ’20

The study of intracellular magnesium and its role in various cellular processes are yet to be understand to the extent of other metal cations. The main issue is being able to synthesize a sensor that is significantly selective to magnesium over other metal cations. The high background of ionic calcium in biological systems presents the greatest challenge to accurate, real-time measurement of ionic magnesium in living systems. To create fluorescent sensors, we used carbon quantum dots (CQDs) bound to coumarin 343. The quantum dots served as both the sensor platform and provided the optical reference signal. Coumarin 343 provides a Mg^{2+} dependent optical signal that is spectrally resolved from the reference signal. Calibration curves were formed by using a fluorimeter and obtaining the fluorescence intensity ratio of coumarin to CQDs at various concentrations of magnesium. These results were compared with calcium to determine selectivity and further optimize the resolution of the ratio metric signal. The best CQD sensing constructs came from synthesizing the CQDs with o-phenyl with urea. Then, these CQDs were linked to coumarin with not only EDC, but also the assistance of sulfo-NHS to stabilize the unstable intermediate formed. Although the results obtained demonstrated discreet peaks for the coumarin 343 and CQDs and the dots appear to be selective of magnesium over calcium, more optimizations must be performed to be definitive of the CQDs selectivity.

Specialist Environmental Courts and Earth System Law: reviewing the literature and identifying research opportunities

Student Researcher: Maddi Schink ’23
Major: Environmental Studies
Faculty Collaborator: Michael Angstadt, Environmental Program

Environmental courts and tribunals – otherwise known as “green” courts, benches, judges, or tribunals - are specialized judicial bodies around the world that have both the expertise and the jurisdiction to deal explicitly with environmental cases. Even though conversations about environmental courts and tribunals have been building in the past decade, a comprehensive literature review to qualitatively characterize prevailing scholarship has been missing from this field. This research aims to fill this gap with a systematic review of existing green courts scholarship, categorizing each piece based on various factors such as temporality, location, vocabulary, type of source, level of analysis, backgrounds of the authors, and relative importance to the field. After several weeks of developing our cross-discipline literature pool with an intended emphasis on seeking non-Western scholarship, we designed a coding system and coded each source. Our initial results revealed that environmental court scholarship has been increasing since 2010 and is primarily non-marginal. Although the majority of authors hail from North American and Europe, courts in the Asia and Oceania regions have received meaningful attention, along with theoretical courts around the world. *Environmental Court* is also the term used most often to describe these specialized courts and existing scholarship is primarily analytical and focused on a single court. These observations open further discussion about the environmental courts and scholarship that may be overlooked in this field and shapes the impetus of future research opportunities.

Looping In Environmental Stewards

Student Researcher: Madison Joy Brauninger ’20
Major: Organismal Biology and Ecology
Faculty Collaborator: Howard Drossman, Education

The following research was based on curriculum building using a lectical assessment, the LESA. The LESA is an assessment of ecological stewardship which relies on responses to a series of open-ended questions relating to an environmental dilemma. Both an incoming fifth grader and freshman took the LESA. After the corresponding development levels were received, the levels were then used to find appropriate virtuous cycles of learning (VCoLs). Using the VCoLs allowed for the curriculum to be tailored towards each individual student. Then, a specific developmental area needing improving was chosen, (in this case it was feedback loops and systems thinking) and then attempt to teach to the need. With the relatively small sample size and initial results of LESA, it can be inferred that LESA can be used to learn more about the development of students’ reasoning related to ecological stewardship which in turn supports the development of environmental stewards.

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