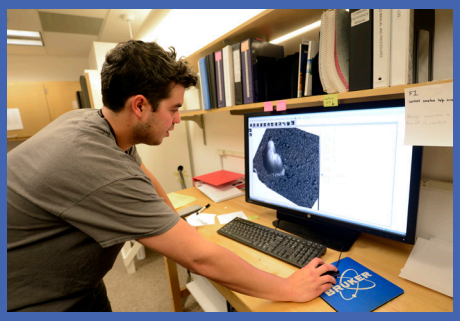
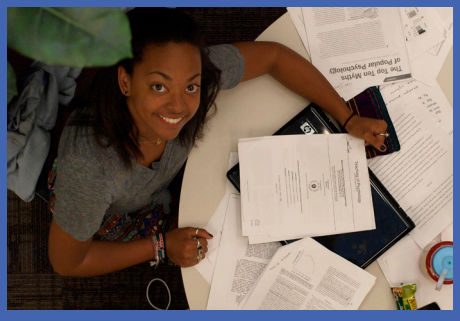
Summer Research Symposium





Faculty-Student Summer Collaborative Research (SCoRe) Presentations

FRIDAY, SEPT. 30, 2016
3:30–5 p.m.

EDITH KINNEY GAYLORD CORNERSTONE ARTS CENTER

SCHEDULE
Faculty-Student Summer Collaborative Research Symposium

Friday, Sept. 30, 2016
Edith Kinney Gaylord Cornerstone Arts Center

3:30–4:05 P.M. RICHARD F. CELESTE THEATRE

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

Student Presentations on their Collaborative Research

Colleen Orr '17
How Carbon and Nitrogen Footprints Can Inform Sustainability Practices at Colorado College

Katherine Miller '17
SUP-26 and CPB-3 are Conserved RNA-binding Proteins that Regulate Dendrite Development

Katlyn Frey '17
Classifier Categories Beyond Counting: A Cross-Linguistic Comparison of Object Perception

Rishi Ling '18
Kunqu Opera and China's Ming Dynasty: An Interactive Timeline

CORNERSTONE MAIN SPACE

Poster Presentations

4:10-4:35 P.M.	Poster Session 1	Abstracts P1-P25
4:35-5 P.M.	Poster Session 2	Abstracts P26-P50

DEAR STUDENTS, FACULTY, STAFF, AND PARENTS,

Welcome to the third Faculty-Student Summer Collaborative Research (SCoRE) Symposium, which brings our community together to celebrate the very best of what we do. Undergraduate research is a powerful way to learn. Studies indicate that students who engage in an experiential and deep learning experience, such as summer research, are more likely to thrive in their careers and lives. Supporting these student experiences is central to our mission at Colorado College.

The symposium features short presentations, poster sessions, and conversation across the disciplines. The work presented here represents many, many hours of research conducted by Colorado College students and their faculty mentors. This celebration is an opportunity to acknowledge great work, thank the faculty who provide invaluable mentoring, and encourage the students whose passion for learning inspires us every day.

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

Best regards,

JILL TIEFENTHALER

Summer research is an extension of my teaching. It is teaching students practical things, like lab skills; it's teaching them how to interact with supervisors in a professional job setting; it's helping them determine whether they like professional science … I have lots of students I continue to mentor when they go on to be graduate students, so these are very long term, meaningful relationships."

KRISTINE LANG, associate professor, Physics

What is SCoRe?

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

In the summer of 2016, 96 students received research stipend and housing scholarships. Students participated weekly in faculty-led professional development workshops, presented their on-going research to their peers, and took part in social programming. Many students took field trips with their faculty mentors.

Close mentorship between faculty and students is one of the best and most distinctive aspects of an education at CC. The Faculty-Student Summer Collaborative Research (SCoRe) Program gives students and faculty members a unique opportunity to work closely together to conduct research and develop their scholarship. While the Block Plan operates on a condensed schedule in the academic year, SCoRe takes place over the course of the summer and allows students to deepen their understanding of a topic and spend quality time conducting their research in the classroom, in a lab, or in the field. The goal of the program is to provide enriching, engaging, and supportive summer opportunities alongside student research with faculty.

STUDENT PRESENTATIONS

Classifier Categories Beyond Counting: A Cross-Linguistic Comparison of Object Perception

Student Researcher: Katlyn Frey '17
Major: Psychology and Asian Studies
Faculty Collaborator: Kevin Holmes, Psychology

Many of the world's languages, including Chinese, have a grammatical device—called classifiers¬—that are used to express the number of objects in a set. Classifiers group together different common nouns on the basis of shared properties such as shape, function, and animacy. Previous research suggests that the categories marked by classifiers may be perceived differently by speakers of classifier and non-classifier languages: Chinese speakers have been shown to rate objects that share a classifier as relatively more similar than objects that do not, compared to English speakers. However, because these studies used explicit measures (e.g., similarity ratings) or contexts that required counting, the findings do not imply that classifiers are automatically accessed during nonlinguistic tasks that do not involve quantification. The current study investigated this possibility. Native Chinese and English speakers were asked to judge which of two objects displayed pictorially were of the same kind as a third object (e.g., whether a cat or a X matched another cat) by making speeded responses. The matching and non-matching either shared the same classifier or were associated with different classifiers. If classifiers affect cognitive processing even in this implicit, non-counting task, Chinese speakers should respond relatively faster on different-classifier than same-classifier trials, compared to English speakers. Such findings would suggest that classifiers have more pervasive effects on cognitive processing than previously demonstrated.

How Carbon and Nitrogen Footprints Can Inform Sustainability Practices at Colorado College

Student Researcher: Colleen Orr '17
Major: Environmental Science
Faculty Collaborator: Rebecca Barnes, Environmental Program

This case study analyzes the carbon and nitrogen savings associated with opportunities Colorado College, a small liberal arts school in the Rocky Mountains, has for sustainability. By analyzing the current carbon and nitrogen footprints of Colorado College (CC), the possible carbon and nitrogen savings associated with ongoing sustainability practices, as well as those under consideration, we will be able to rank sustainability activities and opportunities; helping to inform decision making. Not surprisingly, CC's carbon and nitrogen footprint are dominated by food consumption and energy use categories. In order to reach Colorado College's goals towards greater sustainability and carbon neutrality in 2020, reductions in these sectors are necessary.

Conserved RNA-Binding Proteins that Regulate Dendrite Development

Student Researcher: Katherine Miller '17
Major: Neuroscience
Research Collaborator: Terrell Blei
Faculty Collaborator: Darrell Killian, Molecular Biology

Dendrites are cellular processes of neurons that receive information from other cells or the environment. Proper branching of dendrites is important for making connections with other cells that dictate learning, memory, and behavior. Defects in dendrite branching are associated with neurological disorders such as autism and schizophrenia. Therefore, an understanding of how dendrite development is controlled at the molecular level is important. Recently, RNA-binding proteins (RBPs) have been implicated in neuron development in several species such as Drosophila, C. elegans, and mouse. However, the specific roles that RBPs play in neurons is still under investigation. RBPs can regulate RNA at many levels such as transcription, splicing, localization, translation, and degradation. The Drosophila RBPs Shep and CPEB and the C. elegans homologs SUP-26 and CPB-3, respectively, are important for dendrite development, suggesting that these RBPs play an evolutionarily conserved role in dendrite development (Olesnicky et al 2014; Antonacci et al 2015; Schachtner et al 2015). However, their molecular functions are unknown. To investigate the molecular mechanism of the role of SUP-26/Shep in dendrite

development, we sought to identify (1) the molecular machinery that these RBPs physically interact with and (2) the RNAs they bind and regulate. To this end we immunoprecipitated SUP-26::GFP and Shep from worm neurons and flies respectively, and identified interacting proteins with mass spectrometry and interacting RNAs with deep sequencing. SUP-26/Shep interacts with translational machinery suggesting that it plays a role in translational regulation. We verified the interaction between the poly-A-binding protein PAB-1, required for mRNA stability and translation, and SUP-26 using a reciprocal co-immunoprecipitation and Western blotting strategy. This summer we also began the process of determining whether mutations in various protein interactors resulted in dendritic defects. Additionally, we identified several conserved RNA targets for SUP-26/Shep such as RNAs that encode other RBPs, cytoskeletal proteins, and Rab-family GTPases. We have confirmed SUP-26 and Shep regulate their own RNA via RT-PCR. Together these data suggest that SUP-26/Shep regulates the translation of conserved RNA targets during dendrite development in diverse animal species. An identical plan of investigation for CPB-3 will be executed next. Summer efforts succeeded in building an integrated mutant CPB-3 C. elegans strain as well as initiating use of CRISPR/Cas9 technology to natively tag CPB-3. Both will be used in future experimental plans.

Kunqu Opera and China's Ming Dynasty: An Interactive Timeline

Student Researcher: Rishi Ling '18
Major: Music
Faculty Collaborators: Victoria Levine, Music, and Tamara Bentley, Art

While working as a student research assistant for the FYE Experiencing Asia Through Music and Art, I was tasked with creating an assignment that teaches important research skills to incoming first years. These skills include information fluency and digital fluency. My research in the Chinese opera Kunqu, along with my desire to utilize digital technologies, inspired me to create an assignment in which students are asked to use web-based resources to present their research in a digital timeline. My project titled Kunqu Opera and China's Ming Dynasty: An Interactive Timeline, demonstrates the possibilities of incorporating tools like Timeline JS3 into original research. In this timeline, I illustrate different ways students can use digital and traditional resources in an online medium effectively and concisely. I also created a website for the timeline using WordPress, which can be found here: http://sites.coloradocollege.edu/ah-mu-pa158/. The timeline teaches information fluency and digital fluency by encouraging students to navigate both traditional and online resources for their timeline. Familiarity with multiple research techniques both traditional and electronic is a skill integral in and out of the classroom. At the end of Block 2, students will be responsible for creating their own timelines on a variety of research topics. This project was encouraged by professors Victoria Levine and Tamara Bentley, and I want to thank them both for their creativity and insight into both my project and their FYE.

POSTER PRESENTATIONS, ABSTRACTS P1-P25

P1 On Minimal Surfaces

Student Researcher: Sohair Abdullah '19
Major: Physics and Computer Science
Faculty Collaborator: Jane McDougall, Mathematics

A harmonic mapping is a univalent harmonic function of one complex variable. We obtain a family of harmonic mappings on the unit disk whose images are rotationally symmetric "rosettes" with n vertices, n greater or equal to 3. For any even number of vertices, the family of harmonic mappings includes an infinite number of minimal surfaces as lifts of the corresponding harmonic mappings. Moreover, for each even number of vertices there is one minimal graph, with piecewise constant height on the disk boundary, that may be completed in R3 by rotations and reflections. In particular, for a four sided rosette mapping there exists an embedded triply periodic minimal surface.nic function of one complex variable. We obtain a family of harmonic mappings on the unit disk whose images are rotationally symmetric "rosettes" with n vertices, n greater or equal to 3. For any even number of vertices, the family of harmonic mappings includes an infinite number of minimal surfaces as lifts of the corresponding harmonic mappings. Moreover, for each even number of vertices there is one minimal graph, with piecewise constant height on the disk boundary, that may be completed in R3 by rotations and reflections. In particular, for a four sided rosette mapping there exists an embedded triply periodic minimal surface.

P2 Morphological Effects of minC, minD, and minE Knockouts in Acinetobacter baylyi Imaged by Atomic Force Microscopy

Student Researcher: Sara Worsham '19
Major: Molecular Biology
Research Collaborator: Valerie Maravilla
Faculty Collaborators: Kristine Lang, Physics, and Phoebe Lostroh, Molecular Biology

Many bacteria, such as Acinetobacter baylyi (ADP1), divide through the process of binary fission creating two identical daughter cells. This essential process is largely controlled by the Min System, composed of MinC, MinD, MinE, and FtsZ proteins. Therefore, bacteria with min knockouts are expected to have irregular morphology due to incorrect placement of their division site. In our research, we utilized atomic force microscopy (AFM) to image and analyze ADP1 cells with minC, minD, and minE knockouts. Our results show that while ADP1 wild type cells produce round identical daughters, the mutants form long rod shape cells with disproportionate mini cells attached. Thus, the three-dimensional surface profile generated by the AFM illustrates how minC, minD, and minE knockouts impact proper cell division. This demonstrates a direct connection between bacterial shape and gene functionality thereby permitting a greater understanding of the role of min genes in the cell.

P3 Tamarix Shade Intolerance in Fountain Creek

Student Researcher: Matthew Chang '17
Major: Organismal Biology and Ecology
Research Collaborators: Lena Webster, Kathryn Dalton
Faculty Collaborator: Shane Heschel, Organismal Biology and Ecology

Over the last century, tamarisk (genus Tamarix) has been infiltrating riparian ecosystems across the Southwestern United States. Due to its high stress tolerance and deep root system, tamarisk is able to outcompete native plains cottonwoods and sandbar willows. Aside from decreasing riparian biodiversity, Tamarix also uses excessive water and can dry out streams by pulling from the water table. While some researchers call for increased flooding and pulsing regimes along rivers of the Southwest (due to previous research indicating that Tamarix is flood intolerant), managers have yet to find a fully effective strategy for tamarisk control. This study tested the hypothesis that Tamarix ramosissima is a shade intolerant species based on observations that shaded tamarisk appear less fit. This study took advantage of three study sites along Fountain Creek and included habitat classified as canopied, canopy edge, and open. Transpiration rates, stomatal density, stomatal aperture, and number of flowering branches were measured. Overall, canopied plants had fewer stomata, slower transpiration rates, and far fewer flowering branches. This implies that tamarisk can be managed using shade as well as flood regimes. Therefore, facilitating the establishment of native cottonwoods and willows along tamarisk-infested riparian zones could be an effective management strategy as cottonwoods grow quickly and form a canopy in only a few years.

P4 Thermodynamic Investigation of the Magnesium Riboswitch

Student Researcher: Ellie Gilbertson '17
Major: Biochemistry
Research Collaborator: Zach Aman
Faculty Collaborator: Neena Grover, Chemistry and Biochemistry

The riboswitch is a cis-acting regulatory unit found in the 5' UTR of mRNA. Comprised of an aptamer domain and an expression platform, riboswitches are highly specific and selective in their metabolite binding. They act independently of proteins in response to environmental cell events in order to either initiate or terminate gene expression. The discovery of this regulatory RNA in 2007 is credited to Ronald Breaker (Yale University), and its emergence lends credibility and support to the existence of an RNA world. The fundamental aim of this research study is to more thoroughly understand the contributions to thermodynamic stability of Core 2 of the M-box Magnesium Riboswitch. This RNA binds magnesium ions at high concentration, inducing a conformational shift that leads to rho-independent termination of transcription of a magnesium transport protein. How parameters of stability are influenced by base pairs surrounding magnesium-binding sites, stems on either side of internal bulge, as well as pH and metal-ion effects were studied.

P5 CD40 Signaling in Germinal Center B Cells does not Change Nutrient Transporter Expression

Student Researcher: Carly Merritt '18
Major: Molecular Biology
Faculty Collaborator: Olivia Hatton, Molecular Biology

Metabolic reprogramming plays an important role in immune system functionality. For example, upon activation T cells increase their metabolic activity, with a disproportionate increase in aerobic glycolysis, supporting growth and proliferation. In contrast, B cells increase oxidative phosphorylation and glycolysis equally upon activation. There is little information about metabolic reprogramming in memory B cells, however it is possible memory B cell metabolism mimics memory T cell metabolism and favors oxidative phosphorylation. Nutrient transporters, such as GLUT1, GLUT5, LAT1, and ASCT2, play an important role in metabolic reprogramming. Nutrient transporters provide the macromolecule building blocks required for cellular growth and proliferation, as well as the necessary substrates for generation of ATP. This study examines how CD40 signaling, necessary for B cell activation, changes nutrient transporter expression in germinal center B cells. Ramos cells, a germinal center like B cell line, were stimulated with MEGACD40L. Stimulation of CD40 signaling was confirmed by examining ICAM upregulation by flow cytometry and quantitative real-time PCR (qRT-PCR). qRT-PCR was also performed to determine expression of GLUT1, GLUT5, ASCT2 and LAT1. There were no significant differences in GLUT1, GLUT5, ASCT2, or LAT1 expression between unstimulated and MEGACD40L stimulated cells. Together, our data suggest that CD40 signaling does not change transcription of GLUT1, GLUT5, ASCT2, or LAT1 in the germinal center like line Ramos.

P6 TAPIR: Teaching Activities for Physics Inclusion Research

Student Researcher: Nathan Agarwal '19
Major: Physics
Research Collaborators: Emiliano Morales, Armand Dominguez
Faculty Collaborators: Barbara Whitten and Brooks Thomas, Physics

Even among STEM disciplines, physics stands out as unusually white- and male-dominated. AIP reports that only 14% of physics faculty are women, and 6% are underrepresented minorities. Rachel Ivie of AIP has studied the pipeline for women in physics, and has identified the transition from high school to college as the greatest "leak point" for women. While most physics books have a plethora of problems at the end of each chapter, they are focused on contexts like sports and the military, which are not of particular interest to women or students of color, and send the message that physics is not for them. Many young faculty who are interested in diversity would like to present a broader variety of contexts. But, pressed for time, they too often fall back on already prepared topics. We are preparing a database, open to faculty everywhere, of materials that illustrate the important concepts of introductory physics, but in different contexts that we intend will interest a broader range of students. These include problems, videos, labs, and discussion topics. With these resources, we hope to encourage women and students of color to major in physics, and eventually increase the diversity of the physics community.

P7 Sign Languages Reveal Spatial Mappings of Valence and Magnitude

Student Researcher: Taylor LeFevre '19
Major: Undeclared
Research Collaborators: Eileen Kitrick, Ruth Rabinovitch
Faculty Collaborator: Kevin Holmes, Psychology

Much research indicates that concepts of magnitude and valence are represented spatially, with more/less and positive/negative relations mapped to vertical and horizontal axes. While these mappings are sometimes manifested linguistically through conventional idioms (e.g., feeling up), recent evidence suggests that they may be built into the very forms of words—traditionally assumed to be arbitrarily related to their meanings. Following previous research, we examined whether the directions of hand motions constituting words in three sign languages predicted the meanings of their English translation equivalents. Upward-moving signs were more positively valenced than downward-moving signs, as found previously, but were also generally greater in magnitude, or intensity. Additionally, rightward-moving (from the viewer's perspective) and inward-moving signs were generally greater in magnitude than leftward-moving and outward-moving signs, respectively. Our findings provide evidence of systematic encoding of multiple spatial-conceptual mappings in signs, adding to the growing literature showing non-arbitrary links between linguistic form and meaning.

P8 Advancements Toward Fabrication of a Modified Carbon Quantum Dot as a Biocompatible Real-time pH Sensor

Student Researcher: Alexander Flugel '17
Major: Chemistry
Faculty Collaborator: Murphy Brasuel, Chemistry and Biochemistry

Carbon Quantum dots as nanosensors offer unique biochemical advantages over traditional metal-metalloid quantum dots, including low cytotoxicity, high temporal stability (months in a fridge), and resistance to degradation by extreme pH conditions. Furthermore, the high population of carbonyl groups (-C=O, -COOH) on the surface of the dot allows for easy modification such as linkage to ion sensitive dyes with the aid of a linking agent such as Fluorescein isothiocyanate or EDC (N-(3-Dimethylaminopropyl)-N-ethylcarbodiimide hydrochloride) combined with a dye. We will report on carbon quantum dots fabricated using a solution of citric acid in ethanol added to heated AEAPMS (CAS No. 3069-29-2) as the capping agent (surface passivator). pH sensitivity was enhanced through a linkage with naphthofluorescein dye, producing a pH probe with linear dynamic ranges of approximately pH 0-4 and pH 8-12.

P9 Deferred Justice: Tribal Water Rights and Representation in the Colorado and Columbia River Basins

Student Researcher: Emelie Frojen '17
Major: Environmental Policy
Collaborators: State of the Rockies

This paper will compare Native American water justice, as well as representation in river policy and management in the Columbia and Colorado River basins. In recent years, water justice in these two basins has become a pressing issue. However, the means in which Native American water rights and representation are actualized varies dramatically between the two western river basins. Despite this there is a strong commonality in that all tribes experience a deferred justice, meaning there is a lag time between when the courts declare Native American water rights and when, if ever, those rights are tangibly received. I will use three tribes as case studies: the Southern Ute Indian Tribe, the Confederated Tribes of the Colville Colville Reservation, and the Nez Perce. This paper will examine the means of water justice on the two rivers, and the issue of deferred justice though seeking to answer the primary questions of: What is the cause of deferred water justice? What can be done to diminish it? What does modern water justice look like, and what are some challenges and solutions to achieving it?

P10 Carbon Stocks and Fluxes in Fire Disturbed Landscapes of Colorado

Student Researcher: Asheton Gilbertson '18
Major: Environmental Science
Research Collaborators: Kyra Wolf and Brian Buma
Faculty Collaborator: Rebecca Barnes, Environmental Program

With CO_2 emissions on the rise, it is important to understand how carbon cycles through Earth systems; especially given the numerous ecosystem responses to the earth's temperature rise. As a result of this change, the frequency and intensity of fire in the Rocky Mountain region is expected to increase. In an effort to understand the recovery and resiliency of forest carbon stocks to severe wildfire in the Rocky Mountains, we examined five burn scars and reference sites of 2002 fires. Previous research suggests that forest type and climate have large roles in determining a forest's recovery trajectory. Therefore, the sites encompassed both dry montane forests and wet subalpine forests. We investigated not only post-disturbance carbon stocks to assess recovery, but more notably, the state and quality of post-disturbance carbon pools. In general, wetter forests and forests dominated by Lodgepole (versus Ponderosa or Fir) tend to have more resilient carbon stocks. Interestingly, while the contribution of black carbon (produced during fire) to the soil organic matter (SOM) pool tends to be higher in burned plots there is no significant difference with disturbance history. This suggests that something other than SOM quality controls the carbon residence time in the soil.

P11 Digital geological map geodatabase for Marie Byrd Land, for tectonic and glaciological applications

Student Researcher: Tristan White '18
Major: Geology
Faculty Collaborator: Christine Siddoway, Geology

Motivated to make the geologic features of Antarctica accessible not only to researchers but the global public, we prepared a geological map of Marie Byrd Land (MBL), a region located south of the Pacific Ocean on the Antarctic continent. In addition to geologic literature and accompanying maps, ground-based and satellite imagery analysis were used to determine the rock types and their respective ages. The map covers an area of ~900,000 km2. Covering 410 km2 of exposed volcanoes and other rock outcrops, 1870 polygons were positioned using data and imagery from the Antarctic Digital Database (www.add.scar.org) and Landsat Image Mosaic of Antarctica (lima.usgs.gov). Rendered in ArcMap GIS software by Esri©, the map is accompanied by a queriable database using GeoSciML data protocols for classification and descriptions of individual polygons. Polygons are tied to primary bibliographic source files which can be used as a starting point for further research. The map can be viewed through Google Earth or ArcGIS software, and will eventually be added to OneGeology, an international geology survey initiative. The map is the first of its kind for MBL and will serve as a baseline for changes to the Antarctic ice sheet that are occurring due to climate warming.

P12 GASP!: Growth Advantage in Stationary Phase in Acinetobacter baylyi

Student Researcher: Rebecca Bloomfield, high school researcher '17
Faculty Collaborators: Phoebe Lostroh, Molecular Biology

Bacteria subsist in an unrelenting competition for survival. Under stress conditions bacteria can exhibit growth advantage in stationary phase (GASP). In GASP, high mutation frequencies allow cells to accumulate beneficial mutations rapidly, and allow aged cells to outcompete younger cells (Finkel, 2006). Intriguingly, competence (DNA uptake) genes are overexpressed in GASP (Lostroh & Voyles, 2010). To test GASP, antibiotic resistance markers were transformed into different-aged bacteria to differentiate strains. Old and young cells were co-incubated in a 1:1000 ratio and separately quantified over a period of seven days. Variations of this experiment were performed to determine the role of competence in GASP. We found that old cells outcompeted young cells, indicating that A. baylyi exhibits a GASP phenotype. Providing old cells with young cells' DNA, and vice versa, resulted in loss of old cells' competitive advantage, indirectly indicating that horizontal gene transfer impacts GASP phenotypes. The influence of competence was confirmed through investigation of double antibiotic acquisition during GASP. These results indicate that horizontal gene transfer is implicated in survival of stressful conditions and that stress induces rapid evolution. Understanding of GASP is an essential weapon in the race against bacterial evolution in hospitals and other critical settings.

P13 A Multidimensional Measurement of Sexual Orientation

Student Researcher: Anne Hale '17
Major: Psychology
Research Collaborators: Regina Henares, Lindsay Miller, Quinn Husney
Faculty Collaborator: Jason Weaver, Psychology

Research on sexual orientations and identities has largely relied on the Kinsey Scale and the Klein Sexual Orientation Grid, which treat orientation as a single dimension ranging from homosexual to heterosexual. This one-dimensional understanding has propagated conceptions of sexual orientations and behaviors as categorical and as entrenched in a ratio of attraction to men versus attraction to women. We measure sexual orientation on two continuous dimensions, with attraction to women measured separately from attraction to men. By using these two separate scales, we can detect more diversity and variation within bisexual and asexual populations than previous measures allow. These new scales are reliable (′ = 0.971 & 0.985), and convergent validity is promising as they correlate with preferences for present partners (p<.001), future partners (p<.001), and childhood sex-type behavior (p<.001) in a manner consistent with past research on sexual orientation. Further correlations have been explored in Sexual Risk-taking Behavior, Relationship Norms and Desires, life satisfaction, and sexual behaviors and roles that indicate that these scales are functional and instrumental in the comparison and understandings of various groups.

P14 Generating New Probability Distributions

Student Researcher: Nate Mankovich '17
Major: Mathematics
Research Collaborator: Sunil Butler
Faculty Collaborator: Andy Glen, Mathematics and Computer Science

Our research demonstrates the utility of APPL (A Probability Programming Language) by using its commands to write a program that generates families of probability distributions. Our program takes a list of known families of probability distributions and applies a list of transformations to them, creating a list of entirely new probability distributions. We performed this on twenty-two known equations, generating approximately 400 families of distributions. We also organized the data into tables based on their useful qualities for easy access by other statisticians, and collected information on unusual of specifically useful distributions.

P15 Invariance of the Free Ferminion Vertex Algebra Under Z/ 2 Action

Student Researchers: Hanbo Shao '17 and Olivia Chandrasekha '17
Majors: Mathematics
Faculty Collaborator: Michael Penn, Mathematics

Many authors, most famously Herman Weyl in the early 20th century, have studied rings of polynomial invariants. More recently, A. Linshaw and co-authors adapted Weyl's techniques to study the invariance of vertex algebras. Inspired by these adaptations, our work describes the invariance of the free-fermion vertex algebra under the action of the Z/2 group.

P16 Self-Objectification Theory and Uptalk?

Student Researcher: Regina Henares '17
Major: Psychology
Faculty Collaborator: Tomi-Ann Roberts, Psychology

The research project is an empirical psychological study that will explore the relationship between uptalk and self-objectification in women. Self-objectification (Fredrickson & Roberts, 1997) occurs when individuals internalize an observer's view of their physical bodies, and engage in cognitive, emotional and behavioral efforts to meet cultural expectations for attractive body appearance. Uptalk is a speech pattern where declarative sentences end with a rising vocal intonation. Our study will test whether self-objectification predicts uptalk. We predict that women who are in a state of self-objectification (where the body's sexually attractive appearance is salient) will uptalk more. In this case, self-objectification compels women to participate in "inviting" speech strategies to align with cultural expectations of how they should interact with or sound to men in order to be considered attractive.

P17 Direct Conversion of Nitrotoluenes to Aminobenzaldehydes by Microwave Assisted Oxidation-Reduction Protocol

Student Researcher: Ingrid Wilt '17
Major: Chemistry
Faculty Collaborator: Habiba Vaghoo, Chemistry and Biochemistry

Simultaneous oxidation and reduction of 3-nitrotoluenes has been accomplished using a microwave-assisted synthesis. The oxidation of the methyl substituent occurs more readily when the nitro group is para to the methyl. The adaptation of this reaction to microwave conditions allows for short reaction times (5 minutes), leading to efficient synthesis of 3-nitrobenzaldehydes. Herein describes attempts to introduce an aromatic aldehyde, ketone, or alcohol and amine to various compounds in one step.

P18 Teacher-Student Relations in the Gharib Sciences in 18th-Century Cairo

Student Researcher: K'lah Rose Yamada '17
Major: Comparative Literature
Faculty Collaborator: Jane Murphy, History

The 18th century text, Marvelous Remnants of Lives and Events by 'Abd al-Rahman al-Jabarti (1753-1825), is a collection of biographies and prominent events in Cairo, Egypt. Within the text is a delineation of student-teacher relationships in the field of the Gharib or the unusual sciences during the 18th century. We aimed to determine if there was a community of scholars in the field of the Gharib sciences that did not revolve around the central figure of Hasan al-Jabarti. In order to determine the existence of the network, we converted old files from FileMaker Pro into quantitative values in Excel. The original files contained qualitative data describing various facts of significant figures' lives, these files contained the names of the teachers and students, their different relationships, and their areas of study. After the conversion, the data became compatible with software programs, such as Palladio, Gephi, and Tableau, which graph desired relationships between students and teachers. We used the two programs, Palladio and Gephi, to confirm the existence of a community, as well as the presence of six smaller networks within the larger community.

P19 Light Microenvironments of Red Rock Formations and Their Implications for Color Vision

Student Researcher: Jamie Rushford '17
Major: Organismal Biology and Ecology
Faculty Collaborator: Nicholas Brandley, Organismal Biology and Ecology

The color of light varies between environments because of physical and geometrical differences (such as the proportion of light coming from the sun, sky and other objects). Variable lighting has a variety of effects throughout nature, including diurnality cues, shifting contrasts, and greater stresses on color constancy, all of which have the potential to impact the visual ecology and visual systems of the local fauna. We evaluated the irradiance of red rock landscapes in the Lyons Formation in Southern Colorado in order to speculate as to its effects on animal vision and coloration. We found little difference in the proportion of four light color bins (UV, short-wavelength, mid-wavelength, and long-wavelength) when looking at downwelling irradiance, except for an increase in short-wavelength light when out of direct sunlight, indicating that irradiance can change temporally based on the position of the sun. However, when facing towards cliffs there was a dramatic increase in the proportion of long-wavelength light compared to other directions, suggesting this environment and viewing direction is likely to change the observed color of many objects. Future work will elucidate how animal behavior and vision may be affected by the changes in light of the red rock landscapes.

P20 Tracking Flammulated owl migration using GPS pinpoints

Student Researcher: Kate McGinn '18
Major: Organismal Biology and Ecology
Research Collaborators: Devon Lucero, Ellen Rigell, Becky Hunter, Ross Calhoun, Max Cialgo
Faculty Collaborator: Brian Linkhart, Organismal Biology and Ecology

Understanding the migratory behaviors of avian species presents important insights into their population dynamics and ultimately illuminates conservation concerns. The Flammulated Owl (Psiloscops flammeolus) is a small raptor that breeds in ponderosa pine ecosystems in the western U.S., and is a long-distant migrant whose wintering habitats influence its ecology. Previous studies on Flammulated Owls used light-sensitive geolocators to determine an approximate wintering habitat in Mexico and stopover areas in New Mexico. The geographical information collected by the geolocators provided foundational information about the species' migration routes. We further developed the investigation into the their migratory patterns by attaching more accurate pinpoint GPS devices onto male P. flammeolus near the end of the 2016 breeding season. We captured five territorial males in Pikes Peak National forest and secured pinpoint trackers onto the owls using small backpack straps. We aim to recapture these subjects during the 2017 breeding season in order to access the data recorded by the pinpoints. The geographical information will provide a more accurate perception of the P. flammeolus migration habitats, thus facilitating a more holistic conception of the year-round ecology of the species.

P21 Activation by CD40 ligation and BCR crosslinking induces mitochondrial biogenesis in germinal center-like B cells

Student Researcher: John Hartman '17
Major: Molecular Biology
Research Collaborator: Carly Merritt
Faculty Collaborator: Olivia Hatton, Molecular Biology

B cell activation is necessary for the response to foreign antigens and the establishment of memory B cells, yet the metabolic changes following activation are not well characterized. T cells share similarities with B cells as they are both adaptive immune cells, and their metabolic response to activation has been studied more extensively. Furthermore, T cells undergo metabolic reprograming upon activation to support development and differentiation. Similarly, we suspect that the activation of B cells will result in metabolic reprogramming. Specifically, we sought to look at the two distinct signals of B cell activation: B cell receptor crosslinking (signal 1) and CD40 ligation (signal 2). To test activation, Ramos B cells, a germinal center-like B lymphoma cell line, were treated with MEGACD40L, anti-IgM (a BCR activator), or anti-IgM+MEGACD40L. We found a 2-fold increase in mitochondria following anti-IgM+MEGACD40L stimulation after 48 hours. Additionally, we observed that treating cells with anti-IgM caused a decrease in cell viability. The decrease in viability by anti-IgM was reduced when cells were treated with both anti-IgM+MEGACD40L. Our study reveals that activation by BCR and CD40 ligation leads to a 2-fold increase in mitochondria, and CD40 ligation partially rescues cell viability from BCR induced apoptosis.

P22 Sources and temporal variability in summertime ambient mercury in Colorado Springs, CO, USA

Student Researcher: Evan Laufman '18
Major: Environmental Science
Faculty Collaborator: Lynne Gratz, Environmental Program

Mercury (Hg) is a potent neurotoxin and global air pollutant emitted from both natural and anthropogenic sources. Often deposited into terrestrial and aquatic ecosystems, Hg can bioaccumulate within food chains. In the US, coal burning for electricity, cement manufacturing, steel production, and biomass burning account for the most Hg emitted to the atmosphere annually. The purpose of this research is to measure and quantify ambient Hg concentrations within Colorado Springs, and attempt to determine the relative effect of the Martin Drake coal-fired power plant as well as other local point sources. We have measured total gaseous Hg (TGM), carbon dioxide (CO_2), carbon monoxide (CO), sulfur dioxide (SO_2), and meteorological data continuously at a site approximately one mile northwest of the power plant. We produced TGM data with an obvious diurnal pattern and possibly correlated CO_2 measurements, suggesting boundary layer interaction with the emissions plume. Through further analysis, we hope to understand the broader implications of the measured atmospheric Hg levels in the surrounding area.

P23 SUP-26 and CPB-3 are conserved RNA-binding proteins that regulate dendrite development

Student Researcher: Terrell Blei '17
Major: Molecular Biology
Research Collaborator: Katherine Miller
Faculty Collaborator: Darrell Killian, Molecular Biology

Dendrites are cellular processes of neurons that receive information from other cells or the environment. Proper branching of dendrites is important for making connections with other cells that dictate learning, memory, and behavior. Defects in dendrite branching are associated with neurological disorders such as autism and schizophrenia. Therefore, an understanding

of how dendrite development is controlled at the molecular level is important. Recently, RNA-binding proteins (RBPs) have been implicated in neuron development in several species such as Drosophila, C. elegans, and mouse. However, the specific roles that RBPs play in neurons is still under investigation. RBPs can regulate RNA at many levels such as transcription, splicing, localization, translation, and degradation. The Drosophila RBPs Shep and CPEB and the C. elegans homologs SUP-26 and CPB-3, respectively, are important for dendrite development, suggesting that these RBPs play an evolutionarily conserved role in dendrite development (Olesnicky et al 2014; Antonacci et al 2015; Schachtner et al 2015). However, their molecular functions are unknown. To investigate the molecular mechanism of the role of SUP-26/Shep in dendrite development, we sought to identify (1) the molecular machinery that these RBPs physically interact with and (2) the RNAs they bind and regulate. To this end we immunoprecipitated SUP-26::GFP and Shep from worm neurons and flies respectively, and identified interacting proteins with mass spectrometry and interacting RNAs with deep sequencing. SUP-26/Shep interacts with translational machinery suggesting that it plays a role in translational regulation. We verified the interaction between the poly-A-binding protein PAB-1, required for mRNA stability and translation, and SUP-26 using a reciprocal co-immunoprecipitation and Western blotting strategy. This summer we also began the process of determining whether mutations in various protein interactors resulted in dendritic defects. Additionally, we identified several conserved RNA targets for SUP-26/Shep such as RNAs that encode other RBPs, cytoskeletal proteins, and Rab-family GTPases. We have confirmed SUP-26 and Shep regulate their own RNA via RT-PCR. Together these data suggest that SUP-26/Shep regulates the translation of conserved RNA targets during dendrite development in diverse animal species. An identical plan of investigation for CPB-3 will be executed next. Summer efforts succeeded in building an integrated mutant CPB-3 C. elegans strain as well as initiating use of CRISPR/Cas9 technology to natively tag CPB-3. Both will be used in future experimental plans.

P24 Build It And They Will Come: A Whitewater Park As a Magnet For Economic Growth

Student Researcher: John Burns '19
Major: Mathematical Economics
Research Collaborator: John Higham (working separately on similar projects)
Faculty Collaborator: Mark Smith, Economics and Business

With a total of 13 official sites, Colorado has more whitewater parks than any other U.S. state. Other states are picking up on this trend, especially in the Midwest. As the kayaking industry continues to gain popularity, there is need to clarify the economic impact that whitewater parks have on their respective communities. The small town of Buena Vista, Colorado is an ideal setting to asses such impacts. The current study sought to identify the economic impact the whitewater park has on the Buena Vista community. The research was conducted in two parts. The first component consisted of a travel cost survey method where a survey link was distributed to both users and spectators of the Buena Vista whitewater park. The second component was a series of interviews with local politicians and business owners, who had experienced changes since the creation of the whitewater park.

P25 Comparative neuronal morphology of gigantopyramidal neurons in canids, felids, primates, artiodactyls, perissodactyls, rodents, and the wallaby

Student Researcher: Beckett Shea-Shumsky '17
Major: Psychology
Research Collaborator: Madeleine Garcia
Faculty Collaborator: Bob Jacobs, Psychology

Although the basic morphological characteristics of gigantopyramidal cells have been documented in limited species, the quantitative characteristics of these neurons across different taxa remain unexplored. To this end, the present study seeks to both qualitatively describe and quantitatively investigate gigantopyramidal cells in the motor cortices of nineteen different species across seven phylogenetic taxa: artiodactyls (giraffe, kudu, blue wildebeest) perissodactyls (plains zebra, mountain zebra), felids (caracal, lion, clouded leopard, mongoose, Siberian tiger), canids (domestic dog, African wild dog), primates (baboon, human, golden lion tamarin, ring-tailed lemur), rodents (rabbit, rat), and one marsupial (wallaby). For comparative purposes, three types of pyramidal neurons (e.g. superficial pyramidal, deep pyramidal, and gigantopyramidal; N= 617) were stained with a modified rapid Golgi technique and quantified on a computer-assisted microscopy system. Quantitatively, gigantopyramidal neurons were substantially larger than typical pyramidal neurons and exhibited more numerous primary basilar dendrites extending circumferentially from the soma. The largest gigantopyramidal cells were exhibited by the felids, particularly of genus Panthera, consistent with Brodmann's observation of exceptionally large gigantopyramidal neurons in carnivores (Brodmann, 1909). Qualitatively, neurons varied considerably between species, especially for perissodactyls and artiodactyls, which demonstrated widely bifurcating V-shaped apical dendrites.

POSTER PRESENTATIONS, ABSTRACTS P26-P50

P26 Preliminary Findings in the Effects of Prescribed Fire on Flammulated Owls Habitat Usage

Student Researcher: Sam Fason '18
Major: Organismal Biology and Ecology
Research Collaborator: Scott Yanco (UC Denver)
Faculty Collaborator: Brian Linkhart, Organismal Biology and Ecology

Ponderosa Pine ecosystems are fire-dependent, and therefore much of the flora and fauna living in these ecosystems have adapted to cope with frequent low to mid-severity burns. However, with decades of fire suppression, rising temperatures globally and increasingly severe droughts, we are now seeing far more high-intensity burns across the American West. Flammulated Owls (Psiloscops flameolus) are a ponderosa pine specialist and therefore have evolved with fire. The Hot Creek RNA, which served as our study site, has not seen fire in almost 60 years, and the fall of 2017 the USFS will carry out a prescribed burn on the RNA. In order to understand how Flammulated Owls may be effected by fire, we have designed a study to look at their pre-fire and post-fire ecology. We affixed territorial male birds with PinPoint GPS tags and others with radio-transmitters so they could be tracked in real time. Of the thirteen territorial males we knew of, six were fixed with radio transmitters and five with GPS tags. The data from the GPS tags and radio telemetry allowed us to get a sense of each territorial male's territorial boundary, and what areas in his territory were of high use or virtually no use. We are in the early stages of this study, so the findings are preliminary.

P27 -Equations. Like, a Lot of Them-

Student Researcher: Sunil Butler '17
Major: Mathematics
Research Collaborator: Nathan Mankovich
Faculty Collaborator: Andy Glen, Mathematics

Our research demonstrates the utility of APPL (A Probability Programming Language) by using its commands to write a program that generates families of probability distributions. Our program takes a list of known families of probability distributions and applies a list of transformations to them, creating a list of entirely new probability distributions. We performed this on twenty-two known equations, generating approximately 400 families of distributions. We also organized the data into tables based on their useful qualities for easy access by other statisticians, and collected information on unusual of specifically useful distributions.

P28 Agricultural Planning and Sustainable Farming Practices in Japan

Student Researcher: Emily Laur '17
Major: Environmental Policy and Asian Studies
Faculty Collaborator: Joan Ericson, German, Russian and East Asian Languages

Despite the large number of Japanese between the ages of 20 and 40 concentrated in urban-city environments, an increasing number of urbanites with little or no previous knowledge of farming are turning to traditional agricultural practices as a full-time profession. This transition is often made with the aid of the Japanese government in the form of 5-year subsidies programs. However, these programs have complicated the relationships between farmers choosing to pursue organic farming methods, farmers who use chemical fertilizers and pesticides, and the government. This study, which recovers some of the farmers' perspectives, was carried out through volunteer farm work, observational research, and a qualitative survey of five farms with differing ranges of organic agricultural backgrounds: three farms registered through World Wide Opportunities on Organic Farms (WWOOF), one former WWOOF site seeking to revitalize traditional Japanese agricultural practices, and one farm member to an organic farming community and cultivated by a Colorado College Alum. An analysis of these experiences shows that although there are several differing personal factors for making the transition to farming, all were impacted by a heightened awareness of existing problems within urban industrialized environments where individuals have limited control over their food production.

P29 Investigating the competence machinery of Acinetobacter baylyi

Student Researcher: Ben Reynolds '19
Major: Molecular Biology
Research Collaborator: Kenn Crossley
Faculty Collaborators: Kristine Lang, Physics, and Phoebe Lostroh, Molecular Biology

Acinetobacter baylyi is a soil-dwelling bacterium which has the unique ability to take in DNA from its surrounding environment and incorporate it into its genome, a phenomenon known as natural competence. The mechanism by which natural competence occurs is largely unknown. One proposed model predicts that cells produce appendages which extrude from the membrane, attach to extracellular DNA, and reel the DNA back inside the cell- much like a fishing pole. It is hypothesized that the competence appendages are structurally homologous to the Type IV pilus, another appendage responsible for cell twitching. Here we present data from an experiment looking at the effects of varying DNA concentrations on appendage production. We used atomic force microscopy (AFM) to generate three-dimensional nanoscale images, enabling visualization and computerized quantification of appendages. Initial results show a positive correlation between DNA concentration and appendage production but require further testing to verify. In an ongoing investigation, we seek to identify the proteins involved in the competence system and determine their specific functions. This study utilizes knockout mutants to analyze five proteins associated with competence and/or Type IV pili. We are using AFM, twitching and transformation efficiency assays, and protein modeling to examine these mutant strains.

P30 Using Non-Born-Oppenheimer Quantum Theory to Better Understand Nanophase Materials

Student Researcher: Xiangmin Yang '18
Major: Physics
Research Collaborator: Zachary Eberhart
Faculty Collaborator: Sally Meyer, Chemistry

Born-Oppenheimer approximation has been using to understand complex molecule system for a long time, but it has been discovered that it's not valid in some systems. The goal of the research is to solve Schrodinger's equation without the Born-Oppenheimer approximation with the help of Modern computers and artificial intelligence. The main approach used in this research is variational theorem. We use variational theorem to evaluate the expectation value of H_2^+ to minimize its gravitational potential energy. But the hard point of not using Born-Oppenheimer approximation is it will be so hard to have the accurate wave function for the whole system. We tried using a harmonic function to present the nuclei part and had it times the trial wave function of a electron to get the final wave function. However, the amount of calculations is so huge that we can't get a result. The possible next step should be changing the nuclei function into a easier one or find a numerical way to evaluate the value.

P31 Consistency protocol for a shared end-to-end encrypted database

Student Researcher: Michal Wisniewski '19
Major: Computer Science
Faculty Collaborator: Benjamin Ylvisaker, Mathematics and Computer Science

Sharing data privately over the internet is a difficult task, since the network traffic can be monitored by ISPs, proxies, cloud providers, etc. It is even more problematic when several users want to edit shared data without central authority. Our project aims to build an end-to-end encrypted database that is stored using external cloud storage providers like Dropbox or Google Drive. Every user will have their own, independent copy of the database, and our protocol is supposed to keep them synchronized. The lack of a central authority produces the need to specify the current version of the database that every user agrees on. Also, we needed to be able to easily undo, redo, reorder or insert changes to the database. To solve those problems, we decided to use a protocol similar to BitCoin, and implement a transaction chain as the main data structure. Users constantly compare their transaction chains, and resolve differences in a deterministic way which results in agreement between users. Our protocol managed to successfully keep several users synchronized, as well as keep the data encrypted, and unreadable for third parties.

P32 Investigation of Hemp Oil as a Paint Binding Media

Student Researcher: Yinzhou Chen '17
Major: Chemistry and Theatre
Faculty Collaborator: Nathan Bower, Chemistry and Biochemistry

The age of an oil painting is important to art history, conservation and authentication. Art historical analysis can be used to date many paintings, but some can only be determined using scientific analysis. This research used several methods of measuring the aging of oil paint, both physical changes (tackiness, optical occlusion) and chemical changes that can be followed instrumentally (ATR-FTIR, Py-GC-MS). Hemp oil, now available to the public, was explored as a potential binding media using an optimized experimental design.

P33 Constraining the subsurface geology of the Ross Ice Shelf, West Antarctica, using airborne gravity and magnetic data

Student Researcher: Alec Lockett '17
Major: Geology
Faculty Collaborator: Christine Siddoway, Geology

The bathymetry beneath the Ross Ice Shelf in West Antarctica controls the circulation of sub-Shelf ocean water that may warm the Ice Shelf from below, with consequences for Shelf stability and climate warming. Thick ice and underlying seawater obscure the seafloor; hence why the bathymetry cannot be measured directly and is only crudely known. The program Oasis Montaj (GeoSoft ©) allows me to manage geophysical datasets within a geospatial framework and its extension, GM-SYS, enables me to model geological profiles by inserting structures and assigning various densities and magnetic susceptibilities to produce a calculated fit for the observed geophysical data. I have imported grid and point geophysical data from ROSETTA-Ice's current survey into Oasis Montaj, sampled that data along a transect, and begun fitting the data using the software GM-SYS. I will use new geophysical data from the ROSETTA-Ice 2016 November-December survey, together with geological information from the bordering region of Marie Byrd Land, to interpret and characterize the bedrock geology of at least two cross-shelf transects including potential fault zones and igneous centers that may be areas of elevated geothermal heat that influence ice shelf stability.

P34 A Random Walk Approach to the Non-Born-Oppenheimer Schrödinger Equation

Student Researcher: Zachary Eberhart '17
Major: Biochemistry
Research Collaborator: Xiangmin Yang
Faculty Collaborator: Sally Meyer, Chemistry

The Schrödinger equation may be used to solve for the wave function or energy of a quantum system. However, as a system becomes increasingly complex, it becomes exponentially more computationally costly to solve the series of differential equations. To this end, several approximations may be made to simplify the calculations- among them is the Born-Oppenheimer approximation, wherein the motion of the nuclei and electrons are considered separately. But, as the size of a system increases, the accuracy of the approximation decreases. Therefore, it is worthwhile to consider alternative methods of solving the Schrödinger equation, such as the Diffusion Quantum Monte Carlo (DQMC). In the DQMC, one rearranges the Schrödinger equation into a form that resembles the diffusion equation. A set of particles is allowed to "diffuse" in imaginary time, eventually arranging themselves into the shape of the ground-state wave function of a quantum system. Here, a lightweight DQMC model, written in Python, is presented. This model was used to accurately determine the wave functions and energies of particles in simple potential energy fields. The DQMC presents a creative way to solve the Schrödinger equation, and future iterations may be able to solve multi-body systems without the need for other approximations.

P35 The Ethics of Geoengineering: Perspectives from Japan

Student Researcher: Anika Grevstad '18
Major: Asian Studies
Faculty Collaborators: Marion Hourdequin (primary), Philosophy, and Joan Ericson (secondary), German, Russian and East Asian Languages

Climate change is having, and will continue to have, serious, widespread impacts. One proposed response to climate change is geoengineering: the intentional, large-scale manipulation of the Earth's climate. If implemented, geoengineering would have global effects, so public engagement is important in discussions and decision-making processes surrounding geoengineering. Particularly, diverse ethical perspectives from around the world are necessary. This project aimed to understand public perceptions of geoengineering in Japan through semi-structured qualitative interviews and online surveys with Japanese college students. While interviewees expressed neither complete support nor opposition for geoengineering, a number of common themes emerged through the interviews. These include the use of a cost-benefit framework, weighing risks and results, to reason about geoengineering, a desire for governance processes that include both experts and the general public, and a preference for Carbon Dioxide Removal methods over Solar Radiation Management methods.

P36 Cloning of the Ter Y-P triad of Acinetobacter baylyi

Student Researcher: Esra Siddeek '17
Major: Biochemistry
Research Collaborators: Madhura Roy, Sam Zuke
Faculty Collaborator: Margaret Daugherty, Chemistry and Biochemistry

Acinetobacter baylyi (A. baylyi) is an abundant soil bacterium that has the ability to survive under starvation conditions such as sterile surfaces in hospitals, which makes them difficult to completely eradicate. It is proposed that the protein products of three genes, collectively known as the TerY-P triad, individually or with other Ter components, create a signaling machinery that allow the cell to respond to oxidative stresses during starvation. Our interest is in the following three genes: ACIAD1964, 1965, and 1966, which are proposed to express a kinase, phosphatase, and a metal-binding protein, respectively. In order to study how these proteins interact with each other, the three genes need to be cloned into a protein expression vector and the expressed proteins will then need to be isolated. DNA sequencing has shown that we have successfully cloned the 1965 gene, and protein purification is being optimized. Our original cloning of the 1964 gene was missing a single nucleotide at the beginning of its sequence, suggesting new primers were needed. A new restriction site for this gene was used and PCR has been optimized. The cloning process of the 1966 gene has yet to be completed.

P37 The Effects of Gene Knockouts on Competence and Twitching Motility of Acinetobacter baylyi

Student Researchers: Cheryn Aouaj '17, Molecular Biology; Sally Zimmerman '17, Molecular Biology; Linnea Ingram '17, Religion
Faculty Collaborators: Phoebe Lostroh, Molecular Biology, and Kristine Lang, Physics

Acinetobacter baylyi (ADP1), a gram-negative bacteria, is naturally competent, allowing the bacteria to incorporate extracellular DNA into its genome and transform its genetic properties. Various proteins assemble within and around the cell membrane of ADP1 to form a competence machine, or a Type VI pilus, that allows the cells to take in new DNA and to move and adhere to surfaces, an ability known as twitching motility. Other membrane proteins preserve cell shape and internal organization during cell division and elongation. In order to determine the importance of specific membrane proteins on twitching and transformation, we studied the following genes: mreB, mreC, maf, rodA, and comE. We quantitatively assessed competence and twitching capability by comparing knockout cells of each gene to wild type ADP1 cells. Our results suggest that mutants mreB, mreC, comE and maf are still capable of transformation but at a lower efficiency as compared to wild type, whereas rodA knockout cells exhibited extremely limited or no transformation ability. Therefore, our results demonstrate that these proteins are necessary for achieving maximum transformation in ADP1, especially rodA, which seems to be a required protein. In parallel to competence testing, further results pertaining to twitching motility indicate that knockout cells have a limited twitching ability as compared to wild type ADP1 cells. From our compiled results, our data highlights the significance of these specific genes in competence and twitching of ADP1.

P38 Correctional Education/ Past, Present, Prison

Student Researcher: Keenan Wright '19
Major: Undeclared
Research Collaborator: Calieigh Cassidy
Faculty Collaborator: Carol Neel, History

Education remains limitless and in exploring conceptions of who is condemned to confinement, this research primarily aims to accomplish three goals. The first, to contextualize how the nation began correctional education and its advancements over time. The second is to discuss how such advancements to correctional education have shifted the conversation from punishment to rehabilitation. And lastly to extend the conversation to how correctional education is more beneficial than the choice of stagnation. The medium of this research will be mounted on a website for the general public to access, in hopes that conversation centered around incarceration continue to grow. As a nation, justice is within our hands, and we all have a contribution to creating alternatives to incarceration.

P39 Conspicuousness of band-winged grasshoppers at rest and in flight

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

To the human observer, many band-winged grasshoppers (subfamily Oedipodinae) appear inconspicuous when stationary because of their brown/green coloration. Conversely, when in flight their colorful (often yellow or red) hindwings are revealed. This flash of color may attract mates or startle potential predators. However, human vision poorly replicates the vision of relevant animals, because it differs in both color and visual acuity from grasshoppers and birds. Here we report the appearance of both stationary and in flight band-winged grasshoppers to their conspecifics and potential predators. First, we used a spectrometer to take reflectance measurements of the forewings and hindwings of band-winged grasshoppers. Second, we input this data into computer models of animal vision that determine how a potential mate or a potential predator would view the grasshoppers' appearance. These results indicate that it is unlikely conspecifics receive enough spatial information for the colorful hindwings of the band-winged grasshopper to effectively function as a mating display.

P40 Environmental and Cultural Sustainability of Japanese Deer Parks

Student Researcher: David Todisco '17
Major: Asian Studies
Faculty Collaborators: Joan Ericson, German, Russian and East Asian Languages, and Krista Fish, Anthropology

This research looks at the controversy involving the population of Japanese sika deer that live in the city of Nara, as well as the surrounding forest. The deer have been protected as religious and cultural icons in Nara for over a thousand years, and have been gradually outgrowing their natural environment. Despite mounting concerns for the deteriorating forest as a result of the sika overpopulation, there is still significant resistance to the possibility of reducing the deer to a more sustainable number. Many of the local business people, who rely on the deer to attract tourists, voice disapproval of such suggestions regardless of other issues the deer continue to pose. This research draws on the cultural history, field observations, and surveys of the local shopkeepers of Nara to highlight the importance of facing this controversy before either the forest or the deer are lost to future generations.

P41 Creativity, Captivity, and Confinement: The history and impact of the arts in U.S. prisons

Student Researcher: Madeleine Engel '18
Major: History
Faculty Collaborators: Jane Murphy, History, and Jessica Hunter-Larsen, I.D.E.A. Space

Working with professor Jane Murphy and curator Jessica Hunter-Larsen, I helped write a historical narrative to accompany an upcoming IDEA Space exhibit dealing with arts and incarceration. Focusing on the topics of solitary confinement and arts programs in prisons, I researched the efficacy and history of these practices in Colorado and nationwide. Our methods

included online and library research, phone interviews, and primary research in the Royal Gorge Museum archives in Cañon City, Colorado. We found that solitary confinement, first imagined by 18th century Quakers, has had destructive consequences for America's prison system and that it remains pervasive in this country despite recent reforms. In addition to building a historical framework for the IDEA Space exhibit, we worked to launch a Colorado version a project called Photo Requests from Solitary. Following in the footsteps of previous activists, we sent letters to offenders held in solitary confinement asking what sort of photograph they would like to see along with a pledge to recreate their visions as actual images. Both the responses and resulting photographs will feature in the exhibit and online and will provide activist material for those seeking to end the use of solitary confinement in the United States.

P42 Critical Karaoke: Day in the Life

Student Researcher: Andy Nunn '17
Major: English
Research Collaborators: Callum Neeson and Jessica Wright
Faculty Collaborators: Steven Hayward, English and Ryan Bañagale, Music

The purpose of this research was to submit a series of short essay scripts that would be broadcasted on KRCC as part of the ongoing "Day in the Life" series established by professors Steven Hayward, Ryan Bañagale, and Idris Goodwin. Andy Nunn collaborated with Professor Hayward by aiding to select topics, conducting research on said topics, and writing a series of episodes to be aired over the course of the year. These scripts included a wide spectrum of information pertaining to the topic, and from these prototypical versions, Steven Hayward was able to assess which information was vital and which was not. From there, he condensed the existing facts into final scripts that fit within the time constrains of a little over 90 seconds. Andy focused primarily on modern genres, such as jazz, hip-hop, and rock and roll to create an evolving portrait of modern music and its destination.

P43 Carbonized leaf as electrode for sodium-ion cells

Student Researcher: Zhiyao Zhu '17
Major: Chemistry
Faculty Collaborator: Ted Lindeman, Chemistry and Biochemistry

Sodium ion cells may become a superior alternative to lithium ion cells for certain applications, if highly effective anode structures can be developed. Motivated by recent studies (with lead scientist Hongbian Li from the University of Maryland) suggesting carbonized tree leaves show promise as anodes, we developed carbonization methods and experimental cell assemblies to investigate the performance of plant-carbon anodes. Eventually, by measuring the time, current flow, number electrons transferred, etc. we calculated the amount of energy we charged our cell with as well as the amount of energy the cells can output. Although we only achieved outputs of about five percent of the power that we charged the cells with, with further studies of types of leaves and the ratio between the amount of electrolyte to that of the electrodes, we will be able to enhance it.

P44 The Critical Karaoke Radio Project: "A Day in the Life"

Student Researcher: Jessica Wright '17
Major: Music and Psychology
Research Collaborators: Callum Neeson, Andy Nunn
Faculty Collaborator: Ryan Bañagale, Music

The Critical Karaoke podcast offers academic oriented insights into the history and culture of music. Its hour-long episodes provide extended discussions on a central musical topic, while its shorter segments, called "A Day In The Life," concisely explore historical events related to music that pertain to each day of the year. The "A Day In The Life" segments flow into three separate genre streams: classical, jazz/hip-hop, and general interest. My summer faculty-student collaborative project involved the development and research of episodes for the classical and general interest streams. The work consisted of identifying dates and events for each day, and then expanding on each selected event using scholarly music databases and related online resources, as well as selecting accompanying audio examples. The final product for each episode is a two minute spoken narrative combined with music samples. These episodes have been broadcast over the course of the summer and will continue to appear on a daily basis into the fall.

P45 Critical Karaoke Project Digital Experience

Student Researcher: Callum Neeson '18
Major: Computer Science
Research Collaborators: Jessica Wright and Andy Nunn
Faculty Collaborator: Ryan Bañagale, Music

This research revolves around web-development tactics used by large scale media-driven websites such as Youtube.com and NPR.com and their application to the Critical Karaoke music history podcast: "A Day in the Life." After reviewing numerous online models for successful media-oriented websites, we established a process for analysis and implementation focused on three key tactics: related content features, succinct visual-centric displays, and high-speed web performance. For the first of these, I listened to and "tagged" over 400 podcast segments with relevant one-word genre, topic, and artist descriptions. I then designed a WordPress widget that displays related podcasts to users listening to any specific episode based on these tags. For visual-centric content displays, I redesigned the "Day in the Life" page as well as the pages for three separate streams (Classical, Jazz & Hip-Hop, Pop Culture) with a user friendly interface for easily navigating hundreds of episodes. Lastly I researched and implemented multiple web-efficiency techniques such as reconfiguring the server, minifying the source code, and image optimization. Such efforts have resulted in a streamlined web interface and set the stage for future development in mobile applications.

P46 The Question of Human Will Power in Late 19th Century Europe

Student Researcher: Drew Turley '17
Major: History
Faculty Collaborator: Susan Ashley, History

This summer, I collaborated with Professor Ashley to examine the attention given to the will and will power in late 19th century Europe. Biological and social scientists began to challenge traditional metaphysical ideas of free will and accepted its biological nature. They believed the will restrained impulses and desires and allowed people to concentrate on routine tasks. But they worried about the will's vulnerability to defects and damage. Their discoveries about the will's vital role coincided with concern about the faltering progress of modern society at the end of the century. Part of our work over the summer was to establish the current historiographical treatment of the subject. I spent the summer familiarizing myself with the prominent nineteenth century medical views of the will, building bibliographies, and summarizing both historical and contemporary secondary literature on the subject, as well as uncovering who had written what about the 19th century commentators on the will. The final component of our collaboration was to use the information we gathered to determine whether the question of will power merited further exploration. I believe that given the continued emphasis on will power in today's society, illuminating the shift from reason to will power and the philosophical foundation of its importance is a critical historical and metaphysical issue that needs further attention.

P47 Impact of precipitation, vegetation type, and fire severity on post-fire vegetation recovery in Colorado ecosystems from 1985-2014

Student Researcher: Maggie Mackinlay '18
Major: Organismal Biology and Ecology
Research Collaborator: Mike Beitner
Faculty Collaborators: Rebecca Barnes, Environmental Program and Kyle Whittinghill, Organismal Biology and Ecology

Wildfire is a significant disturbance in Southwestern US forests. With future climate change, the frequency and severity of wildfires are predicted to intensify. During and immediately after a wildfire, forests become a source of carbon to the atmosphere as opposed to a carbon sink. This shift contributes to the continuation of climate change. Whether a forest's carbon stocks return to their pre-fire state depends on post-fire vegetation and soil recovery as well as the time between fires. If fires alter the long-term carbon balance in Southwestern US forests, it would represent a positive feedback to global climate change. This research aimed to elucidate the variables that influence post-wildfire vegetation recovery in Colorado between 1985 and 2014. We analyzed the post-fire recovery of annual maximum NDVI and EVI in relation to burn severity (MTBS), precipitation (PRISM), vegetation cover (USGS National GAP Analysis Program), elevation (USGS NED), slope (USGS NED), rock type (USDA NRCC), and soil organic carbon (USDA NRCC). We also examined long-term patterns of annual maximum NDVI (AVHRR: 1989-2015) and EVI (MODIS: 2000-2015) in unburned areas of Colorado's major natural ecosystem types (subalpine conifer forest, montane conifer forest, aspen forest, pinyon-juniper woodland, gamble oak woodland, saltbush and sagebrush steppes, semi-desert scrub steppe, and grassland). As expected, NDVI and EVI were significantly correlated with precipitation and differed among vegetation types. In addition, severe burn areas were more likely to exhibit changes in NDVI than moderate burn or low burn areas. Pinyon-Juniper woodlands, montane forests, and subalpine forests showed significant drops in NDVI and EVI following severe fires. However, NDVI and EVI in grasslands, deciduous shrub ecosystems,

and gambel oak woodlands showed minimal or no impact of fire and sometimes exhibited a small increase in the year following fire. NDVI and EVI in conifer ecosystems at higher elevation or with higher annual precipitation tended to recover more quickly than conifer ecosystems at lower elevation or with lower annual precipitation. Since vegetation recovery is related to ecosystem carbon stocks, the effects of fire on long-term carbon stocks will depend on the vegetation type and local precipitation regime in addition to the fire return interval.

P48 Building a Database of Diversity and Equity at Colorado College

Student Researcher: Austin Lukondi '17
Major: Education and Sociology
Faculty Collaborator: Manya Whitaker, Education and Gail Murphy-Geiss, Sociology

The issue of diversity and equity on college campuses is a significant and highly contentious issue. In this research, academic publications, non-academic periodicals, and other resources were complied in an attempt to start creating a database of diversity and equity at Colorado College. The research covers a wide range of topics including: disability, race, gender, sexuality, socioeconomic status, and other identity groups who remain underserved in education. Divided into five parts: general knowledge, classroom teaching, college culture, faculty experiences, and student experiences, this research is meant to be used as a resource for staff and faculty when dealing in issues of diversity and equity. While an online, readily-accessible database is the long term goal for this project, this part of the project was primarily concerned with deciding what kinds of research were important to include, which identities needed to be centered in diversity and equity, and how faculty and staff should best handle these issues.

P49 Increasing the Resolution of Forensic Isoscapes and Exploring Changes in Lead Exposure in the United States

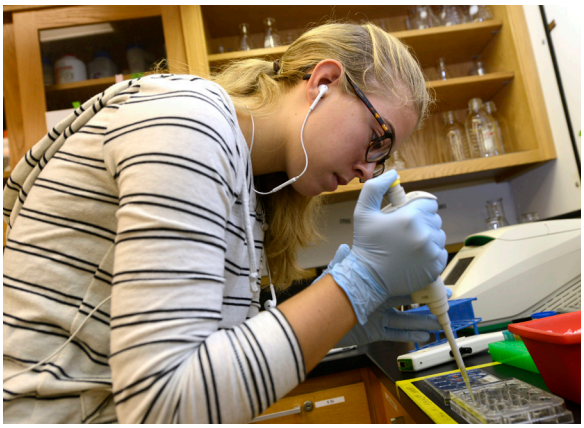
Student Researcher: Samuel Brown '18
Major: Chemistry
Faculty Collaborator: Nate Bower, Chemistry and Biochemistry

Stable isotope analysis of heavy elements has become a powerful tool in modern forensic and archaeological investigations. In the past, work has been done to build environmental isoscapes of Pb, but due to shifting populations and the variability of Pb sources over time, there is little correlation found between recent environmental Pb isoscapes and human tissue Pb isoscapes. This lack of correlation calls for building an isoscape based off actual human tissue. This study utilizes ICP-MS and Multi Collector High-Resolution ICP-MS instrumentation to examine Pb concentrations and isotopic distributions in tooth enamel and dentin samples removed from Air Force Academy cadets. The cadets were all born and raised in the same place with little movement in their life, with samples coming from cadets all born closely together in time. The sample set attempts to represent the United States as fully as possible. Our results add to the small amount of data like this previously created, to improve the potential forensic utility of these types of isotopic distribution maps. The isoscapes created demonstrate how the comparison of dentin and enamel Pb concentrations and isotopic distributions could be useful in highlighting differences in human Pb intake over time and provide value to forensic investigations as well as migratory and environmental studies.

P50 Cardiorespiratory Fitness, Self-Selected Training Volume, Dietary Intake, and Iron Status of Female Endurance Athletes

Student Researcher: Julia Lauzon '17
Major: Organismal Biology and Ecology
Faculty Collaborator: Anthony Bull, Human Biology and Kinesiology

The purpose of this research was to examine the effect of training volume, dietary intake, and optional iron supplementation on female endurance athletes' maximal oxygen consumption (VO2max) and iron status during a period of increased training volume. The participants were female endurance athletes (VO2max > 80th percentile for age) who participated in a moderate to high volume endurance training program (5-6 days a week), and were not currently supplementing with iron. Participants completed a VO2max trial for familiarization and inclusion criteria, followed by baseline and follow-up trials separated by about eight weeks. Blood was drawn at a local clinic and analyzed for hemoglobin and ferritin to assess iron status at baseline and follow-up. Three-day dietary and seven-day activity records were completed at baseline, four weeks, and follow-up and analyzed for iron intake and total activity volume, respectively. Participants whose plasma ferritin levels fell below established guidelines were suggested to take an over the counter supplement by our medical supervisor. However, this supplementation was not required nor was it provided by the investigators in order to determine if participants would supplement. We regret that due to study delays, follow-up data was not available at the time of this submission.



COLORADO COLLEGE

Office of the Dean

Faculty-Student Summer Collaborative Research (SCoRe)

BUILDING ON THE BLOCK

Part of the **Colorado College Plan: Building on the Block**

ADDITIONAL SUPPORT FOR THE BLOCK PLAN:
The Center for Immersive Learning and Engaged Teaching