SUMMER RESEARCH SYMPOSIUM & CELEBRATION

Friday, October 20, 2017
Weitz Center Commons
3:30-5:30 P.M.
October 20, 2017

Welcome to this Year’s Student Research Symposium and Celebration at Carleton. Today we honor the many students who have engaged in advanced work in their respective fields, building on the knowledge and skills they acquired throughout their course work both at Carleton and on off-campus programs.

Research is at the heart of a Carleton education. Through their posters and oral presentations these students reveal the habits of mind that an outstanding liberal arts education provides – a passion for intellectual exploration, skills of careful observation and analysis, the ability to frame questions in fruitful ways, to interpret both quantitative and qualitative data, and to convey their findings clearly and concisely, both verbally and visually. We are proud of their accomplishments.

We also wish to acknowledge and celebrate the great diversity of research represented here. Faculty and staff from eighteen departments and programs have supervised student research projects, as well as several staff members. Taken together, the work of these students attests to the breadth of research opportunities at Carleton and the many ways in which faculty and staff throughout the College inspire and support student scholarship.

Finally, we call attention to the many significant mentoring relationships that fostered this work and were deepened as a result of it. As generations of Carleton students will attest, the opportunity to work closely with faculty is among the most impactful and memorable of their experiences here. Behind each of these presentations is a faculty or staff member whose guidance, encouragement and coaching enriched the education of students and inspired them to go further than they imagined they could. We are grateful for the dedication and attentiveness of all these mentors.

We invite you to engage with these students, to question them about their work and its significance. In this way, we hope you will join them, at least briefly, on the intellectual journey they have undertaken.

Thank you for joining us for this symposium and celebration.

Bev Nagel
Dean of the College

Carolyn H. Livingston
Vice President for Student Life and
Dean of Students
1. **T2 Limited DC Magnetometry**  
   **Alexander Aeppli ’18**  
   Summer 2017  
   **Supervisor:** Dr. Alexander Wood (University of Melbourne), Prof. Robert Scholten (University of Melbourne), Prof. Andy Martin (University of Melbourne), Prof. Lloyd Hollenberg (University of Melbourne)  
   We present a method for DC magnetometry at the T2 limit using nitrogen vacancy (NV) centers in diamonds. Standard DC magnetometry in NV centers using Ramsey interferometry is limited by the T2* relaxation time. By rotating the diamond at 200,000RPM, we induce a time varying Zeeman shift that allows us to use spin-echo to achieve T2 limited resolution. Experimentally, we use an ensemble of NV centers to show a sensitivity improve of two orders of magnitude.  
   *This research was funded in part by the Kolenkow-Reitz Fund for Undergraduate Research.*

2. **Role of actin in Hedgehog pathway in skin cancer**  
   **Saki Amagai ’18**  
   **Authors/Contributors:** Ramon Whitson (Post-doctoral fellow, Stanford University), Anthony Oro (Professor of Dermatology, Stanford University)  
   Summer 2017  
   **Supervisor:** Ramon Whitson (Post-doctoral fellow, Stanford University), Anthony Oro (Professor of Dermatology, Stanford University)  
   Basal cell carcinoma (BCC) is one of the most common skin cancer. It is known to be caused by the malfunction of the Hedgehog (HH) cell signal pathway. My lab has been working to understand the mechanism of the non-canonical pathway for BCCs that become resistant to Smo inhibitors. I primarily worked on looking at the role of actin cytoskeleton in the non-canonical HH pathway and its effect on transcriptional regulation of the target gene.

3. **Using Gaussian Beam Interference to Manipulate Trapped Atoms**  
   **Marshall Basson ’20 and Sean Gallagher ’19**  
   **Authors/Contributors:** Eric Hazlett (Assistant Professor of Physics, Carleton College), Mark Zach (Instrument Project Manager, Carleton College), Ashley Carlson ’18, Adam Rutkowski ’17  
   Summer 2017  
   **Supervisor:** Eric Hazlett (Assistant Professor of Physics, Carleton College)  
   We have built an apparatus that successfully uses laser trapping to cool Rubidium atoms to near on the order of microKelvin. We now seek to use Gaussian beams to manipulate these trapped atoms. To this end, we have built a stable half-symmetric optical resonator that can filter specific modes of the beam. Through Mathematica we show that these beams can be used to create an atom wave-guide with a corkscrew-shaped profile. This profile could maybe be used as an Archimedes screw to counter gravity and transport the atoms upwards in a controlled and precise manner.

4. **The Search for Water-Spitting Metal Oxide Photocatalysts**  
   **Alexander Battiste ’19 and Keaton Mertz ’18**  
   **Authors/Contributors:** Steven Drew (Charles "Jim" and Marjorie Kade Professor of the Sciences and Chemistry, Carleton College)  
   Summer 2017  
   **Supervisor:** Steven Drew (Charles "Jim" and Marjorie Kade Professor of the Sciences and Chemistry, Carleton College)  
   Producing hydrogen from sunlight and water is a potential renewable energy of the future. There may exist a metal oxide catalyst capable of efficiently and inexpensively photoelectrolyzing water with visible light. An essential step in mounting a search for a suitable metal oxide is the assembly of a research grade scanning station that probes the water-splitting ability of metal oxide photocatalysts. The primary goal of this research was to modify our scanning station to improve the signal to noise ratio for photocurrent measurements. Attempts at the synthesis of mixed metal oxide thin films using a combination of three different metals will also be reported.
5. **Sonic Signatures: Do Shakespeare's Characters Have Distinct Speech Qualities?**
   
   Estelle Bayer ’19 and Liz Nichols ’20
   
   **Authors/Contributors:** Eric Alexander (Assistant Professor of Computer Science, Carleton College), Summer 2017
   
   **Supervisor:** Eric Alexander (Assistant Professor of Computer Science, Carleton College)
   
   Do the sounds that comprise a text have inherent meaning? Can the phonetic features of a text inform classification and analysis of characters? We sought to answer these questions using machine classification and visualization tools. We broke Shakespearean characters' texts into phonemes, and quantified their speech as vectors of phoneme frequency. We created tools that made use of these vectors in a variety of ways, including visualizing the multi-dimensional space of character speech, classifying characters based on gender and role-type, depicting the most distinctive speech features for roles, and picturing how 'bright' or 'dark' a given character's speech sounds. These tools are intended to help literary scholars and linguists deepen their understanding of the way Shakespeare used sound to distinguish his characters' speech, and may be applied to other texts and speakers going forward.

6. **Paleoecological Phytolith Investigation of Anthropogenically Influenced Vegetation Change, Umstead State Park, North Carolina**
   
   Aidan Burdick ’18
   
   **Authors/Contributors:** Ethan Hyland (Associate Professor of Marine, Earth, and Atmospheric Sciences, North Carolina State University), Summer 2017
   
   **Supervisor:** Ethan Hyland (Associate Professor of Marine, Earth, and Atmospheric Sciences, North Carolina State University), Daniel Maxbauer (Visiting Assistant Professor of Geology, Carleton College)
   
   This project examines the effects of European settlement on vegetation change in central North Carolina using phytoliths as a paleoenvironmental proxy. Phytoliths are microscopic deposits of silica found on and produced by plants that are often diagnostic to the genus level. Here, phytoliths are being used to reconstruct historical vegetation assemblages in central North Carolina over the last 3,300 years. Sediment samples were collected at six legacy sediment exposures in Umstead State Park, NC, and processed in order to make counts of representative taxa within the phytolith assemblages. The data on phytolith assemblages will then be correlated with existing radiocarbon dates in order to temporally constrain recent vegetation change in the region. As a critical first step, a modern reference collection of about 70 plants found in and near the study area has been created and will be used as a library for comparison with historical samples. Further data collection for phytoliths found in historical sediments is ongoing.
   
   *This research was funded in part by the Kolenkow-Reitz Fund for Undergraduate Research.*

7. **A Scientific Study on Mesoamerican Greenstone Objects from the Dallas Museum of Art**
   
   Maximiliano Burgess ’18
   
   **Authors/Contributors:** Dr. Marcus Young (Assistant Professor of Materials Science and Engineering, University of North Texas), Matthew Carl (PhD Student, University of North Texas), Summer 2017
   
   **Supervisor:** Dr. Marcus Young (Assistant Professor of Materials Science and Engineering, University of North Texas), Matthew Carl (PhD Student, University of North Texas)
   
   Scientific analysis of cultural heritage objects aids museum conservators and curators in preservation and provenance. This sort of characterization is best done with a variety of complimentary scientific techniques. This summer, we analyzed a set of eight greenstone objects from the collection of the Dallas Museum of Art, each dating back to the height of the Olmec civilization in Central America. Raman spectroscopy was carried out on these objects to identify the molecular structure of each one, X-Ray diffraction was done to identify the different phases present in the material, Scanning Electron Microscopy images were taken to examine microstructural features, and Energy-Dispersive Spectroscopy was used to determine elemental composition. The results of these analyses were compared against standard reference databases to try and evaluate the primary constituent minerals in each object.
8. **Investigation of the Interaction Between the Measles Virus Replication Machinery and C Protein**  
Sandra Carson ’18  
Authors/Contributors: Christian K. Pfaller, Ph.D. (Department of Molecular Medicine, Mayo Clinic)  
Roberto Cattaneo, Ph.D. (Virology and Gene Therapy Program, Mayo Clinic Graduate School of Biomedical Sciences; Department of Molecular Medicine, Mayo Clinic)  
Summer 2017  
Supervisor: Christian K. Pfaller, Ph.D. (Department of Molecular Medicine, Mayo Clinic)  
Roberto Cattaneo, Ph.D. (Virology and Gene Therapy Program, Mayo Clinic Graduate School of Biomedical Sciences; Department of Molecular Medicine, Mayo Clinic)  
Measles virus (MV) is a negative strand RNA virus with a single strand RNA genome encoding six genes, from which eight proteins are expressed. Three of these proteins, nucleoprotein (N), phosphoprotein (P) and large protein (L) form the viral replication complex. The C protein (C) has been previously shown by this lab to impact correct RNA synthesis, suggesting that it acts as a processivity factor of the viral polymerase (2). Here we show through immunoprecipitation (IP) and western blot analysis that C interacts with the viral replication complex. We developed a two-step IP protocol for purification of viral replication complexes from unbound cellular components for future mass spectrometric analysis. Importantly, comparing various IP samples directed against N, P, L and C we noticed that only a small fraction of expressed C was associated with the viral replication complex, whereas the majority of C seemed not to interact.

9. **Gynecology, Obstetrics, and Family Planning: Bettering the Fields via Quantitative and Qualitative Approaches**  
Sarina Chaiken ’18  
Summer 2016- Present  
Supervisor: Dr. Jennifer Kerns (UCSF), Dr. Wenjia Zhang (UCSF), Dr. Jensara Clay (UCSF), Dr. Elissa Serapio (UCSF)  
We seek to improve patients’ gynecological experiences. To improve diagnostic tools for admitting patients for polypectomies, we conducted a retrospective chart analysis of UCSF admissions. To determine the regimen of medicines to give to patients prior to an induction termination for late pregnancies, a similar procedure was followed. We conducted 30-minute qualitative interviews with patients who received the medication digoxin prior to their 2nd trimester abortion to determine emotional responses to the medicine. In order to determine if the drug methergine can prophylactically treat bleeding following second trimester abortions, we collected procedure-room data such as volume of blood loss and noted other complications. Following the creation of a tool to help genetic counselors whose patients must choose between an induction termination and second term abortion, we conducted a focus group to determine uses of and improvements for the tool. Lastly we are working on a stand-alone clinic curriculum project.

10. **Investigating perceptions of Cobalt and its supply chain in the technology industry**  
Avery Cheng ’18  
Authors/Contributors: Dan Hernandez (Associate Professor of Biology, Carleton College)  
Summer 2017  
Supervisor: Mr. William Olson (Seagate Technology)  
Cobalt mining was recently found to promote child labor and is under consideration to be deemed a ‘conflict mineral’. While the Dodd-Frank Consumer Protection act regulates the supply chain of conflict minerals in the United States, Cobalt is not currently regulated. As part of my internship for Seagate Technology, I examined the various viewpoints of stakeholders in the Cobalt mining process to determine the next steps for this industry. I interviewed companies, consultants and academic researchers to learn about their perceptions of the industry, and also examined how Cobalt mining was portrayed in the media. There were mixed reactions about Cobalt as a conflict mineral, and most questioned the feasibility of changing the Cobalt supply chain. In order for companies to be environmentally and socially ethical in their practices, while maintaining profits, I suggest that a standardized materials infrastructure is necessary for an industry-wide supply chain change to occur.
11. Analyzing Stimuli-Responsive Liquid Crystal Photopolymers
Madeline Chosy ’18
Authors/Contributors: Christopher N. Bowman (James and Catherine Patten Endowed Chair, University of Colorado at Boulder), Matt K. McBride (Ph.D. student, University of Colorado at Boulder), Alina Martinez (Ph.D. student, University of Colorado at Boulder)
Summer 2017
Supervisor: Christopher N. Bowman (James and Catherine Patten Endowed Chair, University of Colorado at Boulder), Matt K. McBride (Ph.D. student, University of Colorado at Boulder), Alina Martinez (Ph.D. student, University of Colorado at Boulder)

The ability to control the shape-changing properties of liquid crystal photopolymers offers an attractive method for fabricating micro-mechanical systems and biomaterials. Micro-mechanical systems show promise as a route to robotic artificial muscles, while shape-changing biomaterials provide a means for drug delivery. However, for successful application, the shape change in the polymer material must be initiated by an appropriate stimulus and the properties of the material must be well characterized and tailored to the application. My research this summer focused on using dye to stimulate a shape change with light instead of heat, and changing the chemical composition of the polymer to achieve lower crosslinking density and enhanced programming in the films.

12. Forecasting Events in the Complex Dynamics of a Semiconductor Laser with Feedback
Meritxell Colet ’20
Authors/Contributors: Andres Aragoneses (Visitant Professor of Physics and Astronomy, Carleton College)
Summer 2017
Supervisor: Andres Aragoneses (Visitant Professor of Physics and Astronomy, Carleton College)

We analyze the dynamics of diode laser with optical feedback in the low frequency fluctuations regime. These optical systems have been shown to present a wide variety of complex behaviors, having similarities with other physical systems, such as neurons. We use ordinal pattern analysis to study different experimental sets, and find that two different regimes are present simultaneously, that can be distinguished based on a moving threshold. We use this dual dynamics to forecast extreme events in the overall dynamics. Our work can be also helpful to understand other systems, as rogue waves or earthquakes.

13. The Effect of Hospital Networks on Clostridium difficile Infection Rates
Carissa Comnick ’18
Authors/Contributors: Dr. Daniel Sewell (Assistant Professor of Biostatistics, University of Iowa), Serenity Budd ’19 (Vassar College), Jordan Baker ’19 (Northwestern College, Iowa)
Summer 2017
Supervisor: Dr. Daniel Sewell (Assistant Professor of Biostatistics, University of Iowa)

According to the CDC, Clostridium difficile (C. diff) caused almost 500,000 infections in the U.S. in 2011, and of those infected, 29,000 died within 30 days of initial diagnosis. The CDC lists this bacterium as an 'Urgent Threat' due to its prevalence and antibiotic resistance. Healthcare workers can spread the bacteria or contaminate surfaces through contact, and people can become infected through touching contaminated surfaces and subsequently their mouth, nose, or eyes. Since C. diff is a healthcare-associated infection, patient sharing among hospitals may serve as a means for the dissemination of C. diff. This research focuses on understanding the connectivity patterns via patient sharing between hospitals and how those patterns affect C. diff incidence rates. We used network visualization techniques and employed a more formal linear network autocorrelation model with a spatial component to estimate the network effect on C. diff infection incidence.

Sam Cooke ’20
Authors/Contributors: James Skeath (Professor Genetics, Washington University in St. Louis), Beth Wilson (Lab technician, Washington University in St. Louis)
Summer 2017
Supervisor: Dr. James Skeath (Washington University School of Medicine in St. Louis)
Neurogenesis is a complex process that is strictly regulated. This summer, I investigated the mutant phenotypes resulting from the inhibited expression of 60+ genes in order to identify specific genetic factors that contribute to or hinder neurogenesis in Drosophila melanogaster and to determine the role of the basement membrane in neurogenesis. The UAS-GAL4 system was utilized along with UAS linked RNAi transgenes to knock down the expression of genes known to code for proteins expressed in the extracellular matrix and critical to the integrity of the basement membrane in the central nervous system in Drosophila. Our references for phenotype scoring were the AdamTS-Arnwy1 phenotype and the wild type phenotype. After scoring the phenotypes of the crosses, preliminary results indicate that the vkg, trol, Rfbag, and rgn genes were critical to neurogenesis in Drosophila.

This research was sponsored in part by the NSF – S-STEM grant.

15. Optimizing AlphaLISA Assay Conditions for Interaction Between IRS-1 and GKAP42
Amanda Crawford ’19
Summer 2017
Supervisor: Shin-Ichiro Takahashi (Associate Professor, University of Tokyo), Fumihiko Hakuno (Assistant Professor, University of Tokyo), Yousuke Yoneyama (Post-Doctoral Fellow, University of Tokyo), and Kento Funaki (University of Tokyo)
Insulin receptor substrates (IRSs) mediate insulin signaling via tyrosine phosphorylation by insulin receptor tyrosine kinases in a ligand-dependent manner. We have reported that 42-kDa cGMP-dependent protein kinase-anchoring protein (GKAP42) increases the effects of insulin-induced GLUT4 translocation and glucose uptake by increasing the availability of IRS-1 to insulin receptor. By interfering with the interaction between GKAP42 and IRS-1, glucose uptake may be selectively decreased in adipocytes, leading to a decrease in whole body insulin-resistance induced by various cytokines such as tumor necrosis factor (TNF)-α. This study is undertaken to establish the rapid and sensitive assay system to screen chemicals that might modulate the interaction between IRS-1 and GKAP42. Here, I improve the conditions of the Amplified Luminescent Proximity Homogeneous Assay (Alpha)LISA for testing the interaction between GST-tagged GKAP42 and FLAG-tagged IRS-1. Then, two previously identified GKAP42-interacting chemicals are tested for their ability to interfere with the interaction between GKAP42 and IRS-1.

16. Computational Investigation of Ruthenium Silylene Complex
Will DeSnoo ’19
Authors/Contributors: Matt T. Whited (Associate Professor of Chemistry) and Daniela Kohen (Professor of Chemistry)
Summer 2017
Supervisor: Matt T. Whited (Associate Professor of Chemistry, Carleton College), Daniela Kohen (Professor of Chemistry, Carleton College)
As part of a research program aimed at unveiling new metal-based chemical reactions involving metal/element multiple bonds, the Whited group has recently synthesized a metal complex that contains a ruthenium silicon double bond and exhibits previously unobserved reactivity with carbon dioxide. In this poster, I present research under the guidance of Prof. Daniela Kohen using computational modeling to gain a better understanding of why and how this complex reacts with carbon dioxide.

17. Determining Human mitochondrial alanyl-tRNA synthetase quaternary structure and affinity for human mitochondrial tRNA-Ala
Samuel Diaz de Leon ’18 and Jacob Heath ’19
Authors/Contributors: Joe Chihade (Professor of Chemistry, Chair of Chemistry, Director of Biochemistry, Carleton College), and Isaac Donnell ’18
Summer 2017
Supervisor: Joe Chihade (Professor of Chemistry, Chair of Chemistry, Director of Biochemistry, Carleton College)
Aminoacyl tRNA synthetases (aaRSs) catalyze the aminoacylation of the 3-end of tRNAs. Our interest is in the human mitochondrial alanyl-tRNA synthetase (AARS2). The human mitochondrial tRNA-Ala lacks most of the conserved nucleotides typically used as recognition elements by alanyl-tRNA synthetases in other organisms. In this work, we sought to determine the quaternary structure of AARS2 by size-exclusion chromatography and characterize protein-tRNA recognition using gel shift assays.
18. Direct and Indirect Effects of Herbivores on Prairie Community Composition
Tris Dodge '19
Authors/Contributors: Kait Libby ’19, Andy Hoyt ’19, Caroline Harvey ’19, Jordan Pruszenski ’16, Daniel Hernandez (Associate Professor of Biology), Mark McKone (Towsley Professor of Biology)
Summer 2017
Supervisor: Daniel Hernandez (Associate Professor of Biology), Mark McKone (Towsley Professor of Biology)

Floral community composition of prairies is, in part, a reflection of what herbivores do not eat. However, how different herbivore species differentially or interactively affect prairies is unknown. In 2010, we erected a combination of different sized mesh fences in the Cowling Arboretum at Carleton College. These fences excluded different sized herbivores, namely whitetail deer (Odocoileus virginianus), Eastern cottontail rabbits (Sylvilagus floridanus), and voles (Microtus sp.), singly or in combination. Within the fences, we measured light availability, plant species richness, and looked for effects among different plant functional groups. In plots from which voles were excluded, we found that less light was available, due to greater litter accumulation. We also found differential effects on independent functional groups of plants, depending on what herbivores were admitted. Thus, we propose voles may play important functional roles in prairies, affecting community composition through direct effects (herbivory) and indirect effects (reducing litter accumulation).

19. Human Mitochondrial tRNA-Ala and Alanyl-tRNA Synthetase: Structural Analysis Using Computational and Biochemical Methodologies
Isaac Donnell '18
Authors/Contributors: Joseph Chihade (Professor of Chemistry, Carleton College), Samuel Diaz De Leon '18, Jacob Heath ’17, Hannah Kennicot ’20, Jessica Makori ’19
Summer 2017
Supervisor: Joseph Chihade (Professor of Chemistry, Carleton College)

The human mitochondria provides the cell with the majority of its ATP, and is a highly important organelle. Most mitochondrial proteins are synthesized in from the cytoplasm and shuttled into the organelle, but there are a few that are made in house. Synthesis of these mitochondrial proteins requires a separate ribosome, tRNAs and aminoacyl-tRNA synthetases. One topic of interest for biochemists is the recognition strategies of the aminoacyl tRNA synthetases. In our study, we focused on the human mitochondrial alanyl-tRNA synthetase (AARS2). Small angle X-ray scattering data (SAXS) obtained previously was used as a reference for developing predicted tertiary structures of our enzyme and tRNA of interest. Using sequence alignment with other mammalian AARS2 and our predicted structural models, we have identified residues that potentially contribute to tRNA recognition. Our current work involves creating mutations at these residues to test their importance.

20. Posthumous Representations of David Livingstone in the United Kingdom
Lizzy Ehren ’18
Authors/Contributors: Thabiti Willis (Associate Professor of History)
Summer 2017
Supervisor: Thabiti Willis (Associate Professor of History)

This project involves a comparative study of British explorer David Livingstone’s posthumous representations (both busts and statues) in England and Scotland. While Scottish born and viewed as a masculine Scottish hero, Livingstone garnered national and international fame as an agent of the British empire during the colonization the African continent. What is unique about my project is my emphasis on the appropriation of his memory for nationalist discourses through the many sculptures and busts created in his honor after his death. My analysis of these representations reveals the ways in which various church-affiliated and scientific organizations drew on the political, symbolic capital of Livingstone, "the figure," to advance their diverse interests. These organizations emphasized different representations of Livingstone’s identity through the clothing or tools depicted in these sculptures. Livingstone as missionary, explorer, or doctor embody trends in British history, views on the African continent and the history of heritage management.

This research was funded in part by a Class of 1963 Fellowship.
21. Kinetics of Heterogeneous N2O5 Uptake to Sea Spray Aerosol Mimics
Kate Faber ’18
Authors/Contributors: Timothy Bertram (Associate Professor of Chemistry, University of Wisconsin-Madison) and Sean Staudt (Ph.D. Candidate, University of Wisconsin-Madison)
Summer 2017
Supervisor: Timothy Bertram (University of Wisconsin-Madison)
Developing accurate climate models depends on understanding atmospheric chemical reactions of trace gases such as nitrogen oxides (NOx). One crucial sink of NOx is the heterogeneous reaction of N2O5 with Cl- on atmospheric aerosol particles, yet the mechanism and kinetics of this reaction are poorly understood. We investigated the relationship between aerosol Cl- and N2O5 uptake to distinguish between two hypothesized mechanisms, a Cl-independent aqueous mechanism and a Cl-dependent interfacial mechanism. Aqueous NaCl/(NH4)2SO4 aerosols were generated in lab, size selected at 150 nm, and mixed with N2O5 in a flow tube with residence time 0-200 s. N2O5 loss was measured using I- chemical ionization mass spectrometry. This summer’s research focused on obtaining sufficient aerosol surface area, modeling expected results, and preparing the instrumental setup. Kinetic data collection is ongoing.

22. Understanding the Link Between Depression and Weight-Related Behavior with Implicit Theories
Rebecca Fairchild ’18
Authors/Contributors: Jaimee Heffner (Fred Hutch Cancer Research Center) and Kristin Mull (Fred Hutch Cancer Research Center)
Summer 2017
Supervisor: Jaimee Heffner (Fred Hutch Cancer Research Center)
Depression is associated with failure to engage in healthy weight-related behaviors. However, the psychological mechanisms linking depression to diet and exercise behaviors have not been fully evaluated despite the potential of this work to identify new targets for intervention. This exploratory study investigates whether the association between depression and weight behaviors can be explained by people's implicit theories of weight i.e., beliefs that body weight is either unchangeable (fixed mindset) or malleable (growth mindset). To do so, this study examined data from the National Cancer Institute’s 2014 Health Information National Trends Survey-4 Cycle 4 (n=3677) to determine associations between depression, implicit theories of weight and weight behaviors. Depression was correlated with a fixed mindset towards weight and less fruit and vegetable consumption, independent of BMI. However, implicit theories of weight were not related to weight behaviors and, thus, are insufficient at explaining the relationship between depression and health behaviors.

23. Can transition state analogues be used to predict enantioselectivity?
Elianna Frank ’18
Authors/Contributors: Gretchen Hofmeister (Professor of Chemistry, Carleton College), Daniela Kohen (Professor of Chemistry, Carleton College)
Summer 2017
Supervisor: Gretchen Hofmeister (Professor of Chemistry, Carleton College), Daniela Kohen (Professor of Chemistry, Carleton College)
Computational chemistry can be used to investigate reactivity and energies of compounds that are difficult to isolate, or too expensive or dangerous for a lab setting. This summer, we used computational chemistry to investigate the viability of certain transition state analogues as accurate models of instantaneous transition states. The reaction we studied was an organocatalyzed asymmetric desymmetrization reaction, and both glutaric anhydride and norbornane systems were studied. Ultimately, the reaction enantioselectivity was effectively modeled by the transition state analogues in both systems; however, catalyst conformation was not consistent with previously computed transition states.
24. Calculating Symmetry Violation Coefficients for Gravitational Light Deflection
Joseph Gais ’19
Authors/Contributors: Jay Tasson (Assistant Professor of Physics, Carleton College)
Summer 2017
Supervisor: Jay Tasson (Assistant Professor of Physics, Carleton College)
Using data from the measurement of gravitational light deflection by the sun during the June 30th, 1973 eclipse in Chinguetti, Mauritania, we place bounds on nine coefficients for Lorentz violation. These coefficients represent anisotropies, or preferred directions in spacetime, and so would be represented by systematic residual deflection of starlight about the sun after taking into account the deflection of light due to general relativity. We limits reaching the order of $10^{-1}$. This is not competitive with the lowest bounds for these coefficients but does represent a new methodology of placing bounds on Lorentz violating coefficients that can be improved on in future eclipse experiments.

25. Archaeal metabolic profiles at deep-sea hydrothermal vents in the Mid-Cayman Rise
David Galambos ’20
Authors/Contributors: Rika Anderson (Assistant Professor of Biology, Carleton College), Julie Reveillaud (Postdoctoral Researcher, Huber Lab, Marine Biological Laboratory), Julie Huber (Associate Scientist, Marine Biological Laboratory)
Summer 2017
Supervisor: Rika Anderson (Assistant Professor of Biology, Carleton College)
Deep-sea hydrothermal vent systems host a wide diversity of bacteria, archaea and viruses. Although the geochemical conditions at these vents are well-documented, the relative metabolic activity of microbial lineages, especially among archaea, remains poorly characterized. Our analysis focused on the Von Damm and Piccard vent fields of the Mid-Cayman Rise. Previous metagenomic work indicated that despite the distinct geochemistry at Von Damm and Piccard, the functional profile of microbial communities between the two sites was similar. We examined relative metabolic gene activity using a metatranscriptomic analysis and observed further functional similarity, which is consistent with previous results. We also analyzed the expression and metabolic profiles of metagenome-assembled genomes (MAGs) across samples. At both vent fields, specific Methanococcus lineages were more highly expressed than others. Future analyses will examine methane-related metabolic genes in various MAGs to assess the impact of potential methane cycling on the activity of these Methanococcus lineages.

26. Investigating Unwanted Features in the Fabrication of Photopolymer Waveguides
Winston Goldthwaite ’19
Authors/Contributors: Marty Baylor (Associate Professor of Physics, Carleton College)
Summer, 2017
Supervisor: Marty Baylor (Associate Professor of Physics, Carleton College)
Use of a new photopolymer offers the possibility to mass-produce consistent and low-loss waveguides with coplanar optofluidic features. This photopolymer is designed so optical intensity patterns of UV-light turn into index of refraction features when curing the sample. In creating samples, we saw unwanted features appear that destroyed or increased loss of waveguides. Using qualitative analysis of waveguides after varying different parts of the fabrication process, we have narrowed down possible causes for these features. Our leading theory is that using quartz slides to make waveguide samples, which have a lower index of refraction than the previously used glass slides, causes additional UV-light to couple into the sample. This unwanted light overexposes the sample, increasing the index of refraction in areas affecting waveguides, which results in increased loss. Future work will verify this hypothesis and find a solution which prevents the formation of these features.

27. Finding Consensus Phylogenetic Trees for Tumor Evolution
Kiya Govek ’18 and Camden Sikes ’18
Authors/Contributors: Layla Oesper (Assistant Professor of Computer Science, Carleton College)
Summer 2017
Supervisor: Layla Oesper (Assistant Professor of Computer Science, Carleton College)
Phylogenetic trees are a structure commonly used to represent the evolutionary history of a set of species. There exist a number of algorithms that solve the problem of building a consensus tree from a set of conflicting phylogenetic trees. We consider a variant on this problem inspired by recent efforts to model cancer evolution with phylogenetic trees. We design two consensus approaches to solve this problem. The first is an adaptation of the majority-rule consensus method for traditional phylogenetic trees. In the second approach we construct a weighted directed graph using relationships from the input trees and return the maximum weight spanning arborescence of that graph. We compare our methods using simulated data and evaluate our results using the total distance between the consensus tree and the input trees. We find that using different distance metrics strongly affects our results, with each method performing close to optimal for one metric.

28. **Interactions and Effects of Invasive Species: A Mesocosm Study**  
*Katie Grosh ’18*  
**Authors/Contributors:** Dr. Scott McNaught (Professor of Biology, Central Michigan University) and Briana Marie Skufca (Central Michigan University)  
**Summer 2017**  
**Supervisor:** Dr. Scott McNaught (Professor of Biology, Central Michigan University)  
Since the early 1800s, ballast water has introduced hundreds of invasive species into the Great Lakes, causing widespread ecologic and economic turmoil. Dreissena bugensis (Quagga mussels) and Hemimysis anomola (Bloody Red Shrimp) are two of these invasive species from the Ponto-Caspian region that are disruptive to the lower food web in the Great Lakes. We performed a mesocosm tank study on Beaver Island, MI, to determine the interactions between the two invasive species and their effects, both individually and combined, on zooplankton, phytoplankton, and Cladophora (filamentous green algae). Quagga mussels and Hemimysis individually negatively impacted both types of plankton, and quagga mussels promoted Cladophora growth. The combination of both invasive species had mixed impacts on plankton, potentially because adult Hemimysis had lower survival rates in tanks with quagga mussels. This competition may lower species’ individual impacts on the lower food web, and potentially create less-detrimental effects on the ecosystem.  
*This research was funded in part by the Kolenkow-Reitz Fund for Undergraduate Research.*

29. **Behind the Drapes: Zoot Suit Tailors in 1940s United States**  
*Simon Gutkin ’18*  
**Supervisor:** Geraldo Cadava, Associate Professor of History, Northwestern University  
The zoot suit, popular in urban cities in the 1940s, is a flamboyant suit worn mostly by young men of color that had wide shoulders, long draped back, and baggy pants that cuffed close to the ankles. In their analyses, zoot suit historians have constructed a thorough history of zoot suit wearers, but with the exception of a few short passages, the tailors of the suits get little attention. In March of 1942, this style became illegal when the War Production Board issued restrictions on material usage during the war that banned the production of zoot suits. Stories of these tailors will further historiography of the style by interrogating and illuminating the role that underground entrepreneurial activity had in the creation of the zoot suit as a physical garment and a political and cultural symbol.

30. **Anarchy! (a handbook)**  
*Emma Halper ’18*  
**Authors/Contributors:** Roger Bechtel (Professor of Theater, Chair of Theater and Dance)  
**Summer 2017**  
**Supervisor:** Roger Bechtel (Professor of Theater, Chair of Theater and Dance)  
This summer I worked with professor Roger Bechtel on creating a piece of devised theater centered around the ideas of anarchy and resistance. We used Noam Chomsky's "On Anarchism" as our grounding text and I researched contemporary anarchist activism. The goal was to devise a play that explored, through both form and content, the principles, uses, and critiques of anarchical thought. We worked with three actors in Minneapolis and performed the play for the Minnesota Fringe Festival in early August.  
*This research was funded in part by the Humanities Center Student Research Fund.*
Anne Hamilton ’18
Authors/Contributors: Dr. Daji Qiao (Associate Professor and the Director of Graduate Education in the Department of Electrical and Computer Engineering, Iowa State University) and Mathew L. Wymore (PhD candidate, Iowa State University)
Summer 2017
Supervisor: Dr. Daji Qiao (Associate Professor and the Director of Graduate Education in the Department of Electrical and Computer Engineering, Iowa State University)
For research to improve operations and maintenance (O&M) of wind plants using advanced monitoring system technology, a better understanding of current industry practices is necessary. In this study, we conducted an online survey for wind turbine operators in Iowa and Southern Minnesota to learn if, and how, advanced wind turbine monitoring systems are being used in industry as well as desired areas for their future development. This study found that the cost of advanced monitoring systems is currently not worth the utility of the data generated. The large quantity of data produced is not able to be analyzed, restricting the ability of operators to mitigate component failure, reducing the benefits of having advanced monitoring systems. Therefore, we recommend the research community focus on improving data processing technologies, advancing engineering technology to allow for earlier mitigation of component failure and conducting more case studies of the economics of advanced monitoring systems.

32. Lethal Impact of Socioeconomic Adversity on Colorectal Cancer Outcomes
Lydia Hanson ’18
Summer 2017
Supervisor: Dr. Robert Goldman (Portland VA Health Center)
Colorectal cancer (CRC) is the third most common and third most lethal cancer in the United States. It is documented that racial and ethnic minority patients and people of low socioeconomic status (SES) experience a greater incidence and mortality from CRC, but the causes for these disparities are not fully understood. We conducted a systematic literature review to understand how social determinants of health impact CRC incidence, survival, and mortality. We found that there was an 8% absolute survival disparity between black and white CRC patients and that only 50-75% of this disparity could be explained by late stage diagnosis, socioeconomic differences, and treatment inequality. Further, this disparity is growing. Between 1970 and 2000, the gap grew from 11% to 33%. We suggest that public policy should address structural inequalities at the community level and provide culturally appropriate recommendations to increase screening rates and reduce excess burden of disease.
This research was funded in part by the Kolenkow-Reitz Fund for Undergraduate Research.

33. Examining the Relationship between Listening Effort and Cognitive Ability
Maryam Hedayati ’18 and Lucia Ray ’20
Authors/Contributors: Violet Brown ’17, and Julia Strand (Assistant Professor of Psychology, Carleton College) 2016-2017
Supervisor: Julia Strand (Assistant Professor of Psychology, Carleton College)
Listening effort (LE) describes the mental exertion required to attend to and understand speech. Despite a large body of research, the relationship between LE and cognitive ability remains poorly understood. One aim of our large-scale validation study was to assess whether individual differences in LE tasks relate to individual differences in other cognitive abilities. To assess this, 111 Carleton College students completed a battery of seven LE tasks and five tests of cognitive ability. Results demonstrated that measures of LE differed in the extent to which they correlated with cognitive variables, but in general, people with high cognitive ability appear to be able to use their resources more efficiently, thereby reducing processing load.

34. Microevolutionary Dynamics in Subseafloor Archaea Populations
Michael Hoffert ’18
Authors/Contributors: Rika Anderson (Assistant Professor of Biology, Carleton College)
Summer 2017
Supervisor: Julie Huber (Woods Hole Oceanographic Institute)
Using single cell amplified genomes and metagenomic data, we seek to detect the microevolution in Methanothermococcus archaea gathered from the Mid-Cayman Rise, a super-slow spreading fault in the Caribbean. SNV accumulation varied significantly among the 5 collected single cell genomes. Additional evidence was found for several genomic islands containing genes of metabolic interest.

35. **Solidago cover affects species richness and plant ecology in restored tallgrass prairies**

   **Andrew Hoyt '19**

   **Authors/Contributors:** Dan Hernandez (Associate Professor of Biology), Mark McKone (Towsley Professor of Biology, Research Supervisor of Cowling Arboretum), Tris Dodge ’19, Caroline Harvey ’19, Kait Libbey ’19, and Jordan Pruszensky ’17

   **Summer 2017**

   The Carleton GRASS project prairie is a restored tallgrass prairie in which two dominant grasses, *Androprogon geradii* and *Sorghastrum nutan*, have been planted selectively. The goal of this project is to study the ecological impact of these two species dominant plant species and their absence, but since the prairie has been planted portions have become dominated by *Solidago* species, particularly *Solidago altissima* and *canadensis*. This has presented the unique opportunity to study the impact of these *Solidago* species on the ecology of the ecosystem. Vegetation surveying in this prairie has revealed several interesting trends regarding these effects. We found that plant species richness declined with higher cover of *Solidago* species. This has complex implications for tallgrass prairie ecology and restoration, especially in the absence of dominant tallgrass species.

36. **TBAB Modified Aquivion Polymers to Enhance Enzymatic Biofuel Cells**

   **Cullen Irvine ‘19**

   **Authors/Contributors:** Rong Cai (Graduate Student in Chemistry, University of Utah), Shelley D. Minteer (Professor of Chemistry, University of Utah), Carol Korzeniewski (Professor of Chemistry, Texas Tech University)

   **Summer 2017**

   **Supervisor:** Shelley D. Minteer (Professor of Chemistry, University of Utah)

   Modifying Nafion with tetra-n-butylammonium bromide (TBAB) increases the polymer's micelles, allowing the perfluorosulfonic acid (PFSA) polymer to effectively immobilize the enzyme laccase on the surface of a biocathode for oxygen reduction. Aquivion, a new class of PFSA polymers, is similar in structure to Nafion, but has shorter side chains. Results from a series of titrations prove that TBA+ is capable of replacing most of the protons present in Aquivion, allowing for the polymer’s micelles to enlarge too. Although Aquivion and Nafion are similar in structure, when TBAB Aquivion was used to immobilize laccase on the surface of a carbon cathode in a biofuel cell with a glucose dehydrogenase bioanode, the fuel cell achieved a higher maximum power density than when TBAB Nafion was used. This suggests that Aquivion polymers create a better microenvironment for laccase and can help enzymatic biofuels generate more power than the standard immobilization polymer Nafion.

37. **Spinning Room Data Analysis in the Workhouse**

   **Brittany Johnson ’18 and Claire Jensen ’18**

   **Authors/Contributors:** Alex Wachino ’18, Elizabeth Budd ’19, and Susannah Ottaway (Professor of History, Carleton College)

   **Summer 2017**

   **Supervisor:** Susannah Ottaway (Professor of History, Carleton College)

   In the early nineteenth century House of Industry children were often assigned to daily work spinning skeins of yarn. Unlike other work positions at Forehoe and similar workhouses, the records of the spinners have survived. These children were often the youngest in the workhouse and their daily skein output was recorded every day, week upon week, for years. These same children occasionally appear in other workhouse account books as they are apprenticed to masters or mistresses offering modern researchers a glimpse at the social and economic networks that were used in an attempt to lift children out of the poverty that had sent them to the workhouse in the first place. Our research seeks to understand the role that work ethic and the possibility of social and economic reward played in the surprisingly industrial setting of early nineteenth century House of Industry spinning rooms.

   *This research was funded in part by the Humanities Center Student Research Fund.*
38. Modelling Funerary Urns: Exploring Anglo-Saxon Memory through Material Culture
Brittany N. Johnson ’18
Authors/Contributors: Austin Mason (Assistant Director of the Humanities Center for the Digital Humanities and Visiting Assistant Professor of History, Carleton College)
Summer 2017
Supervisor: Austin Mason (Assistant Director of the Humanities Center for the Digital Humanities and Visiting Assistant Professor of History, Carleton College)
Little is known about the social or cultural context surrounding early Anglo-Saxon funeral practice in the fifth and sixth centuries. Scholars must make assumptions based on the material culture left behind. Of note to our research are early funeral urns bearing geometric patterns and later brooches and jewelry bearing very similar patterns - after the end of funeral urn usage. Current theories place women into cultural prominence and authority surrounding death and funerals in the Anglo-Saxon world, meaning a physical connection between early funeral practice and later fashion could point to a cultural memory proving these theories. Our research used 3D modelling to trace the patterns and stamps on Anglo-Saxon funerary urns in order to seek out cultural connections and memory across time, place, and gender in the Anglo-Saxon world. By converting the urns into digital models, we also seek to encourage further scholarship with researchers and institutions who will now have access to distant materials. This research was funded in part by the Humanities Center Student Research Fund.

39. Generating a Knockout of AND1 in HCT116 Cells Using a CRISPR/Cas9 System
Katherine Jones ’18
Authors/Contributors: Dr. Anja-Katrin Bielinsky (Department of Biochemistry, Molecular Biology & Biophysics, University of Minnesota Medical School) and Marissa Oram (Ph.D. Student at University of Minnesota)
Summer 2017
Supervisor: Dr. Anja-Katrin Bielinsky (Department of Biochemistry, Molecular Biology & Biophysics, University of Minnesota Medical School)
Genome instability is one of the hallmarks of cancer. One of the ways DNA can become unstable is through replication fork stress. When stressed, replication forks can lead to double stranded breaks in the DNA, which can result in mutations. Understanding the mechanism of replication forks and their components will help us better understand how to prevent stress and mutations in the genome. AND1 is an essential gene involved in the replication fork process. We created a +/- knockout of AND1 in a human colon cancer cell line (HCT116) to determine whether or not it is responsible for maintaining telomere integrity. To do so, we used CRISPR/Cas9, a gene editing technology, to knock out one copy of the gene. These AND1 knockout cells will allow us to study the function of AND1 in future work. This research was funded in part by the Kolenkow-Reitz Fund for Undergraduate Research.

40. American Idle: Job Loss Among Aging Americans
Camille Jonlin ’19
Authors/Contributors: Annette Nierobisz (Professor of Sociology, Carleton College), and Cecilia Kryzda ’20
Summer 2017
Supervisor: Annette Nierobisz (Professor of Sociology, Carleton College)
American Idle: Job Loss Among Aging Americans examines the experiences of older workers, specifically those 50 years of age or older, who reported job loss between 2008 and 2014, a period marked by severe economic recession, a subsequent long-term jobless recovery, decline of longstanding institutional protections for American workers, and a dramatic inversion of the population age demographic. In-depth interviews were conducted with individuals residing within a 75 mile radius of Minnesota's Twin Cities, Minneapolis and St. Paul. Engaged in the formal economy as long-term employees, temporary employees, and independent contractors, interviewees encountered job loss due to downsizings, reorganizations, businesses closing, and other significant responses to the Great Recession and its sluggish recovery. The project broadly explores how older, unemployed workers navigated job loss against the backdrop of an unprecedented and volatile confluence of socio-economic conditions. This research was funded in part by the Humanities Center Student Research Fund.
41. Investigating Key Predictors of Subjective Well-being with a Critical Race Perspective
Audrey Kan ’18
Authors/Contributors: Adam Y. Kim, University of Minnesota Twin Cities Graduate Student
Dr. Richard M. Lee, Professor of Psychology, University of Minnesota Twin Cities
Amy Verrando ’18, University of Minnesota Twin Cities
Summer 2017
Supervisor: Dr. Richard M. Lee (University of Minnesota Twin Cities)
The FamiLee lab at the University of Minnesota investigates several aspects of social psychology including race, ethnicity, and migration and how they relate to development, well-being, and mental health in individuals and families. This summer we examined cross-cultural differences on subjective well-being, specifically differences between racial identities. We took an ethnic studies perspective by incorporating Critical Race theory on well-being across various racial groups to attend to how race is defined. Additionally, we reviewed empirical literature of four common race and ethnic specific predictors related to subjective well-being: discrimination, identity, acculturation, and socialization. All specific predictors affected perceived and experienced subjective well-being in individuals, and demonstrated the dynamic relationship between racial challenges, resiliency, and well-being of people of color.
Further research that examines the roles of race in other salient identities such as class and gender is suggested in order to include an ethnic studies perspective for multiple analytical frameworks.
This research was funded in part by the Kolenkow-Reitz Fund for Undergraduate Research.

42. Understanding the Role of Lung Stem Cells in Lung Fibrosis
Pavana Khan ’19
Summer 2017
Supervisor: Dr. Carolina Garcia de Alba Rivas (Boston Children’s Hospital and the Harvard Stem Cell Institute), Dr. Patrizia Pessina (Boston Children’s Hospital and the Harvard Stem Cell Institute) and Dr. Carla Kim (Boston Children’s Hospital and the Harvard Stem Cell Institute).
Idiopathic Pulmonary Fibrosis (IPF) is a lung disease characterized by aberrant activation of the alveolar epithelium followed by migration and proliferation of fibroblasts and myofibroblasts with consequent excessive extracellular matrix deposition and destruction of the lung parenchyma architecture. It has been hypothesized that the epithelial cells of the lung are primarily responsible for starting and orchestrating fibrosis. Some of the pathological features of IPF can be reproduced in a mouse model of the disease, where repeated injury of lung epithelium with intratracheal instillation of Bleomycin leads to areas of epithelial cell damage, death, and fibrosis in the lung. This project was focused on characterizing the populations of endogenous lung stem cells that dominate the epithelial response to damage from Bleomycin using immunofluorescence microscopy, and evaluating their functional phenotype using a 3D coculture system developed in the Kim Lab.

43. Honey Bee Foraging Preference in Restored Prairie
Belle Kinder ’18
Summer 2017
Authors/Contributors: Morgan Carr-Markell (PhD student, University of Minnesota Honey Bee Lab)
Supervisor: Morgan Carr-Markell (PhD student, University of Minnesota Honey Bee Lab)
It is important that we confirm that honeybees have access to adequate nectar and pollen sources to support their health and honey production. Native prairies are important resources for native bees, but little research has been conducted on how honeybees utilize native and restored prairie. We study this relationship by analyzing the unique honeybee waggle dance language, their method of resource communication. By filming waggle dances in glass-walled observation hives and decoding these signals, along with regular flower surveys to show us what is blooming, we can see whether honey bees prefer or avoid prairies resources.
This research was funded in part by the Kolenkow-Reitz Fund for Undergraduate Research.
44. Topic Modeling: Stoplist Optimization  
Michael Kipp ’18  
Authors/Contributors: Eric Alexander (Assistant Professor of Computer Science, Carleton College)  
Summer 2017  
Supervisor: Eric Alexander (Assistant Professor of Computer Science, Carleton College)  
Topic modeling is a method for uncovering hidden semantic relationships in bodies of text. While the insights it provides can be powerful, its training process can be complex. This summer we set out to create a tool to improve the process of topic modeling and make it more accessible to researchers from non-technical areas of study. Specifically, we wanted to streamline, and partially automate, the generation of stoplists: collections of words that are semantically unimportant to a specific domain of text. By using intuitive visual interactions, topic modeling can be made approachable to users with a limited computational background.

45. OTOC and the Kicked Top System  
Alex Kiral ’20  
Authors/Contributors: Arjendu Pattanayak (Professor of Physics, Chair of Physics and Astronomy, Carleton College)  
Spring/Summer, 2017  
Supervisor: Arjendu Pattanayak (Professor of Physics, Chair of Physics and Astronomy, Carleton College)  
Out-of-time-ordered Correlators (OTOCs) are a common technique used in quantum physics to understand the behavior of a chaotic system over time. Despite the importance of these equations, they have not been studied extensively at very small scales. We address this issue by applying the OTOC to the quantum kicked top model, a standard model used to study chaotic systems, with a small number of qubits (2 to 6). We found numerical solutions to the OTOC for this system and plotted them to find patterns within the data. We hope to use our greater understanding of the OTOC to find an exact or approximate equation which describes its behavior as we vary each of its parameters. This furthers the theoretical understanding of the OTOC, and gives physicists further insight into the behavior they should expect when using this technique.

46. Summer Internships: Boulder JCC Farm and New Era Colorado  
Bex Klafter ’18  
Summer 2017  
Supervisor: Becca Levy (Boulder JCC), Amanda Glucklich (Boulder JCC), and Emma Marion (New Era Colorado)  
This summer, I had two internships sponsored by the ENTS Department. I was working on the Boulder Jewish Community Center's Farm--both helping with the farming and assisting with the farm camps for 5-10 year olds. Additionally, I had an internship with New Era Colorado--an organization working to engage young people in democracy. With New Era, I attended leadership workshops, assisted with various campaigns, and registered voters. Although very different from each other, I loved both internships and gained valuable skills ranging from how to thin parsnips to how to pre-register a high-schooler to vote. I'm so grateful to the ENTS department for giving me the opportunity to pursue both internships and continue investigating my long-term career goals.

47. Signaling Pathways that Contribute to Leukemia Chemo-resistance in the CNS  
Benjamin Kopp ’18  
Authors/Contributors: Dr. Peter Gordon (Assistant Professor of Pediatric Hematology, University of Minnesota), Maryam Ebadi (Researcher 1, University of Minnesota), Leslie Jonart (Researcher 5, University of Minnesota), Dr. Patrick Basile (NIH/NRSA Med Fellow, University of Minnesota), Jordan Naumann (Research Assistant, University of Minnesota)  
Summer 2017  
Supervisor: Dr. Peter Gordon (University of Minnesota)  
Leukemia is the most common form of cancer in children with around 3500 new cases diagnosed each year in the US. Therapeutic options, and their effectiveness, have evolved substantially over the last 60 years; however, there are still considerable percentages of patients who, despite receiving treatment, aren't being cured. Leukemia can occupy many niches, including the central nervous system, which is of particular interest because it is the only niche
that lies across the blood brain barrier. CNS leukemia has a reduced sensitivity to chemotherapeutics, making it difficult to treat and resulting in poorer prognoses for patients. The Gordon lab is currently exploring pathways within CNS leukemia to identify those that have become deregulated, and potentially contribute to chemo-resistance. Based on preliminary experiments in vitro, the JAK/STAT pathway seems to be deregulated in CNS leukemia, and is targetable, suggesting it may represent a potential therapeutic option for overcoming chemo-resistance.

48. Study of complex dynamics in optical systems
Daniel Kupetsky '19
Authors/Contributors: Andreas Aragoneses (Visiting Assistant Professor of Physics and Astronomy, Carleton College)
Summer 2017
Supervisor: Cristina Masoller (Associate Professor, Departament de Fisica, Escola Superior d'Enginyeries Industrial, Aeroespacial i Audiovisual de Terrassa, Universitat Politècnica de Catalunya)
Lasers are optical systems that can show a broad variety of complex dynamics in its output power. Studying its time series is of great scientific importance as it helps us understand other complex systems, but also leads us to exploit it for practical purposes. Here we identify and explore correlations patterns in the complex dynamics of a fiber laser with feedback. Using symbolic analysis, we unveil time and intensity correlations in the power output of the laser. This research was funded in part by Carleton's Towsley Endowment.

49. Mazi Archaeological Project 2017
Yuecheng "Russell" Li '19
Authors/Contributors: Alex Knodell (Assistant Professor of Classics, Co-Director of Archaeology, Carleton College), Sarah Craft (Visiting Assistant Professor of Classics, Carleton College), and teams from Texas Tech University, Brown University, University College Dublin, University of Geneva, University of Virginia, University of Cincinnati, and University of Nebraska-Lincoln.
Summer 2017
Supervisor: Alex Knodell (Assistant Professor of Classics, Co-Director of Archaeology, Carleton College), Sarah Craft (Visiting Assistant Professor of Classics, Carleton College)
This summer, I worked as student research assistant on the 2017 season of the Mazi Archaeological Project. This project, started in 2014, is a multi-component archaeological survey aiming at understanding the long-term human and environmental history of the Mazi Plain in northwest Attica, Greece. During this season, project members focused primarily on studying materials in a both detailed and contextualized manner. Specifically, we carried out pottery analysis and catalogue to identify typological change through time, test excavations to sort out chronological matters, mapping of features to provide visual representation of features, and extensive survey both inside and outside the project area to understand the landscape in its broader regional context. Although the processing of results is still on-going on multiple fronts, the accomplishments of this study season have provided a clearer understanding of the diachronic landscape history of the Mazi Plain.
This research was funded in part by the Humanities Center Student Research Fund.

50. Exploring the Use of BRET to Visualize the Physical Interaction Between OX1R and SHP2
Henry Liedl '2019
Authors/Contributors: Jennifer Wolff (Assistant Professor of Biology, Biology Chair, Carleton College)
Summer 2017
Supervisor: Dr. Alain Couvineau (INSERM)
The Centre de Recherche sur L'inflammation has been studying the anti-tumoral effects of the neuropeptide orexin. In my research I attempted to test the theory of bioluminescence resonance energy transfer (BRET) as a means of visualizing the physical interaction between OX1R (an orexin receptor anchored in the cell membrane) and Src homology region 2-containing protein tyrosine phosphatase 2 (SHP2), which has been linked to various cancers. I used plasmids that had been modified to included YFP or NanoLuciferase and transformed human embryonic kidney cells and tested for BRET using spectroscopy. We were unable to observe any physical interactions due to BRET. Because of a lack of necessary equipment the project was eventually abandoned.
This research was funded in part by the Kolenkow-Reitz Fund for Undergraduate Research.
51. Experimental Deformation of Etchegoin Sandstone: Implications for Inferring Stress Directions in Central California

Peter Lindquist '18

Authors/Contributors: Melodie French (Assistant Professor, Department of Earth, Environmental and Planetary Sciences, Rice University) and Sarah Titus (Associate Professor of Geology, Carleton College)

Summer 2017

Supervisor: Melodie French (Assistant Professor, Department of Earth, Environmental and Planetary Sciences, Rice University) and Sarah Titus (Associate Professor of Geology, Carleton College)

The Etchegoin Formation of central California hosts deformation bands, which are akin to small faults. Outcrops of the Etchegoin exhibiting deformation bands occur between 1 and 30 km northeast of the San Andreas fault. Our field observations suggest that these tabular structures form in specific orientations relative to the forces exerted on their host rock, but these directions are at odds with other measures of stresses in central California. To better constrain the relationship between deformation band orientation and applied stresses, we conducted a suite of triaxial deformation experiments on cores of Etchegoin sandstone. The experiments simulated conditions at 1 km depth, and applied prescribed amounts of strain to the samples. Although deformation bands did not form in laboratory deformed samples, comparing these with naturally deformed Etchegoin sandstone samples provides useful information on deformation processes in central California and the conditions necessary for deformation band formation.

This research was funded in part by the Kolenkow-Reitz Fund for Undergraduate Research.

52. Reconstructing Chain Email Propogation

Tina Liu '20 and Kiran Tomlinson '19

Authors/Contributors: David Liben-Nowell (Professor of Computer Science, Chair of Computer Science, Carleton College), Patty Commins '19

Spring 2017

Supervisor: David Liben-Nowell (Professor of Computer Science, Chair of Computer Science, Carleton College)

Today, information is spread through a variety of social network avenues, serving a wide range of purposes. During the Iraq War, petition email chains were spread widely, reaching hundreds of thousands or millions of recipients. In these emails, supporters added their names to an existing list before forwarding it on to others. The paper “Tracing information flow on a global scale using Internet chain-letter data” by Liben-Nowell and Kleinberg examined various methods to model the spread of these email chains. Our research is based on their existing work, with a goal of reconstructing the petition propagation. So far, to determine if and where different petition copies diverge, we have focused on analyzing variations on edit distance to identify whether two names from different petitions are in fact the same.

53. Determining the Gel Point of a Photopolymer

Anthony Lynch '18

Authors/Contributors: Gretchen Hofmeister (Associate Dean of the College and Professor of Chemistry, Carleton College), Marty Baylor (Associate Professor of Physics, Carleton College)

Summer 2017

Supervisor: Gretchen Hofmeister (Associate Dean of the College and Professor of Chemistry, Carleton College), Marty Baylor (Associate Professor of Physics, Carleton College)

A three-component photopolymer undergoes two distinct light driven reactions that can be used together to create small-scale devices with integrated physical and optical features. For the photopolymer to be controllable and useful in device fabrication, we must accurately measure its gel point, the time when it changes phase from liquid to solid. Using nuclear magnetic resonance (NMR), we perform T1 Inversion-recovery experiments on samples of the polymer that were cured with UV light for varying amounts of time to see how UV curing impacts proton relaxation. An initial attempt to measure proton peaks from different constituent components of the photopolymer resin yielded gel points that were inconsistent with the empirically determined gel point. However, by adding the bystander chemical TMS to uncured photopolymer, we observe a potentially new method of predicting the gel point of the photopolymer dependent on how the curing process impacts the relaxation of TMS protons.
54. Rhodium Catalyzed Asymmetric Hydroformylation of 2,3-Dihydrofurans
Senjie Ma ’18
Authors/Contributors: Andrew M. Maza (Graduate Student, University of Wisconsin, Madison)
Summer 2017
Supervisor: Clark R. Landis (Professor of Chemistry, University of Wisconsin, Madison) and Spring M. M. Knapp (Assistant Professor of Chemistry, The College of Wooster)
Asymmetric hydroformylation (AHF) is a highly chemoselective and atom economic reaction that allows the conversion of alkenes into chiral aldehydes. Hydroformylation of 2,3-dihydrofuran and its derivatives provides potential precursors for the total synthesis of various types promising antitumor and pesticidal natural products. However, the mediocre regioselectivity of this reaction limits its current application. In this study, I investigated the effect of lithium salt additives on the regioselectivity of the hydroformylation of 2,3-dihydrofuran derivatives. This research was funded in part by the Kolenkow-Reitz Fund for Undergraduate Research.

55. Characterization of Pathogenic Mutations in a Mitochondrial Enzyme
Jessica Makori ’19 and Hannah Kennicott ’20
Authors/Contributors: Dr. Joseph Chihade (Chair of Chemistry, Director of Biochemistry, Carleton College)
Summer 2017
Supervisor: Dr. Joseph Chihade (Chair of Chemistry, Director of Biochemistry, Carleton College)
The mitochondria is highly regarded as the powerhouse of the cell, as it provides the body with energy in the form of adenosine triphosphate (ATP) to function. Defects in this organelle, such as mutations in the gene which codes for the mitochondrial alanyl-tRNA synthetase, AARS2, can be catastrophic and lead to serious disease, as exhibited in patients with cardiomyopathy and neuropathologies. Fortunately, with advances in genomics, sequenced exomes of patients are available, and specific mutations linked to disease are known. We can further study how mutations in the AARS2 gene affect the structure and function of the encoded protein. We hope to do this by expressing the mutants in Escherichia coli, and then using enzymatic and biophysical assays to study their effects. This research was sponsored in part by the NSF–LSAMP and S-STEM grants.

56. Classifying the Composition of Cosmic Rays
Caroline Mather ’19
Authors/Contributors: Frank McNally (Visiting Assistant Professor of Physics and Astronomy, Carleton College)
Summer, 2017
Supervisor: Frank McNally (Visiting Assistant Professor of Physics and Astronomy, Carleton College)
When a cosmic ray interacts with our atmosphere, it breaks down into a shower of secondary particles, which we can detect using large surface arrays. Although we are constantly detecting these cosmic-ray showers, we don’t have a reliable way to determine the composition of the initial cosmic ray. Knowing the composition of incoming high-energy particles could give us a better picture of the composition of the universe. Taking data from hundreds of thousands of simulated air showers with known composition, we can train a machine learning algorithm to search for some correlation between particle composition and charge deposited per tank of an array. We can then use that algorithm to classify the composition of a detected cosmic ray just by looking at the air shower produced.

57. Orientational Disorder in Epitaxially Connected Quantum Dot Solids
Arthur McCray ’18
Authors/Contributors: Ben Savitzky, PhD Candidate, Physics, Cornell University
Lena Kourkoutis, Professor in the Department of Applied and Engineering Physics, Cornell University
Summer 2016,17
Supervisor: Dr. Lena Kourkoutis (Cornell University)
Superlattices of epitaxially connected quantum dots (QDs) present a promising pathway for the creation of custom materials with tunable electronic properties. The predicted emergent properties of these films, however, are impeded by disorder arising in the oriented attachment process through which the films are grown. We directly measure orientational disorder using aberration corrected scanning transmission electron microscopy and find a clear connection between atomic lattice and superlattice orientational order in these films. QDs preferentially align
with neighboring atomic lattices more than the local superlattice, evident in statistical analysis and directly observable at grain boundaries. QDs which are well oriented in the out-of-plane direction are also found to align better in-plane (azimuthally) with their nearest neighbors, highlighting the importance of out-of-plane alignment in film growth. By examining the orientational disorder in epitaxially connected films, we uncover clues about the workings of the oriented attachment process and identify factors affecting the formation of more organized films.

58. Complexity of Tilings
Anna Meyer '18, Zephyr Lucas '18 and Walt O'Connor '20
Authors/Contributors: Jed Yang (Visiting Assistant Professor of Computer Science, Carleton College)
Summer 2017
Supervisor: Jed Yang (Visiting Assistant Professor of Computer Science, Carleton College)

A tiling problem seeks to count the number of ways a given set of tiles fit into a larger region (or to determine whether doing so is even possible). The Littlewood-Richardson rule, which is important in combinatorics, can be converted into a tiling problem using triangles, rhombuses, and red and blue edges. With this framework in mind, we developed a program that computes the number of tilings of any given region with any given set of tiles. This type of tiling problem is known to be #P-complete, so a major focus of our work was to design optimizations so that the tiling counter would be fast enough to be of practical use. We then used our program to attempt to find other tilesets that behave similarly to the Littlewood-Richardson tiles, that is, tilesets that are commutative and associative.

59. Deciphering AMB Biosynthesis
Yuheng(Kitty) Miao '19
Authors/Contributors: Christopher T. Calderone (Assistant Professor of Chemistry, Carleton College), Aditya Vaze '18
Summer 2017
Supervisor: Christopher T. Calderone (Assistant Professor of Chemistry, Carleton College)

The Pseudomonas aeruginosa toxin L-2-amino-4-methoxy-trans-3-butanoic acid (AMB) is a very useful antibiotic that was shown to function as a methionine antimetabolite. Previous studies have identified gene clusters responsible for AMB production, but detailed mechanistic pathways for AMB synthesis have remained a mystery. By analysis of the Non-Ribosomal Peptide Synthase modular structures and identification of two iron(II)/α-ketoglutarate-dependent oxygenases (AmbC and AmbD), we are now able to propose a plausible biosynthetic pathway through which AMB gets generated. This summer, we successfully expressed AmbE, the protein sequence responsible for making AMB, and tried to confirm the hydroxylation functions of AmbC/D.

60. Fabrication and Characterization of SCALE Printed Resistors
Yuheng(Kitty) Miao '19
Authors/Contributors: Daniel C. Frisbie (Distinguished McKnight University Professor and Head, Department of Chemical Engineering and Material Science, University of Minnesota, Twin Cities), Motao Cao (PhD student at University of Minnesota), Steven M. Drew (Charles "Jim" and Marjorie Kade Professor of the Sciences and Chemistry, Carleton College)
Winter break 2017
Supervisor: Professor Daniel C. Frisbie (Distinguished McKnight University Professor and Head, Department of Chemical Engineering and Material Science, University of Minnesota, Twin Cities)

Inkjet printing is attractive for its capability to be integrated with roll-to-roll (R2R) manufacturing, making cheap mass production of electronic devices on flexible substrates possible. One challenge faced by this printing method is to ensure precise ink placement and feature size of multilayered electronics. With the newly developed approach Self-aligned Capillarity-Assisted Lithography for Electronics (SCALE), these devices can be printed on flexible plastic substrates in a self-aligned, additive and scalable manner under low temperatures. However, the delivery of inks by capillarity is uncontrollable and performance of these inkjet-printed devices varies. In order to reduce the variances and improve performance, individual passive components need to be fabricated with multiple designs and characterizations of them need to be compared. In this work, resistors were SCALE printed and their electrical performance was measured and compared. A decrease in resistances was expected when there was an increase in
channel lengths or a decrease in amount of resistive inks. Empirically, variances in resistances were negligible for changes in electrode separations but significant for changes in ink amounts. By exploring factors controlling the resistance, we can gain insights about how electricity flow in the device and create new resistor designs for better performances.

61. BubR1 N-terminus Alleviates Glomerulosclerosis in BubR1 Hypomorphic Mice
Sarah Min ‘18
Authors/ Contributors: Asef Aziz, Michael Poeschla, Dr. Jan van Deursen, Dr. Darren J. Baker (Mayo Clinic), Bennett Childs
Summer 2017
Supervisor: Dr. Darren J. Baker (Mayo Clinic)
BubR1 is a spindle checkpoint protein that ensures fidelity of chromosome segregation. Reduced expression of BubR1 is associated with aneuploidy and premature aging phenotypes in both humans and mice. Previous work by this lab has shown that cellular senescence is heavily implicated in the premature aging of BubR1 hypomorphs and that overexpression of BubR1’s N-terminal region attenuates progeroid features of BubR1 hypomorphic mice. In this study, we analyzed the kidney phenotype of BubR1 hypomorphic mice, and investigated whether overexpression of BubR1 fragments or clearance of p16-positive cells could alleviate glomerulosclerosis. We find that BubR1 hypomorphs have increased incidence of glomerulosclerosis, a phenotype that is partially rescued by BubR1 N-terminus overexpression.

62. Tracing Sediment Source Response to Water Infrastructure Development and Management in Medicine Lake National Wildlife Refuge, Montana
Mallory Mintz ’18
Authors/ Contributors: Daniel P. Maxbauer (Visiting Assistant Professor of Geology, Carleton College), Mark D. Shapley (Research Associate, National Lacustrine Core Facility and Continental Scientific Drilling Coordination Office University of Minnesota) Amy E. Myrbo (Director of Outreach and Research Associate, National Lacustrine Core Facility and Continental Scientific Drilling Coordination Office University of Minnesota) and Mike Borgreen (Wildlife Biologist, US Fish and Wildlife Service, Medicine Lake National Wildlife Refuge)
Summer 2017
Supervisor: Daniel P. Maxbauer (Visiting Assistant Professor of Geology, Carleton College), Mark D. Shapley (Research Associate, National Lacustrine Core Facility and Continental Scientific Drilling Coordination Office University of Minnesota) Amy E. Myrbo (Director of Outreach and Research Associate, National Lacustrine Core Facility and Continental Scientific Drilling Coordination Office University of Minnesota) and Mike Borgreen (Wildlife Biologist, US Fish and Wildlife Service, Medicine Lake National Wildlife Refuge)
Medicine Lake (ML), within the Medicine Lake National Wildlife Refuge complex in northeastern Montana, is crucial habitat for migratory birds. After two episodes of ML drying out in 1900 and 1935, water control structures were installed within the lake, including a large diversion channel from nearby Big Muddy Creek, in order to mitigate habitat loss during future periods of drought. Water level management practices since this time introduced an unknown amount of sediment into the lake basin, with unknown impacts to the lake ecosystem and associated wildlife. To better describe these impacts within ML, we analyzed the magnetic and physical properties of four sediment cores that capture 20th century sedimentation within the lake. We compare the bulk magnetic properties of lake core sediments from sites proximal and distal to water control structures, as well as those of surficial sediment sources surrounding the lake basin, to evaluate historic fluxes in sediment sources through the twentieth century. Finally, we compare our magnetic data to physical characteristics of these lake sediments to better constrain and trace sediment sourcing within Medicine Lake.

63. Analysis of Lorentz Violation in the MICROSCOPE Experiment
Geoffrey Mo ’19
Authors/ Contributors: Jay Tasson (Assistant Professor of Physics)
Summer 2017
Supervisor: Jay Tasson (Assistant Professor of Physics, Carleton College)
The weak equivalence principle (WEP) states that objects fall at the same rate independent of their composition. Through monitoring the differential acceleration of two test masses freely falling in space, the MICROSCOPE mission aims to test this principle. Lorentz invariance, the idea that physical results should not change based on the rotation or boost of the experiment, can also be tested with MICROSCOPE. The general framework provided by the Standard-Model Extension describes possible Lorentz-violating effects that result in a unique WEP-violating signature. By calculating the theoretical differential acceleration of the masses in the MICROSCOPE experiment we provide a template for the Lorentz-violation search with MICROSCOPE.

64. Relativity Tests in Ring Laser Gyrosopes
Serena Moseley ’20

Authors/Contributors: Jay Tasson (Associate Professor of Physics, Carleton College)
Summer 2017

Supervisor: Jay Tasson (Associate Professor of Physics, Carleton College)

Within the general test framework known as the Standard-Model Extension (SME), we perform a theoretical analysis of ring-laser gyroscope experiments as tests of Lorentz symmetry, which underlies the principle of relativity. We develop expressions for the effects of violations of this symmetry (Lorentz violation) on ring laser signals and make sensitivity estimates for the GINGER project, a large ring-laser gyroscope experiment in preparation.

This research was sponsored in part by the NSF–LSAMP and S-STEM grants.

65. Are protein levels predictable from mRNA levels?
Alief Moulana ’19

Authors/Contributors: Mehdi Bouhaddou (Roche Postdoctoral Fellow, Roche Innovation Center, New York City NY), DeAnalisa Jones (MD/PhD Student, Icahn School of Medicine at Mount Sinai, New York City NY), and Marc Birtwistle (Associate Professor, Department of Chemical and Biomolecular Engineering, Clemson University, Clemson SC)
Summer 2017

Supervisor: Marc Birtwistle (Associate Professor, Department of Chemical and Biomolecular Engineering, Clemson University, Clemson SC)

It is thought impossible to computationally translate mRNA levels into protein levels because they correlate poorly. However, here, we hypothesize that protein abundance is predictable from mRNA abundance using a constant across-tissue protein-to-mRNA ratio using publicly-available transcriptomic (GTex) and proteomic (ProteomicsDB) data. We also study translationally and transcriptionally regulated genes based on their mRNA and ratio variations through gene set enrichment analysis. We define a single protein-to-mRNA ratio for each gene as the median across tissues, and use this tissue-median ratio with tissue-specific mRNA data to predict protein abundance. The predicted protein abundances have significantly increased correlation with measured protein for all 12 tissue types (r~0.8 vs. r~0.3). We also perform gene set enrichment analysis on outlier genes which shows tissue-specific biological processes being enriched in each gene list.

66. Clustering Action Sequences
Micah Nacht ’18

Authors/Contributors: Anna Rafferty (Assistant Professor of Computer Science, Carleton College)
Summer 2017

Supervisor: Anna Rafferty (Assistant Professor of Computer Science, Carleton College)

Students’ strategies in interactive educational technologies can provide clues to their understanding of a domain, but identifying similar strategies poses computational challenges. We clustered the action sequences that students from 13 high schools used to solve stoichiometry problems in a virtual chemistry lab, then compared the efficacy of two different clustering techniques using cluster stability, detection of successful strategies, and runtime. Clustering Markov chains performed better than clustering hidden Markov models in all three categories. While neither algorithm was able to reliably partition successful strategies, but it is possible that different strategies are equally likely to succeed. Further research will explore using the same clustering methods with richer representations of
student actions, and compare automated results to human annotations of strategies.

67. Comparative Historical Giant Panda Conservation at the San Diego and Smithsonian's National Zoos
Avery Naughton '18

Authors/Contributors: Marynel Ryan Van Zee (Director of Student Fellowships, Carleton College)
Supervisor: Marynel Ryan Van Zee (Director of Student Fellowships, Carleton College)

In preparation for my integrative exercise in history, I pursued a research project emphasizing conservation biology at the San Diego Zoo and Smithsonian's National Zoo in Washington D.C. Through archival research, visiting of the zoos, and interviews with zookeepers, managers, and conservation biologists, I found that the zoos’ interactions with Chinese experts were the cornerstone of captive breeding programs. In other words, the repopulation of pandas in captive breeding centers within United States zoos could not have worked without help from Chinese colleagues. In this sense, my research became a cross-cultural look into comparative conservation at different institutions all promoting the protection of the giant panda bear.

This research was funded in part by a Class of 1963 Fellowship.

68. Satellite Remote Sensing at Cornell University
Thu Nguyen '19

Authors/Contributors: Bruce C. Monger (Senior Lecturer, Earth and Atmospheric Sciences, Cornell University)
Supervisor: Kim Smith (Professor of Environmental Studies and Political Science, Carleton College)

In June, I was given the opportunity to go to Cornell University in Ithaca, NY and take a course on Oceanographic Satellite Remote Sensing. The goal of this endeavor was to see if the course would be of interest to other Environmental Studies majors, or students interested in remote sensing, and to see if the course was feasible for undergraduate students to take.

69. Treatment of Mitochondrial Trifunctional Protein Deficiency in Mice Model with Bezafibrate
Phuong Nguyen '18

Authors/Contributors: Hye-Ri Kang Ph.D. (Department of Pediatric Medical Genetics, Duke University Medical Center) and Dwight Koeberl M.D. (Professor of Pediatrics, Duke University Medical Center)
Supervisor: Dr. Dwight Koeberl (Duke University Medical Center)

Mitochondrial trifunctional protein (MTFP) is an enzyme complex that catalyzes three important metabolic steps during fatty acid beta-oxidation. Patients that are deficient in this enzyme exhibit vomiting, lethargy, and coma during times of metabolic stress. Bezafibrate, a hypolipidemic drug that has been shown to increase transcription of beta-oxidation-related genes including MTFP subunits, is chosen as a potential form of treatment. In this study, we investigate whether intraperitoneal injection of bezafibrate (100 mg/kg) is an effective treatment for MTFP-deficient patients in murine models. Observation of various physical and metabolic differences between bezafibrate-treated and untreated mice will provide information about physiological changes due to drug delivery. Compiled results from the bezafibrate treatment reveal no significant changes between treated and untreated mice. Further studies will be dedicated towards different drug deliverance methods and usage of adeno-associated viral vectors.

70. Studying Zeolites through Molecular Dynamic Simulations
Adam Nijhawan '19 and Brody Lynch '20

Authors/Contributors: Daniel Kohen (Associate Professor of Chemistry, Carleton College)
Supervisor: Daniela Kohen (Associate Professor of Chemistry, Carleton College)

Zeolites are natural minerals with microscopic pores. These pores allow for zeolites to act as sieves for gasses. Specifically, some zeolites trap CO₂ in much greater quantities than other gasses. Thus, there is potential in using them as filters for emissions. We used computer models to study the process by which zeolites trap CO₂ because they allow us to better understand what is happening on a microscopic level. Using these models, we are able to analyze how the atoms in the zeolite interact with each other, and by doing so, how zeolites can function as natural filters.
71. Characterization of Cytokines Secreted by B16/OVA Melanoma and PyMT Breast Cancer
Katherine Ortell '18
Summer 2017
Supervisors: Dr. Stephanie Watowich (MD Anderson) and Dr. Natalie Slone (MD Anderson)
The innate immune system plays an essential role in protecting humans from microbial pathogens by patrolling the body in homeostasis and responding rapidly to infection. Cancer is a disease characterized by the uncontrolled division of abnormal cells. These irregular cells are typically recognized by our immune system and destroyed. However, cancer cells exert a powerful influence over their microenvironment through the secretion of signaling molecules including cytokines. Since innate immune pathways are regulated by the actions of soluble factors such as cytokines, a deeper understanding of the involvement of these molecules in tumors may offer new treatment options. In 2016, Li et al. demonstrated that melanoma cells secrete a variety of cytokines into the tumor's microenvironment such as IL-6, IL-10, and VEGF. These cytokines have been implicated in decreasing the antitumor immune response by activating the STAT3 pathway in tumor-infiltrating immune cells.

72. Identifying Human Origins of Replication with Single Cell Sequencing
William E. Pangburn '20
Authors/Contributors: Anna K. Casasent (Graduate student, UT Health), Aislyn Schalck (Graduate student, UT Health), and Hossein Bakhshandeh ('20, Davidson College)
Summer 2017
Supervisor: Dr. Nicholas E. Navin (MD Anderson)
DNA is replicated or synthesized during the S-phase part of Interphase. While origins of DNA replication have been discovered in other organisms, such as bacteria, and yeast, origins of replication in larger eukaryotes, especially humans, are still unknown. We tried to pinpoint origins of replication in lymphoblasts using single cell sequencing of nuclei. We used Fluorescence-Activated Cell Sorting (FACS), pooling and purification to prepare the samples for Next generation sequencing. To determine any origins, we need to collect more data. The more we know about how S-phase is regulated, the more we can understand how cells replicate their DNA with minimal mutations and how DNA replication changes in cancer cells.

73. Reconstructing the history of the proliferation of genes involved in the biological nitrogen cycle
Chris Parsons '18
Authors/Contributors: Rika Anderson '06 (Assistant Professor of Biology, Carleton College)
Summer 2017
Supervisor: Rika Anderson '06 (Assistant Professor of Biology, Carleton College)
Nitrogen is an essential element to life on Earth and the basis of a variety of Bacterial and Archaean metabolisms. Recent isotope studies have shown the biological cycling of various forms of nitrogen to be around 3.5 billion years old, occurring in a series of redox reactions catalyzed by a set of specific enzymes. While it is possible to roughly date the origins of these enzymes, dating their proliferation through horizontal gene transfer can provide additional insights. By comparing the phylogenies of these enzymes to a time-calibrated tree of life, we identified and timed loss, duplication, and horizontal gene transfer events. Our results show a major spike in the rate of horizontal gene transfer for most nitrogen-cycling enzymes around 2.5 billion years ago, which coincides neatly with the oxygenation of the atmosphere, suggesting that the increased availability of oxidized forms of nitrogen stimulated the nitrogen cycle.

74. Jumping into new genomes? Exploring transposable element mobilization in hybrid yeast
Kira Patterson '18
Summer 2017
Supervisor: Caiti Smukowski Heil (Postdoc, University of Washington) and Maitreya Dunham (Principal Investigator, University of Washington)
Transposable elements (TEs) are found in virtually every organism and can serve as a mechanism for large scale genomic changes such as copy number variation and rearrangements. However, little is known about the conditions
that influence transposable element mobilization within and between different genomes. Previous work has suggested that interspecific hybridization can increase TE mobilization. To test the impact of hybridization on TE movement, we are utilizing Saccharomyces yeasts, which differ in TE copy number, and can readily hybridize. In order to directly compare TE activity between parental and hybrid yeast strains, we created a hybrid species by crossing Saccharomyces cerevisiae, whose reference genome contains 35 TEs, and Saccharomyces uvarum, whose genome contains no TEs. By evolving the hybrid for hundreds of generations, measuring transposition rate, and studying insertion bias in sequencing data, we hope to develop a more comprehensive understanding of transposable element mobilization in this yeast hybrid.

75. Prospects of Wetland Restoration in Carleton's Ogden Meadow
Ian Peters '18
Authors/Contributors: Mary Savina '72 (Charles L. Denison Professor of Geology, Carleton College)
Summer 2017
Supervisor: Mary Savina '72 (Charles L. Denison Professor of Geology, Carleton College)
About 60% of the wetlands that were present in Minnesota in the early nineteenth century have been drained, mainly for agricultural use. In Dakota County, this figure is closer to 80%. Ogden Meadow covers 9 hectares in Carleton's Lower Arboretum, and may formerly have been a wetland. Ogden Meadow has been out of cultivation since 2008. Using soil analyses and evaluation of local geomorphology and hydrology, this project seeks to determine whether the meadow could be made to support a perennially saturated wet prairie. We hope also to confirm the hypothesis that the meadow is a former wetland. This presentation will include descriptions of soils and geomorphology, based on work done in July and August of 2017, the methods of analysis, and an overview of literature on successful wetland restoration.

76. Analog modeling of off-fault deformation: Application to the San Andreas fault in central California
Grace Pipes '18
Authors/Contributors: Sarah Titus (Associate Professor of Geology, Carleton College)
Summer 2017
Supervisor: Jacqueline Reber (Assistant Professor, Department of Geological and Atmospheric Sciences, Iowa State University)
In central California, the style of slip along the dextral San Andreas fault changes from locked to creeping behavior near the town of Parkfield. GPS velocities measured over decades in this region record the interseismic velocity field, which has regions of off-fault deformation that are correlated with the transition in slip style. Contraction NE of the fault corresponds to a region of well-developed young folds; extension SW of the fault coincides with the Paso Robles basin. Assuming that the crust is elastic, it is commonly believed that these regions of off-fault deformation will disappear after an earthquake. But what if the crust is not elastic and this signal can persist over many earthquake cycles? I use a physical model that recreates the transition from locked to creeping behavior along a strike-slip fault in analog materials of the upper crust (kaolin) and the lower crust (silicone). The behavior of kaolin varies with the rate of deformation, allowing me to investigate patterns of off-fault deformation in the crustal analog that behaves elastically and viscoelastically. The preliminary results show that off-fault deformation in the physical model can persist during a seismic event.

77. Global Landslide Cataloging and Analysis
Gerrit Postema '18
Authors/Contributors: Cindy Blaha (Professor of Physics and Astronomy)
Summer 2017
Supervisor: Dr. Dalia Kirschbaum (NASA Goddard Space Flight Center)
NASA’s Global Landslide Catalog (GLC) is a landslide event inventory gathered from global news sources, which are biased towards events that affect population centers and infrastructure. This investigation aimed to determine the existence of bias within event inventories relative to predicted data from GLC-derived products. The Great African Rift is an area of high susceptibility but sparse landslide reporting. The majority of Rift Valley landslide events shared a landslide susceptibility rating over 3 (indicating greater than moderate risk) and an annual landslide
hazard nowcast rate greater than 4% per year (i.e., issued a landslide warning an average of 4 out of 100 given days). The area where these ratings intersected was deemed 'high-susceptibility'. Compared to the total distribution of these 'high-susceptibility' areas, reported events were biased towards roads and areas of high population. While most 'high-susceptibility' areas are more remote, 'high-susceptibility' areas in Ethiopia are proximal to roads and population and completely devoid of reports.

78. Mechanoelectrical Transduction in Hair Cells Using a Novel Mode of Stimulation  
Daniel Quintero ’20  
Authors/Contributors: Fernán Jaramillo (Professor of Biology, Carleton College)  
Summer 2017  
Supervisor: Fernán Jaramillo (Professor of Biology, Carleton College)  
Hair cells are the receptors of the internal ear of vertebrates. These cells have specialized organelles called hair bundles. When a mechanical stimulus, like a sound wave, reaches the inner ear, deflections of the hair bundles along the X axis stretch elastic components, the tip links, near the top of the bundles. Tip links are unresponsive to deflections along the Y axis, but we don’t know how they respond to forces along the Z axis (perpendicular to the epithelium). Due to the elastic nature of the hair bundles, the nature of mechanical stimuli, and the positioning of hair bundles in the inner ear organs, it is possible that these structures can also experience deflections along the Z axis. We are investigating whether hair bundles can experience significant displacement in the Z axis and, if this is the case, whether such displacements result in transduction.  
This research was sponsored in part by the NSF –LSAMP and S-STEM grants.

79. The Demographics of Healthcare Accessibility  
Margot Radding ’18  
Summer 2017  
Supervisor: Pamela Feldman-Savelsberg (Brook Professor of Social Demography and Anthropology, Carleton College)  
Only 45 percent of pregnant women in India receive the recommended amount of prenatal healthcare. In 2010, India accounted for 56,000 maternal deaths, more than any country in the world. This project focuses on the demographics of healthcare access in northern India. I conducted interviews with 12 pregnant patients in a government hospital in northern India. Data collected from these interviews reveals how healthcare accessibility is shaped by women’s transportation options, accompanying family, time available, and cost. Although the hospital provides basic health services, its ultrasound machines are not functional, leaving many women to turn to expensive private clinics, some of which also offer fetal sex-determination tests, despite being banned in 1994. I suggest that healthcare accessibility is not synonymous with health knowledge, noting how my positionality impacted my expectations and interactions. This research seeks to understand prenatal care in a broader cultural context, through an anthropological lens.  
This research was funded in part by a Professor Roy Grow Fellowship.

80. Optimization of Problem Sets for Diagnosing Algebra Misunderstandings  
Kilian Roberts ’18  
Authors/Contributors: Anna Rafferty, Assistant Professor of Computer Science, Carleton College  
Summer 2017  
Supervisor: Anna Rafferty, Assistant Professor of Computer Science, Carleton College  
This project’s goal was to improve the ability of an automated algebra tutoring system to generate problem sets to diagnose algebra-related misunderstandings. We sought to quantify the amount of improvement in understanding that the tutoring system has of the user’s algebra skills, and to automate the process of finding problem sets that lead to improvements in understanding. We estimated the algebra skill information gain by fitting a beta distribution
to our program’s estimates of four skill parameters and used this measure to assess the effectiveness of a problem set. We then implemented a probabilistic optimization algorithm, simulated annealing, to search for good problem sets. Our most valuable finding was that larger problem sets consistently generate more information about a user’s algebra skills, and that there is likely to be a trade-off between the program’s level of understanding and the time the user must spend working on diagnostic problem sets.

81. **Modeling 13.3 nm Fe XXIII Flare Emissions Using the GOES-R EXIS Instrument**  
**Henry Rook ’20**  
**Authors/Contributors:** Ed Thiemann (Research Scientist, Laboratory for Atmospheric and Space Physics)  
**Summer 2017**  
**Supervisor:** Dr. Ed Thiemann  
Quantifying solar flare spectral irradiance is important for constraining models of Earth’s atmosphere. The EVE MEGS-A instrument aboard SDO collected high time cadence 0.1nm EUV spectrum data from 2010 until 2014, allowing us to quantify solar EUV irradiance. Prior work demonstrates that one hot flare EUV line, such as the 13.3nm Fe XXIII line, can be used to model cooler flare EUV line emissions, filling the role of MEGS-A. Since unblended measurements of Fe XXIII are typically unavailable, a proxy for the Fe XXIII line must be found. In this study, we construct two models of this line, first using the GOES 0.1-0.8nm soft x-ray (SXR) channel as the Fe XXIII proxy, and second using a theoretical model dependent on GOES emission measure and temperature data. We determine that the GOES SXR correlates better with Fe XXIII measurements than the more sophisticated theoretical model.

82. **Laser Cooling and Trapping Rb-87 in a Magneto-Optical Trap**  
**Sophie Rooks ’18**  
**Authors/Contributors:** Eric Hazlett (Assistant Professor of Physics, Carleton College), Alex Aeppli ’18, Marshall Basson ’20, and Sean Gallagher ’19  
**Summer 2017**  
**Supervisor:** Eric Hazlett (Assistant Professor of Physics, Carleton College)  
Atoms can be trapped and cooled to temperatures close to absolute zero with the help of precisely tuned laser diodes. This summer we continued to work on the setup of the optical systems for a main cooling transition laser and a repump laser. With the combination of detuned counter-propagated beams and stabilized magnetic fields, we were able to successfully trap ⁸⁷Rb atoms in a magneto-optical trap - the first laser-trapped atoms in Carleton history! We estimate that these atoms were cooled down to temperatures below a mK. We will continue to optimize and better characterize this system to determine the precise temperature and atom number.

83. **Ways of Being Home.**  
**Fernando Saldivia ’20**  
**Authors/Contributors:** Cecilia Cornejo (Instructor in Cinema and Media Studies, Carleton College)  
**Summer 2017**  
**Supervisor:** Cecilia Cornejo (Instructor in Cinema and Media Studies, Carleton College)  
As part of the ongoing documentary film project titled *Ways of Being Home*, I traveled to the small Mexican town of Maltrata, Veracruz in order to record interviews with members of the community and trace the life stories that connect them with Northfield, Minnesota. Through my labor as researcher and video and sound recorder, I was able to understand the social, economic and emotional complexities behind the immigration process held by individuals and groups from the Mexican community to the United States and how this process represents different outcomes for the social dynamics within Maltrata and Northfield.  
*This research was funded in part by the Humanities Center Student Research Fund.*

84. **Inferring Mal-Rules from Step-by-Step Equation Solving**  
**Soren Schlassa ’18**  
**Authors/Contributors:** Anna Rafferty (Assistant Professor of Computer Science, Carleton College)  
**Summer, 2017**  
**Supervisor:** Anna Rafferty (Assistant Professor of Computer Science, Carleton College)
Some misunderstandings in algebra learners can be explained by "malrules": patterns of error that resemble the correct rules used in solving algebraic equations. Accordingly, we can characterize a person's understanding of how to do algebra by specifying the (mal)rules they possess. We develop a consistent and computer usable syntax for the (mal)rules of algebra, as well as an algorithm to infer a person's rules from their observed step-by-step equation solutions. This algorithm agrees with human raters about 53% of steps, with another projected 34% of steps susceptible to it after further improvements are made. Future work enabled by this approach may include empirically studying the "hypothesis space" of algebra (mis)understandings or generating highly personalized feedback for students using automated tutors.

85. Exploring Geometric Characteristics of Fabricated Photopolymer Lenses on Liquid Substrates
Emily Schwartz ‘19
Authors/Contributors: Martha-Elizabeth Baylor (Associate Professor of Physics, Carleton College)
Summer 2017
Supervisor: Martha-Elizabeth Baylor (Associate Professor of Physics, Carleton College)
Photopolymers offer a cheaper and easier way to fabricate lenses than glass. However, with current methods, polymer lenses have surfaces that are too rough for when high quality surfaces are required and cannot be polished like glass. We have developed a method to reduce surface roughness of large (>1cm) polymer lenses to the atomic level by curing photopolymer resin on the surface of liquid substrates. We are currently in the process of developing methods to manipulate the focal lengths of these polymer lenses so they can be used in arbitrary optical systems. Recent work has focused on developing a robust fabrication process. Future steps include exploring how hydrophobicity of the resin affects the focal length of the lenses.

86. The Drosophila Neuromuscular Junction as a Model for the Study of Synaptic Homeostasis
Jacob Schwartz ‘19
Authors/Contributors: Fernán Jaramillo (Professor of Biology)
Summer 2017
Supervisor: Fernán Jaramillo (Professor of Biology)
In synaptic homeostasis, a decrease in the sensitivity of a postsynaptic neuron to neurotransmitter elicits a compensatory increase in neurotransmitter release from the presynaptic cell. This phenomenon has been observed in both the vertebrate and the invertebrate, including at the glutamatergic Drosophila melanogaster neuromuscular junction (NMJ). Here we present a set of procedures for the use of the Drosophila NMJ as a model for studying synaptic homeostasis, including a novel method for the reliable and simultaneous stimulation of many motor neurons by delivering a current to the entire ventral ganglion. We also report on our development of a technique involving the injection of small currents into muscle cells, which we intend to employ in future studies of the relationship between synaptic homeostasis and spontaneous, miniature neurotransmission.

87. The Role of Glypicans in Hedgehog Signaling
Preethiya Sekar ‘18
Authors/Contributors: Bradley Wierbowski (Harvard Medical School), and Adrian Salic (Associate Professor of Cell Biology, Harvard Medical School)
Summer 2017
Supervisor: Bradley Wierbowski (Department of Cell Biology, Harvard Medical School), Adrian Salic (Department of Cell Biology, Harvard Medical School)
The Hedgehog (Hh) signaling pathway plays critical roles in tissue maintenance, renewal, and regeneration. Little is known about Hedgehog ligand reception specifically relating to the SCUBE/CDON complex. SCUBE is a lipoprotein that is purported to interact with Hedgehog and allow for the transit of Hh from the sending cell to the receiving cell. The lipoprotein subsequently interacts with coreceptors on the receiving cells such as CDON to promote Hedgehog binding to its receptor, Patched (Ptc). The lab has previously shown that SCUBE2 limits CDON binding ability. Thus, it's plausible there are endogenous factors controlling CDON binding potential. We hypothesize a family of heparin sulfate proteoglycans, glypicans, may be responsible for mediating this interaction.
88. Measuring Listening Effort: Convergent Validity and Sensitivity
Julia Smith ’18 and Sasha Mayn ’18
Authors/Contributors: Violet Brown ’17, and Julia Strand (Assistant Professor of Psychology, Carleton College) 2016-2017
Supervisor: Julia Strand (Assistant Professor of Psychology, Carleton College)
Listening effort (LE) describes the attentional or cognitive requirements for successful speech understanding. Despite substantial theoretical and clinical interest in LE, the construct itself remains poorly defined. This large-scale validation study sought to evaluate the convergent validity and sensitivity of seven tasks that have previously been used to measure LE. The tasks differed substantially in their sensitivity to changes in signal-to-noise ratio. Scores on some behavioral LE tasks were moderately intercorrelated, but were generally not correlated with subjective and physiological measures of LE, suggesting that these tasks may not be tapping into the same underlying construct.

89. Aerosol ParticEmissions and Efficiency of Cookstove Prototypes for Use in Ethiopia
Clarissa Smith ’19
Authors/Contributors: Deborah Gross (Professor of Chemistry, Carleton College), Tsegaye Nega (Associate Professor of Environmental Studies, Carleton College), Elizabeth Grubb ’17, Panhia Yang ’17 Summer 2016-Summer 2017
Supervisor: Deborah Gross (Professor of Chemistry, Carleton College), Tsegaye Nega (Associate Professor of Environmental Studies, Carleton College)
In many areas in the developing world, people cook over open fires fueled by wood, charcoal, or animal waste. The emissions from these fires significantly impact the health of the cooks, leading to ~4 million deaths per year, globally, according to the W.H.O. In addition, gathering the highly demanded fuel contributes to deforestation as well as having social costs, as it requires timely labor. We have been developing a cookstove for use in Ethiopia, with the goal of developing a low-emission, high efficiency stove that meets the needs of Ethiopian cooks while being affordable. We have characterized the particulate emissions from a series of prototype Top-Lit Updraft (TLUD) stoves as well as one commercially available exemplar stove using single-particle mass spectrometry, and have found that the design has a significant impact on the PM2.5 emission rate as well as the EC/OC ratio and the specific composition of the emitted particles. This research was sponsored in part by the NSF –LSAMP grant.

90. Dots on a Ball: What do They Mean and Where do They Come From?
M. Fares Soufan ’20
Authors/Contributors: Liz Sattler (Visiting Assistant Professor of Mathematics, Carleton College), Rob Thompson (Assistant Professor of Mathematics, Carleton College), and Nupur Bindal ’19 Summer 2017
Supervisor: Liz Sattler (Visiting Assistant Professor of Mathematics, Carleton College), and Rob Thompson (Assistant Professor of Mathematics, Carleton College)
The spherical Voronoi region associated to a generating point is the collection of all points on the sphere closer to that generating point than any other generating point. A spherical Voronoi diagram consists of the set of spherical Voronoi regions for a finite set of generating points on the sphere. The boundaries of three or more of these regions intersect at points, called Voronoi vertices. By taking these vertices as a new set of generating points we can generate a new Voronoi diagram, and iterate this process. This is a called a Voronoi iteration. We analyze the dynamics of this iteration, count the number of vertices and find periodic patterns in the iteration.

91. Role of Sall1 and Sall4 in the caudal progenitor zone for body elongation in mouse embryos
Avery Swearer ’18
Authors/Contributors: Yasuhiko Kawakami (Associate Professor of Genetics, Cell Biology, and Development), Hiroko Kawakami (University of Minnesota), Samantha Young (Student, University of Minnesota) Summer 2017
Supervisor: Yasuhiko Kawakami (Associate Professor of Genetics, Cell Biology, and Development)
This summer I worked at the Kawakami Lab at the University of Minnesota researching the role of Sall1 and Sall4 in
the caudal progenitor zone (CPZ) in body elongation in mouse embryos. Sall1 and Sall4 double knockout mice exhibit severe body truncation and other developmental anomalies. From these findings, we looked to determine how Sall1 and Sall4 interact with molecules that maintain the undifferentiated state of the CPZ and regulate body elongation. I performed in situ hybridization to determine changes in gene expression in conditional Sall1 Sall4 double knockout mice that had been bred in the lab. We found that Sall1 and Sall4 might regulate the expression of Cyp26a1, a protein that protects cells of the CPZ from retinoic acid (RA). Changes in RA concentration would cause severe downstream effects on body elongation, likely leading to previously observed phenotypes.

This research was funded in part by the Kolenkow-Reitz Fund for Undergraduate Research.

92. Playing the Past: 18th Century Sources to 21st Century Gameplay
Lydia Symchych ’18
Authors/Contributors: Serena Zabin (Professor of American History and Director of American Studies) and Austin Mason (Assistant Director of the Humanities Center for the Digital Humanities and Visiting Assistant Professor of History)
Summer 2017
Supervisor: Serena Zabin (Professor of American History and Director of American Studies) and Austin Mason (Assistant Director of the Humanities Center for the Digital Humanities and Visiting Assistant Professor of History)
This past summer, I continued my work on the historical video game, ‘Witness to the Massacre’. The game begins next to the Old State House in Boston, March 6th, 1770, the day after the Boston Massacre. The goal is to talk to people around colonial Boston and gather their depositions (witness testimonies) about what happened during the massacre. At the end, the player must reckon with conflicting accounts and decide how they think the massacre unfolded. I spent my summer reading deposition compilations, and witness testimonies from the trials of Captain Preston and his men. From hundreds of depositions, I picked fifteen which I then turned into conversations between the player and the deponent. For each conversation I wrote a voice acting script and a dialogue tree stored in the video game engine, Unity. As the game progresses, my work will allow us to quickly add content to the game.

93. 15M and the Construction of Collective Knowledge: Studying the Derivations of a Landmark Social Movement
Christina Tarazi ’18 and Carinna Nikkel ’18
Authors/Contributors: Palmar Alvarez-Blanco (Associate Professor of Spanish, Carleton College)
Summer 2017
Supervisor: Palmar Alvarez-Blanco (Associate Professor of Spanish, Carleton College)
15M was a watershed citizen movement in Spain that inspired a wave of social activism around the world. Today the 15M movement continues through the work of various Spanish colectivos: these are citizen projects that advocate for the same basic rights through community education workshops, publicity campaigns, and media production. In our project we researched colectivos that addressed education reform and the housing crisis in Spain. We asked questions such as, how do the colectivos relate to 15M? What materials are provided by the colectivos to educate the public? We found that the colectivos work in citizen co-education advocacy and the formation of collective citizen knowledge.

This research was funded in part by the Humanities Center Student Research Fund.

94. Separating Nestedness from Species Replacement in Measures of Beta Diversity in Montane Meadows of the Western Cascades
Elaina Thomas ’18
Summer, 2017
Supervisor: Dr. Julia Jones (Oregon State University) and Dr. Rebecca Hutchinson (Oregon State University)
Beta diversity quantifies differences in species composition across sites. However, alone, measures of beta diversity do not distinguish which processes are driving dissimilarity. Partitioning beta diversity into dissimilarity resulting from nestedness and species replacement has relevance to the understanding of fragmented habitats. I separated
nestedness and species replacement in measures of beta diversity of plant and pollinator communities of montane meadows of the Western Cascades. Pollinator communities showed a higher amount of dissimilarity than plant communities between meadows. Species replacement contributed more to beta diversity than nestedness. Meadow soil moisture exhibited more influence on dissimilarity of plant and pollinator species compositions than difference in meadow size and distance between meadows. The ratio of species replacement to dissimilarity increased with difference in meadow soil moisture for plants. These results highlight the contribution of heterogeneity in meadow soil characteristics to diversity of plant and pollinator species in the landscape.

96. Effect of prolonged sleep restriction on the cardiovascular response to mental stress
Zachary Trottier ’19
Summer 2017

Supervisor: Jacqueline K. Limberg (Assistant Professor, Mayo Clinic), Michael J. Joyner (Professor of Anesthesiology, Mayo Clinic), and Virend K. Somers (Professor of Medicine, Mayo Clinic)

Individuals sleeping under 6 hours nightly are at increased risk of cardiovascular disease. Cardiovascular reactivity to stress is predictive of future cardiovascular disease development. 24-hour sleep deprivation elicits exaggerated blood pressure (BP) responses to mental stress (MS), however, the driving mechanisms and generalizability to prolonged sleep restriction (SR) are unclear. The objective of this study was to examine hemodynamic responses to MS in individuals before and during prolonged SR. We hypothesized that peak BP response to MS would be greater following SR. Subjects underwent an acclimation period followed by 9 days of experimental SR. Heart rate and BP were measured at baseline, followed by during 5 min of mental arithmetic. Subjects were studied during acclimation and restriction. Peak changes in hemodynamic variables during MS were analyzed. Following SR, individuals achieved peak systolic BP and mean BP earlier, and the rate of rise in BP was higher. The early rise in BP was driven by a greater fall in total peripheral resistance. These data suggest rapid increases in BP during MS are driven by increases in cardiac output. This rise in BP attenuates sympathetic outflow via baroreflex-mediated mechanisms, lowering TPR. Future studies are necessary to further examine effects of SR on cardiovascular hemodynamics.

97. Important, Non-Risky Adolescent Decision Making
Valerie Umscheid ’19

Authors/Contributors: Kathleen Galotti (William H. Laird Professor of Cognitive Science, Director of Cognitive Science, Carleton College)

Summer 2017

Supervisor: Kathleen Galotti (William H. Laird Professor of Cognitive Science, Director of Cognitive Science, Carleton College)

Important, non-risky adolescent decision making was studied by surveying high school students about their academic course selection decisions for the upcoming year. High school (165) and college (186) students were recruited through the online platform Qualtrics to participate in this study; both groups had approximately even distributions of age and gender. Participants listed their course options for the upcoming year, the criteria they were using to make their decision, and filled out the Reactions to Decision (RTD) Instrument. Cronbach's $\alpha$ values for RTD scales were generally high in both populations, and significant Gender by Class Year interactions were found for both high school and college students regarding the number of criteria they used. The results of this study provide insight into the similarities and differences between adolescent and college-age non-risky, important decision making, and are thus important to consider when guiding adolescents through their decisions.

98. Noncanonical NRPS Modules in Bleomycin Biosynthesis
Aditya Vaze ’18

Authors/Contributors: Chris Calderone (Assistant Professor of Chemistry, Carleton College) and Kitty Miao, ’19

Summer 2017

Supervisor: Chris Calderone (Assistant Professor of Chemistry, Carleton College)

The collection of non-ribosomal peptide synthetases that produce the cancer drug bleomycin in Streptomyces Verticillis is hypothesized to contain a novel example of a dual function condensation-dehydration domain acting on a histidine and a hydroxyasparagine residue. With a view to eventually characterize this domain, we attempted to synthesize and study a number of related enzymes, namely those involved in the synthesis of the hydroxyasparagine.
This involved expression of the enzyme using *E. coli*, purification of the resulting protein, followed by characterization of the enzyme using HPLC experiments. We successfully expressed and purified three hydroxylases. Of these, one was found to be a promising candidate for an aspartate hydroxylase, while another could potentially be a novel type of hydroxylase. However, owing to purification difficulties, determination of their role in bleomycin biosynthesis is as yet inconclusive.

99. Examining the Age of Midcontinent Rift Reversal through Paleomagnetism
Taiyi Wang ’19
Summer 2017

**Supervisor:** Professor Nicholas Swanson-hysell (Department of Earth and Planetary Science, UC Berkeley), Luke Fairchild (PhD candidate, Department of Earth and Planetary Science, UC Berkeley), and Sarah Titus (Associate Professor of Geology, Carleton College)

It has been proposed that the failure of Midcontinent Rift (MCR) was due to the onset of the Grenville Orogeny. Thus the regional compression that led to the failure of MCR has been estimated to occur ca. 1060 Ma. However, recent geochronologic data of Jacobsville Sandstone, partly deformed by compression, suggests that the compressional event postdates Grenville Orogeny. We attempt to use preliminary paleomagnetic data from Douglas Fault, a major reverse fault on the southern shore of Lake Superior, to constrain the age of the compressional event. 70 paleomagnetic cores were sampled from Douglas Fault and are measured in UC Berkeley Paleomagnetism Laboratory. We anticipate a thermal overprint from these samples due to frictional heat at the point of fault rupture. If a thermal overprint was found, comparing the thermal remnant direction with the North American Apparent Wander Path would generate a constraint on the age of the compressional event.

100. Echelon fault development depends on strain rate in wet kaolin
Yijun Wang ’18
Summer 2017

**Authors/Contributors:** Michelle Cooke, Sarah Titus (Associate Professor of Geology, Carleton College)

**Supervisor:** Sarah Titus (Associate Professor of Geology, Carleton College)

We investigate strike-slip fault development using viscoelastic wet kaolin under different strain rates. The 15-minute Maxwell relaxation time for wet kaolin means that slower experiments, run >1 hour, will have greater stress relaxation. Because the Earth’s crust also has viscoelastic behavior over long time scales, the sensitivity of strike-slip fault growth in wet kaolin to strain rate may replicate strain rate sensitivity of crustal strike-slip systems. *This research was funded in part by the Kolenkow-Reitz Fund for Undergraduate Research.*

101. Community-Based Conservation with Global Environment Institute, China
Zifeng Wang ’18
Summer 2017

**Authors/Contributors:** Tsegaye Nega (Professor of Environmental Studies, Carleton College) and Kimberly Smith (Professor of Environmental Studies and Political Science, Carleton College)

**Supervisor:** Dr. Kui Peng (Global Environment Institute)

During the summer I worked with the Community-Based Conservation and Development project group of a Chinese NGO based in Beijing named Global Environment Institute from June to August. Over the three months I did some theoretical research on the concept of Community Conservation Concession Agreement, as well as designed the theoretical frameworks and survey forms for application for the evaluation of the effectiveness of the community-based conservation projects. I also carried out some progress evaluations of the projects of GEI in Myanmar and Qinghai, China.
102. Transgenic and CRISPR Approaches to Understanding Hox-mediated Ventral Nerve Cord Patterning in *C. elegans*

Andrew Wheeler ’18  
**Authors/Contributors:** Amarantha Ballmer ’18 and Jennifer Wolff (Associate Professor of Biology, Carleton College)  
Summer 2017  
**Supervisor:** Jennifer Wolff (Associate Professor of Biology, Carleton College)

*Caenorhabditis elegans* show sexually dimorphic expression in the ventral nerve cord. While hermaphrodites have six individual sex-specific neurons (VCs), these cells continue developing in males to form nine pairs of neurons (CAs and CPs). These nine pairs of neurons in males show different gene expression patterns in zones that correspond to the expression of the Hox genes *lin-39* and *mab-5*. We are interested in how Hox genes influence the development of the ventral nerve cord, and how they influence downstream targets. Our lab has created several promoter constructs for reporter genes that show Hox responsive expression patterns. By this approach, we hope to identify Hox responsive genomic elements, and further clarify the pathways through which Hox genes regulate gene expression in the ventral nerve cord. We are also pursuing a CRISPR-Cas9 approach to fluorescently tag the genomic *lin-39* locus for use as a tool to further probe Hox gene interactions.

103. Cascadia Research Collective Internship  
Kadin Woolever ’18  
Summer 2017  
**Supervisor:** John Calombokidis, Research Biologist & Founder of Cascadia Research Collective, and Kiirsten Flynn, Research Assistant & Intern Coordinator

I worked as an intern with Cascadia Research Collective, a marine mammal research collective based in Olympia, Washington, conducting research on pinnipeds and cetaceans along the US west coast and around the Hawaiian islands. My work involved photo collection, identification, and matching of humpback, blue, and gray whales. I also had the opportunity to respond to stranded mammals, collecting data samples, performing necropsies, and completing live rescues when necessary.

104. Exploration of Different Distributed Machine Learning Architectures  
Nyla Worker ’19  
**Authors/Contributors:** Rankyung Hong (Graduate student in the Department of Computer Science and Engineering, University of Minnesota)  
Summer 2017  
**Supervisor:** Abhishek Chandra (Associate Professor in the Department of Computer Science and Engineering, University of Minnesota)

Machine learning is used in various big data applications such as natural language processing. Neural networks are a key machine learning tool. However, with growing datasets, they are too intensive computationally. Hence, we explore different architectures of distributed machine learning systems and test their speed and accuracy. For our experiments, we focus on image processing using the Cifar-10 dataset. As a base, we recreate past successful algorithms such as AlexNet, which consist on a combination of convolutional, pooling, dropout and fully connected layers. We distribute these architectures among various workers, in this case CPUs, and connect them to a parameter server, where the parameters get updated asynchronously with information from the workers. These architectures increase the speed at which they train, but they lose their accuracy. We found, however, that they marginally decrease efficiency by one percent. Following this scheme we hope to find a scalable system with increased efficiency.
Combining transition metals with metalloids can lead to interesting reactivity to make difficult reactions more accessible. We are exploring this idea by pairing an electron rich cobalt(I) center with electron poor silicon in a pincer-type complex. Through the summer, we were able to make & characterize a likely first isolable base-free cobalt silylene.