SUMMER RESEARCH SYMPOSIUM & CELEBRATION

FRIDAY, OCTOBER 21, 2016

Weitz Center Commons

3:30-5:30 P.M.

October 21, 2016

Welcome to this Year's Student Research Symposium and Celebration at Carleton College. 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 twenty-two departments and programs have supervised student research projects, as well as several staff members who work in Academic Civic Engagement, Academic Skills Support, and the Cowling Arboretum, among others. 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 are pleased that this research symposium is part of a larger Day of Student Engagement, for research at its best is just that – the result of deep intellectual engagement of students and faculty and staff with their subjects and with one another. 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
VP for Student Life/Dean of Students

1. **Automated Crowdsourcing Framework: Transcript Annotation**
   Hami Abdi ’17
   Winter 2015
   Supervisor: Justine Cassell (Professor of Human-Computer Interaction, Carnegie Mellon University), Michael Madaio (PhD, Carnegie Mellon Universit), Yoichi Matsuyama (Post-Doctoral Fellow, Carnegie Mellon University), and Alexandros Papangelis (Former Post-Doctoral Fellow, Carnegie Mellon University)
   This research project is to construct a framework that automates the process of crowdsourcing transcript-annotation tasks, specifically transcripts involving dialogue between two children subjects. This framework can be modified to include other tasks. The framework can be improved in the future through the incorporation of machine learning and other artificial intelligence techniques to integrate various annotations based on different characteristics of annotators (e.g. previous accuracy of annotations, number of annotations, and difficulty level of annotations). This framework helps various labs, such as Carnegie Mellon University's ArticuLab, reduce reliance on having a person physically present in the lab performing tedious manual labor.
   This research was funded in part by the Kolenkow-Reitz Fund for Undergraduate Research.

2. **Investigation into Cooling Rb Atoms with Additive Manufacturing**
   Alexander Aeppli ’18
   Authors/ Contributors: Eric Hazlett (Assistant Professor of Physics, Carleton College), Henry Rook '18
   Summer 2016
   Supervisor: Eric Hazlett (Assistant Professor of Physics, Carleton College)
   We continued our investigation into the feasibility of using additive manufacturing to laser cool and trap atoms. This summer we set up our optical system for both the main cooling laser and repump lasers. Additionally, we have constructed a vacuum chamber and attained pressures on the order of $1*10^{-10}$ torr. While the optical paths are close to being aligned, we still need another laser to serve as our master cooling laser. This mounts for this laser will be constructed via additive manufacturing. This laser has a mode-hop free range of at least 6 GHz and can be used for absorption spectroscopy of Rb. This demonstration shows that it is a strong candidate to laser cool and trap atoms.

3. **Role of Notch in Skin Cancer**
   Saki Amagai ’18
   Authors/ Contributors: Hiroshi Maeno (Research Associate, Perelman School of Medicine), John Seykora (Associate Professor of Dermatology, Perelman School of Medicine)
   Summer 2016
   Supervisor: Hiroshi Maeno (Perelman School of Medicine), John Seykora (Perelman School of Medicine)
   Squamous Cell Carcinoma is the second most common skin cancer that is estimated to affect 700,000 individuals in the United States alone. We do know that prolonged UV exposure increases the risk of skin cancer and the chances of getting mutations in the squamous cells, but little is known about the exact molecular pathogenesis. Our lab believes that the Notch cell signal pathway plays an important role in maintaining the skin and, therefore, a dysfunction in Notch could be the underlying cause for SCC tumor formations. I primarily worked on quantifying the DNA damage in normal HaCaT cells and Notch-inhibited HaCaT cells to determine if blocking Notch would have an effect on the amount of DNA damage when treated with UVB radiation. We found that the damage is greater for Notch-inhibited cells and that it is dose/time dependent, suggesting the important role Notch plays in the skin cells.

4. **Expanding the Hypothesis Space for Inferring Learner's Knowledge from Algebra Problems**
   Alice Antia ’18
   Authors/ Contributors: Anna Rafferty (Assistant Professor of Computer Science, Carleton College)
   Summer 2016
   Supervisor: Anna Rafferty (Assistant Professor of Computer Science, Carleton College)
   We can infer a learner's (mis)understandings from a set of step by step solutions to algebra problems using a Bayesian inverse planning algorithm that takes problem solving data as input, and calculates a probability distribution over a hypothesis space of possible understandings. This probability distribution provides an estimate of learner's skill that separates learner's proficiency at correctly using different algebra rules and making arithmetic

calculations. Here we look at expanding this hypothesis space to take into account the different skill levels exhibited by a learner depending on context. For example, a learner might make more arithmetic errors with fractions than with whole numbers. This allows for a more detailed diagnosis of learner's understandings, but it raises some questions. (1) Does the inference algorithm retrieve the correct (mis)understanding? (2) Does inference with the correct structure results in a better model fit? And (3) Can we find the simplest model for each learner? We use simulated data to address these questions.
This research was funded in part by Carleton's Towsley Endowment.

5. **Investigating the Effects of Sugar Configurations on Alternative Nucleobases and Their Ability to Form Self Assemblies**
Anirudh Appachar '18
Summer 2016
Supervisor: Professor Ramanarayanan Krishnamurthy (The Scripps Research Institute)
One of the prominent questions in Origins-of-Life research is the origin of extant nucleic acids like RNA. Modern day nucleobases, such as adenine, do not spontaneously combine with ribose sugars in prebiotic conditions to form RNA. Many studies therefore seek to find plausible alternative pathways to RNA. However, in prebiotic environments, the possibility of non-ribose-based nucleic acid formation also exists, and remains largely unexplored. For this reason, the interactions of 2,4,6-Triaminopyrimidine(TAP) and Melamine, two plausible ancestral nucleobases, were investigated across four sugars. Visible reactions occurred for both nucleobases. Results were confirmed through NMR and mass spectroscopy. Products were then treated with cyanuric acid and heated under slightly basic conditions. All TAP-based products formed gels, indicating the possibility of these products to interact in a manner similar to modern day base-pairing. These findings suggest that plausible prebiotic pathways of nucleosides and self-assemblies may exist for sugars other than ribose.

6. **Remote Sensing of Land Loss on the Mississippi River Deltaic Plain**
Josie Arcuri '17
Summer 2016
Supervisor: Doug Edmonds (Assistant Professor of Geological Sciences-Sedimentology and Malcom and Sylvia Boyce Chair in Geological Sciences, Indiana University), Alejandra C. Ortiz (Post-Doctoral Research Fellow, Indiana University)
The wetlands comprising the Mississippi River Deltaic Plain (MRDP) on Louisiana's coast have been disappearing over the last century. This problem is immense given the cultural and economic value of the MRDP. While the occurrence of land loss is well known, it is not yet clear what processes drive land loss. Using remote sensing, we analyze what potential processes are driving land loss. To do this we examine satellite imagery of the MRDP to see how lakes have changed in area and extent. Additionally, we use data from the Coastwide Reference and Monitoring System (CRMS) in Louisiana to look at trends in soil chemistry and surface elevation, and compare them to the lake data.
This research was funded in part by the Kolenkow-Reitz Fund for Undergraduate Research.

7. **Sexual experience induced changes in paced mating behavior are unrelated to testing interval and anxiety**
Moriah Arnold '17
Authors/ Contributors: Sarah Meerts (Assistant Professor of Psychology, Carleton College), Jennifer Fehring '16, Lauren Azuma '17, Sophie Guterl '15, Ria Sekahawat '17, Malavika Suresh '18, and Sabrina Velasco '18
Winter/Spring, 2016
Supervisor: Sarah Meerts (Assistant Professor of Psychology, Carleton College)
During paced mating, sexually experienced female rats show changes in behavior relative to naive rats. Experiment 1 tested whether the time interval between mating sessions affects sexual experience induced changes in behavior.Female rats showed changed behaviors over the four tests, as expected, but groups did not differ from each other. Experiment 2 tested the hypothesis that anxiety during a mating interaction is elevated in sexually naive relative to experienced female rats. No difference in anxiety or circulating corticosterone was observed between groups, but significantly less anxiety was seen under hormone vs. oil. Overall, the study demonstrates that number of sexual interactions influences paced mating behavior, but that mating intervals and level of anxiety does not appear to affect experience induced changes.

8. **Template-Stripped Aluminum Arrays for Ultraviolet Plasmonics**
   Lisa Au '18
   Summer 2016
   Authors/ Contributors: Teri W. Odom (Professor of Chemistry, Northwestern University), Michael Knudson (Graduate Student, Northwestern University), Thaddeus Reese (Graduate Student, Northwestern University)
   Summer, 2016
   Supervisor: Michael Knudson (Northwestern University), Thaddeus Reese (Northwestern University), Dr. Teri W. Odom (Northwestern University)
   Plasmonic devices have many applications, including chemical and biological sensing and photocatalysis, due to their unique interaction with light and surrounding media. Fabrication of plasmonic nanostructures supporting visible and near-infrared resonances is well-developed; however ultraviolet plasmonics presents new fabrication requirements and challenges. This project aims to generate periodic nanoscale aluminum arrays that support optical resonances at ultraviolet wavelengths using unconventional nanofabrication techniques. These parallel fabrication techniques will be tested to create nanostructures with small periodicities and feature sizes over large (square-centimeter) areas. Line and square lattice arrays will be template-stripped using aluminum from silicon masters and characterized for optical reflectance as a function of wavelength and angle.
   This research was funded in part by Carleton's HHMI grant.

9. **Effect of Sal4 IgG on Salmonella typhimurium Invasion Into Macrophage-like U937 Cells**
   Amarantha Ballmer '18
   Summer 2016
   Supervisor: Nicholas J Mantis (Wadsworth Center, New York Department of Public Health)
   Salmonella enterica serovar Typhimurium (ST) is a foodborne pathogen that initiates infection in the gastrointestinal tract and then spreads systemically by infecting macrophages and traveling through the blood stream and lymphatics to the spleen and liver. Using a cell-culture invasion assay model, I found that the anti-lipopolysaccharide, monoclonal antibody Sal4 IgG enhanced by ~8 fold the uptake of ST into macrophage-like U937 cells. In contrast, Sal4 IgA reduced uptake of ST. Based on these results, we postulated that opsonization of ST with IgG results in Fc-receptor (FcR) mediated uptake and degradation of bacteria in macrophages. This finding aids in future vaccine development by revealing protective and functional differences between the poorly understood IgA and IgG antibodies.

10. **microRNA-1253 Regulation of WAVE2 and it's Relationship with Hypertension**
    Lori Barrientos Sanchez '18
    Authors/ Contributors: Dr. Douglas F. Dluzen, Paul Bastian, Dr. Nicole Noren Hooten, Dr. Michele K. Evans
    Summer 2016
    Supervisor: Dr. Douglas F. Dluzen (National Institute of Health)
    Hypertension occurs more frequently in African Americans (AAs) than any other population, with earlier onset and disparate morbidity and mortality. Transcriptional profiling of peripheral blood mononuclear cells (PBMCs) from participants in the Healthy Aging in Neighborhoods of Diversity across the Lifespan (HANDLS) cohort identified significant differences in mRNA and microRNA (miRNA) expression between AA and white women who were either hypertensive or normotensive. MiRNAs post-transcriptionally regulate gene expression. Recent data indicates that they play an important role in cardiovascular development and disease. Previously our laboratory found that miRNA-1253 is expressed at lower levels in AA hypertensive women compared to white hypertensive women, which suggests miR-1253 may have a role in hypertension health disparities. Using in silico and in vitro analysis, we hypothesized that miR-1235 may be a previously unidentified regulator of WAVE2, a protein involved with aortic endothelial cell development. To test whether miR-1235 indeed regulates WAVE2, we transfected Human Aortic Endothelial Cells (HAECs) with a miR-1253 mimic and observed that WAVE2 mRNA and protein expression was significantly repressed ($P<0.05$). Conversely, transfection of HAECs and Human Umbilical Vein Endothelial Cells (HUVECs) with an miR-1253 inhibitor increased WAVE2 protein expression. Together, these results confirm that miR-1253 does downregulate WAVE2 gene and protein expression in endothelial cells. Future studies will investigate how the interaction between miR-1253 and WAVE2 potentially contributes to hypertension pathophysiology.
    This research was funded in part by Carleton's HHMI grant and NSF-LSAMP grant.

11. **Construction and Testing of a 2D Photocurrent Scanning Station**
Alex Battiste ’19
Authors/ Contributors: Keaton Mertz '17, and Steven Drew (Charles "Jim" and Marjorie Kade Professor of the Sciences and Chemistry, Carleton College)
Summer 2016
Supervisor: Steven Drew (Charles "Jim" and Marjorie Kade Professor of the Sciences and Chemistry, Carleton College)
The construction of a 2D photocurrent scanning station capable of measuring the current generated by photovoltaic cells or water-splitting photocatalysts is reported. The purpose of the scanning station is to spatially map out the amount of photocurrent generated in different zones of a solar cell or a water-splitting photocatalyst. The scanning station is comprised of a 2D galvanometer, a laser pointer, a darkened enclosure,and a picoammeter. A LabVIEW program controls the 2D galvanometer and obtains readings from the picoammeter to relate a photocurrent generated by the solar cell or water-splitting photocatalyst to a x-y coordinate on the sample. These data will be used to analyze solar cells or water-splitting photocatalyst assembled in our lab.
This research was funded in part by Carleton’s Towsley Endowment.

12. **Keep Listening: Grammatical Context Reduces but Does Not Eliminate Activation for Unexpected Words**
Violet Brown ’17
Authors/ Contributors: Julia Strand (Assistant Professor of Psychology, Carleton College), Violet Brown '17, Hunter Brown '17, Jeff Berg '14
Summer 2016
Supervisor: Julia Strand (Assistant Professor of Psychology, Carleton College)
While perceiving speech, listeners combine expectations derived from semantic and grammatical context with the bottom-up, auditory input. Studies on semantic context have generally supported continuous-integration models, in which listeners maintain sensitivity to the bottom-up signal irrespective of semantic fit (Dahan &Tanenhaus, 2004). In contrast, studies on grammatical context typically support restrictive-access models, in which context completely eliminates activation of grammatically inconsistent neighbors (similar-sounding words) (Dahan et al. 2000). In the current eye-tracking study, participants were presented with target words in grammatically constraining or unconstraining contexts. Grammatical context reduced but did not eliminate activation of contextually inappropriate neighbors when the target contained co-articulatory information from the neighbor. The data are consistent with continuous-integration accounts and suggest that although grammatical context constrains lexical activation, listeners remain sensitive to the bottom-up input, just as they do with semantic context.
This research was funded in part by Carleton’s Towsley Endowment.

13. **Workhouse Archaeology: Uncovering the Material Culture of Workhouse Inmates**
Elizabeth Budd ’19
Authors/ Contributors: Brittany Johnson '18, Susannah Ottaway '89 (Professor of History, Carleton College), and Austin Mason (Assistant Director of the Humanities Center for the Digital Humanities and Visiting Assistant Professor of History, Carleton College)
Summer 2016
Supervisor: Susannah Ottaway '89 (Professor of History, Carleton College), Austin Mason (Assistant Director of the Humanities Center for the Digital Humanities and Visiting Assistant Professor of History, Carleton College), and Megan Dennis (Gressenhall Farm and Workhouse Museum)
This summer, we traveled to Norfolk, England to conduct archaeological research into the material culture of the poor. We worked with Megan Dennis, curator of Gressenhall Farm and Workhouse Museum, to excavate a rubbish heap on site. Once the objects were excavated, we cleaned, sorted, catalogued, marked, photographed, and packaged our finds to the museum’s standards. Although we determined that our finds were of 20th century date, the processes that govern material survival are relevant to earlier objects as well. Upon our return, we were able to apply our understanding of object survival to earlier eras. Then we worked with Professor Austin Mason to prepare and present a paper at the Midwest Conference on British Studies on the material culture of the workhouse and the difficulties of digital reconstruction of that material culture.
This research was sponsored in part by the Humanities Center Student Research Fund.

14. **A Life in Music: Kurt Masur**
    Briannon Carlsen ’17
    Authors/ Contributors: Briannon Carlsen '17
    Juliane Schicker (Assistant Professor of German, Carleton College)
    Summer 2016
    Supervisor: Juliane Schicker (Assistant Professor of German, Carleton College)
    Our goal is to familiarize modern American audiences with the conductor Kurt Masur, who has remained a central figure in German society long after his death. His contributions to the reunification of East and West Germany were invaluable, and his humanist approach to music has influenced audiences on a global scale. In order to share his story, we began the process of transcribing audio from interviews with Mr. Masur and his colleagues in their native language of German. These intimate interviews shed light on Masur’s personal philosophies, experiences, and sentiments that are waiting to be shared with a wider audience. In order to overcome the language barrier, these interviews will be translated and subtitled from German into English and included in a documentary about Mr. Masur's legacy.
    This research was sponsored in part by the Humanities Center Student Research Fund.

15. **Workhouses: Expectations of the Poor**
    Madison Chambers ’18
    Authors/ Contributors: Susannah Ottaway (Professor of History, Carleton College), Alex Wachino, '18
    Summer 2016
    Supervisor: Susannah Ottaway (Professor of History, Carleton College)
    Spinning skeins of worsted was a common work task of paupers living in the houses of industry surrounding Norwich. Paupers would be responsible for converting the raw fibers into yarn using spinning wheels and other machinery. Our research involved collecting data from account books that a number of workhouses kept in order to record weekly production and earnings at the institution. These documents provide a clear record of how much work was being completed by people of different genders and ages, allowing one to draw conclusions on how expectations for work might have differed for distinct groups. Our research and paper seek to understand the importance of labor within the workhouse, finding that workhouses were driven by profit rather than moral reform for the poor.
    This research was sponsored in part by the Humanities Center Student Research Fund.

16. **Analyzing Data from the Pulsar B1913+16**
    Sanjay Chepuri ’17
    Authors/ Contributors: Joel Weisberg (Herman and Gertrude Mosier Stark Professor of Physics and Astronomy and the Natural Sciences, Carleton College)
    Summer 2016
    Supervisor: Joel Weisberg (Herman and Gertrude Mosier Stark Professor of Physics and Astronomy and the Natural Sciences, Carleton College)
    The pulsar B1913+16 is part of a binary neutron star system which has been used to test principles of general relativity. We took data of the pulsar from the 305 m radio telescope at Arecibo Observatory in Puerto Rico in August. We then analyzed data from this and the previous (2012) session, producing fully polarized pulse profiles and pulse times-of-arrival accurate to 10 millionths of a second for each five minutes of observation. These new data were than compared with thirty years of earlier data. With all the data, we further developed our models relating to the shape and geometry of the pulsar's beam, which precesses due to a general relativistic phenomenon call geodetic spin-orbit coupling; and we also refined our measurements of several other relativistic phenomena.

17. **Enhanced Index Contrast in Holographic Photopolymers**
    Madeline Chosy ’18
    Authors/ Contributors: Robert R. McLeod (Richard & Joy Dorf Endowed Professor, University of Colorado at Boulder), Amy C. Sullivan (Postdoctoral Research Associate), David J. Glugla (PhD student), Marvin Alim (PhD student)
    Summer 2016

Supervisor: Dr. Robert R. McLeod (University of Colorado at Boulder)
The ability to arbitrarily change the index of refraction of a holographic photopolymer offers an attractive method for fabricating 3-D optical interconnects and holographic optical elements. Optical interconnects provide a means for faster chip-to-chip communication while holographic optical elements show promise as tools for implementing virtual reality devices such as heads-up displays. However, for successful application, a high contrast in the index of refraction between the bulk material and the holographic regions (index contrast) must be achieved. Most current materials are limited to index contrast values of about 0.02. My research this summer focused on characterizing index contrast over a variety of optical exposure conditions using the transport of intensity (TIE) equation. I also used repeated exposures on a sample to reach amplified index contrast values of up to 0.03.

18. **MAP-ping Land Occupation in Border Regions of Ancient Greece: Mazi Archaeological Project 2016**
Alex Claman '17
Authors/ Contributors: Alex Knodell (Assistant Professor of Classics, Co-Director of Archaeology, Carleton College), Chloe Bergstrand '16 (Educational Associate: STEM FOCUS Coordinator, Carleton College) , Julia Miller '18, Liza Davis '16, and teams from Texas Tech University, Brown University, University of Switzerland Geneva, and University of Nebraska-Lincoln
Summer 2016
Supervisor: Alex Knodell (Assistant Professor of Classics, Co-Director of Archaeology, Carleton College)
This summer we worked as student research assistants on the 2016 summer field season of the Mazi Archaeological Project in the Attiac region of Greece, an ongoing study led by Alex R. Knodell (CarletonCollege), Sylvian Fachard (University of Geneva), and Kalliopi Papangeli (Greek Ministry of Culture). The project used survey archaeology methods to examine diachronic occupation and land usage in the area of the Mazi Plain, a valley on the border between ancient Attica and Boeotia. This field season the project collected pottery, tile and lithic remains dating from the Neolithic to Byzantine eras. We also started to map several Neolithic and Late Roman Byzantine settlement areas. The data collected in this field season furthered our understanding of ancient settlement patterns and land use.
This research was sponsored in part by the Independent Research Fellowship.

19. **Mapping Masquerades**
Jackie Culotta '19
Authors/ Contributors: Thabiti Willis (Assistant Professor of History, Carleton College)
Summer 2016
Supervisor: Thabiti Willis (Assistant Professor of History, Carleton College)
This summer I worked on Professor Thabiti Willis' research on Egungun masquerading in Otta, Nigeria. Egungun is a masquerade practice and masquerade society devoted to honoring the ancestors and their living descendants. While honoring ancestors, Egungun narrate history and shape social relations. I learned about these aspects of Egungun when I read the introduction to Professor Willis' book, Masquerading Politics. Inspired by his work, I created an online story map. The story map combines visual media, including b-roll footage that I and other students have edited about the role of gender in Egungun. I coordinate data from the locations of families that organized Egungun and performance sites at Otta.
This research was sponsored in part by the Humanities Center Student Research Fund.

20. **Studying the Galactic Magnetic Field Using Pulsars**
Alice Curtin '19
Authors/ Contributors: Joel M. Weisberg (Herman and Gertrude Mosier Stark Professor of Physics and Astronomy and the Natural Sciences, Carleton College) , Joanna Rankin (Professor of Physics & Astronomy at the University of Vermont)
Summer 2016
Supervisor: Joel Weisberg (Herman and Gertrude Mosier Stark Professor of Physics and Astronomy and the Natural Sciences, Carleton College)
Pulsars are rapidly rotating neutron stars which emit beams of radiation as they spin. When these polarized beams pass through the interstellar medium, magnetic fields cause the plane of polarization to rotate. This rotation is called

Faraday Rotation. This phenomenon, quantified by the pulsar's rotation measure (RM), can be directly related to the Galactic magnetic field. We have obtained new data from Arecibo Observatory in Puerto Rico, and will be combining them with all other known RM data. We will be relating these RMs, and therefore the Galactic magnetic field, to the Spiral Arms of the Milky Way. Our Galaxy's spiral arms are currently an area of active research, requiring us to do an extensive literature search to arrive at a best model for their locations.

21. **Testing Protein-Protein Interaction in Neurological Disorders**
    Amanda d'Almeida '17
    Authors/ Contributors: Alexandre Neves (Postdoctoral Fred Hutchinson Research Center), and Robert Eisenman (Physical Investigator, Fred Hutchinson Research Center)
    Summer 2016
    Supervisor: Alexandre Neves (Postdoctoral Fred Hutchinson Research Center), and Robert Eisenman (Physical Investigator, Fred Hutchinson Research Center)
    To understand the role of proteins in neurological disorders, I investigated TBP, TAFs, and TRF2 and the interaction between these proteins. TBP and TAFs are known to form complexes together. When TRF2 and TAF1 are manipulated there is an analogous decrease in neural stem cells (NSCs). From these results, we predicted that TAF1 would interact with TRF2. TAF1 is significant because intellectual disability was found to be associated with mutations in this genes. I pulled down GFP labeled TAF1 genes using GFP beads and investigated whether TRF2 was pulled down with TAF1, forming a complex. In this experiment, TBP was pulled down, validating the TBP/TAF1 interaction. There was no evidence for a TRF2/TAF1 interaction.
    This research was funded in part by the Kolenkow-Reitz Fund for Undergraduate Research.

22. **Hydrogenation Using a Silyl Pincer-Supported Rhodium Complex**
    Kate DeMeulenaere '17
    Authors/ Contributors: Matt Whited (Assistant Professor of Chemistry, Carleton College)
    Buck Taylor (Visiting Assistant Professor of Chemistry, Carleton College), Mike Trenerry '17, Teddy Donnell '17, Jim Zhang '18, Sarah Wang '17, Paul Peterson '18
    Summer 2016
    Supervisor: Matt Whited (Assistant Professor of Chemistry, Carleton College)
    As science looks to alternative fuels, more catalysts will be needed in order to make those alternatives feasible. As part of a research program exploring metal/silicon cooperation, we have sought to understand the mechanisms of catalysis in rhodium silyl complexes where cooperation is not operative. To accomplish this goal, we have developed reliable synthetic routes to a series of silyl pincer-supported rhodium complexes and investigated reactivity relevant to hydrogenation catalysis for comparison with computations. Notable recent findings include synthesis of a dihydrogen complex that is a relevant intermediate and its characterization by NMR. Our goals for the future include performing more kinetic experiments with varying H2 pressures in order to determine the mechanism behind hydrogenation.

23. **Rational and computational approach towards the development of inhibitors targeting Acetyl CoA Carboxylase as a cancer therapeutic**
    Samuel Diaz de Leon '18
    Authors/ Contributors: James Alburger (Graduate Student, The Scripps Research Institute)
    Summer 2016
    Supervisor: Dr. William Roush (The Scripps Research Institute)
    Acetyl CoA Carboxylase is characterized by two isoforms (ACC1 & ACC2) both of which generate malonyl-CoA. ACC1, located in the cytosol, produces malonyl-CoA which acts as a substrate for de novo lipogenesis while ACC2 acts to inhibit mitochondrial fatty acid oxidation. Our work focuses on targeting ACC1 as a potential cancer therapeutic as it is overexpressed in various cancers. Furthermore, studies have shown that a complete knockout of ACC1 has led to cancer cell apoptosis while leaving normal cells alive. As a launching pad for our synthesis of potential inhibitors, Schrödinger Glide Docking software was used to run a virtual High Throughput Screen of the TSRI compound library through the crystal structure of ACC1's CT active site. Most of the top ranked compounds contained a hydantoin core. Using a hydantoin core scaffold, we synthesized the 'best looking' derivatives and

tested them for potency against A549 lung cancer cells via an MTT Assay. Using this computational approach, we created two inhibitors with EC50 values in the 1-10ÂµM range. These values align with the potency of other known inhibitors synthesized by Pfeizer and BMS.
This research was funded in part by Carleton's HHMI grant and NSF-LSAMP grant.

24. **Investigating Cosmic Ray Energy Spectrum Anisotropy with IceCube**
Brian DiGiorgio '17
Authors/ Contributors: Frank McNally (Visiting Assistant Professor of Physics and Astronomy, Carleton College)
Summer 2016
Supervisor: Frank McNally (Visiting Assistant Professor of Physics and Astronomy, Carleton College)
IceCube is a Cherenkov detector embedded in the Antarctic ice sheet. Though its stated purpose is to observe high energy neutrinos, it also detects cosmic rays at unprecedented precision and energy levels with incredibly high statistics, making a full survey of the southern sky possible. Using the past seven years of reconstructed cosmic ray events detected by IceCube, an energy spectrum for each small area of the sky was obtained, allowing for comparisons within declination bands to look for anomalies. The energy spectra followed the expected power law fit and areas with noticeable differences in fit line slope were seen across the sky, indicating some level of anisotropy. However, upon performing a Bayes Factor analysis comparing each pixel the average spectrum for its declination band, it was found that there was no significant evidence that the spectra had different sources. Though no cosmic ray point sources were found, methods for data extraction and analysis were developed that can be applied to future work.

25. **Rhodium-Silicon Cooperation in Small Molecule Activation**
Theodore Donnell '17
Authors/ Contributors: Matthew Whited (Assistant Professor of Chemistry, Carleton College), Kate Demeulenaere '17, Mike Trennery '17, Sarah Wang '17, Jim Zhang '18, Paul Peterson '18
Summer 2016
Supervisor: Matthew Whited (Assistant Professor of Chemistry, Carleton College)
Traditional transition metal chemistry takes place exclusively on the metal atom, while our work focuses on using a silicon ligand to promote small molecule activation in a cooperative fashion. By combining a rhodium metal atom with a pincer-type silicon ligand, we have demonstrated the reductive cleavage of carbon dioxide (CO_2). We will present results on this reaction as well as further efforts to transform CO_2 and related molecules via cooperative catalysis.

26. **Behavioral control of incipient speciation in Heliconius butterflies**
Sylvia Durkin '17
Authors/ Contributors: W. Owen McMillan (Staff Scientist, Smithsonian Tropical Research Institute)
Elizabeth Evans (Graduate Student, University of Puerto Rico)
Summer 2016
Supervisor: Dr. W. Owen McMillan (Smithsonian Tropical Research Institute), Elizabeth Evans (University of Puerto Rico)
Speciation is the process that generates our world's extraordinary biodiversity. Recent advances in our understanding of how new forms arise have helped to elucidate the speciation process. Approximately 40 species of butterfly in the genus, Heliconius, comprise hundreds of forms in all stages of diversification, making this group a great model system in which to study speciation. The sibling species H. erato and H. himera allow for the study of the behavioral control speciation, as their lack of hybridization is driven solely by assortative mating. We examined the relative importance of chemical and visual cues in interspecific mate discrimination between the two species, and found that H. himera females focus primarily on pheromones during mate interactions. These data on the behavioral cues regulating the divergence of the incipient pair give a better picture as to what species characteristics are important in the early stages of speciation in Heliconius butterflies.

27. **Criminals, Victims, Allies, Friends: The Gay Rights Movement in Weimar Berlin and Attitudes towards Male Prostitution**
Ellie Durling '17
Summer 2016
Supervisor: David Tompkins (Associate Professor of History, Carleton College)
In my research this summer, I studied the gay rights movement that was based in Berlin, Germany during the 1920s. Using contemporary German language books, magazines and archival documents at the Schwules (Gay) Museum of Berlin, the Magnus Hirschfeld Society and the Berlin State Library, I looked specifically at two major gay rights organizations, the League for Human Rights and the Scientific Humanitarian Committee, and their attitudes towards male prostitution. Through this research I hope to shed more light on the ways in which these organizations sought to present themselves to German society at large, and on patterns of inclusion or exclusion towards male sex workers in the gay community of the time period.
This research was sponsored in part by the Independent Research Fellowship.

28. **Expression of CamK1D in Neural Crest Cells**
Fayzeh El Banna '19
Authors/ Contributors: Bridget Jacques-Fricke (Visiting Assistant Professor of Biology, Carleton College)
Summer 2016
Supervisor: Bridget Jacques-Fricke (Visiting Assistant Professor of Biology, Carleton College)
Neural crest cells are a temporary population unique to vertebrates and critical for the development of melanocytes, smooth muscle, craniofacial cartilage and bones and more. Disruption of neural crest development and migration can result in birth defects and cancer metastasis, so understanding the mechanisms of their migration enhances prevention and treatment of these defects. It's hypothesized that Calcium/ calmodulin-dependent protein kinase 1D plays a role in regulating neural crest migration. My work in the lab was focused on determining the relative locations and stages of chick embryo development at which Camk1D is expressed. For that purpose, I collected embryos at different stages and performed in situ hybridization, followed by imaging. I also sectioned labeled chick embryos with interesting expression patterns. In the future, the plan is to deliver reagents to knock down Camk1D by electroporation and assess changes in neural crest development.
This research was funded in part by Carleton's HHMI grant.

29. **Mechanistic Studies of Organocatalytic Desymmetrization Reactions**
Edith Emmings '17
Authors/ Contributors: David Alberg (Professor of Chemistry, Carleton College), Gretchen Hofmeister (Professor of Chemistry, Carleton College), and Clare Leahy '17
Summer 2016
Supervisor: David Alberg (Professor of Chemistry, Carleton College) and Gretchen Hofmeister (Professor of Chemistry, Carleton College)
Mediated by chiral organocatalysts, achiral cyclic anhydrides can be opened with nucleophiles to generate chiral products, often with excellent enantioselectivities. These asymmetric desymmetrization (ASD) reactions are useful for the preparation of chiral building blocks in organic synthesis and have been used in the synthesis of pharmaceuticals, such as pain medication. Despite the practical utility of these ASD reactions, little is known about the actual substrate-catalyst interactions that account for the enantioselectivities. We designed a transition state analogue (TSA) that mimics the structure of the putative tetrahedral transition state adopted by one anhydride in the course of the reaction. We expect the interactions between the TSA and the catalyst to be analogous to the interactions between the catalyst and the substrates transition state form. We are using NMR spectroscopy to study these interactions, with the ultimate goal of using what we learn to design more effective catalysts.

30. **Therapeutic Opportunities through blockade of prolactin in uterine cancer**
Ziyu Fan '18
Summer 2016
Supervisor: Dr. Anil K.Sood (MD Anderson Cancer Center), Dr. Yunfei Wen (MD Anderson Cancer Center)
Human prolactin plays a key role in the development and function of the reproductive system, angiogenesis,

metabolism, and regulation of the immune system. Elevated expression of human prolactin and its receptor activates downstream signaling which contributes to the development and progression of gynecologic cancers, particularly hormone-dependent endometrial carcinoma, the most common type of uterine cancer. Despite the importance of PRL and PRLR, in growth and development of uterine cancer, the underlying mechanisms are not well understood, and current means of targeting this pathway are limited. Thus, we investigated the biological mechanisms and preclinical implications for new biomarkers in endometrial cancer, and improved the clinical outcomes of chemotherapeutic strategies against uterine cancer through blockade of the tumoral PRL/PRLR axis.

31. **Using Computational Chemistry to Understand the Open Transmetalation Mechanism of the Stille Cross Coupling Reaction**
    Elianna Frank '18
    Authors/ Contributors: JD Slaugh '17, Buck Taylor (Visiting Assistant Professor of Chemistry Professor of Chemistry, Carleton College)
    Summer 2016
    Supervisor: Buck Taylor (Visiting Assistant 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 one reaction pathway of the Nobel Prize-winning Stille reaction, which forms new carbon-carbon bonds via a palladium catalyst. I looked at the energetic favorability of this reaction proceeding via an open pathway, while JD Slaugh '17 investigated the energetic favorability of the reaction proceeding via a cyclic pathway, to help understand the stereochemical outcome of the reaction. This research is continuing into the 2016 school year.

32. **Investigating the Role of ANKRD26 in Megakaryocytes**
    Vianne Gao '18
    Authors/ Contributors: Vianne Gao '18
    Summer 2016
    Supervisor: Dr. Alan Cantor (Boston Children's Hospital and the Harvard Stem Cell Institute), Dr. Md Almamun (Boston Children's Hospital), Dr. Alireza Ghamari (Boston Children's Hospital)
    Point mutations in the 5' UTR of ANKRD26 gene is found to be associated with many cases of Thrombocytopenia 2 (THC2). Highly expressed in hematopoietic stem cells, ANKRD26 is normally down-regulated during megakaryopoiesis, but remains highly expressed if the 5' UTR of ANKRD26 is mutated. Previous studies using co-immunoprecipitation (Co-IP) followed by mass spectrometry showed that ANKRD26 protein interacts significantly with several members of the septin family in human megakaryoblasts, especially septin9. ANKRD26 also contains the SbcC conserved domain, which is often involved in DNA damage repair.However, the role of ANKRD26 in the development of hematopoietic stem cells and in DNA damage repair remains unknown. As a preliminary study, my project investigates the localization of ANKRD26 and septin9 proteins in normal and DNA-damaged human megakaryoblast cells by performing double immunofluorescence staining and imaging.

33. **Unraveling Splenic Natural Killer (NK) Cell Heterogeneity**
    Drew Gerber '18
    Summer 2016
    Supervisor: Robert Harms (University of Nebraska Medical Center Surgery-Transplant), Nora Sarvetnick (University of Nebraska Medical Center Surgery-Transplant and University of Nebraska Medical Center Regenerative Medicine Program)
    Interleukin-18 binding protein (IL-18BP) is the natural inhibitor of IL-18, a cytokine that augments NK cell cytotoxicity and effector function. It is currently unknown how the absence of IL-18BP may affect NK cell maturity. We have observed that IL-18BP knockout (IL-18BPKO) mice harbor an expanded population of CD27+, CD11b- NK cells. This naia live-like population was found to possess an IL-18 receptor alpha- (IL-18Rα⁻) subset, which has not previously been described in NK cell differentiation. Using flow cytometry, we explored the phenotypic diversity of this CD27+, CD11b-, IL-18Ra- NK cell subset in order to place it within the established NK cell differentiation pathway. Our results suggest that this novel subset is immature, phenotypically unique, and functionally distinct. Furthermore, our results demonstrate that IL-18BP plays a key role in NK cell maturity.

34. **Folkloric Nature: Sunken Virgins, Drunken Donkeys and a Mexican Tarzan as Environmental Education Tools in Unlikely Ecotourism Experiences**
Shayna Gleason '17
Authors/ Contributors: Constanza Ocampo-Raeder (Assistant Professor of Anthropology, Carleton College)
Summer 2016
Supervisor: Constanza Ocampo-Raeder (Assistant Professor of Anthropology, Carleton College)
Ecotourism is typically marketed towards elites living in the Global North, and often offers intercultural exchange with 'exotic' populations as one of its main attractions. In this project, we ask: could meaningful interactions with nature occur in places that are not considered 'wild' or 'pristine' like a highly-visited, popular beach in Acapulco, Mexico? Must guests and hosts be considered distinct populations, or could guests come from within host countries, even those located in the so-called Global South? Could a non-Western interpretation of nature also be a powerful inciter of environmental action, or is success bound to perceptions of nature formulated solely in the Global North?
This research was sponsored in part by the Humanities Center Student Research Fund.

35. **Contribution of Various Particle Types to Air Quality in Northfield, MN**
Elizabeth Grubb '17
Authors/ Contributors: Clarissa Smith '19, Panhia Yang '17, Lisa Au '17, Jumaanah Flowers '16, Ernesto Polania-Gonzalez '17, Aurora Janes '15, Deborah Gross (Professor of Chemistry, Carleton College)
Summer 2016
Supervisor: Deborah Gross (Professor of Chemistry)
Single-particle mass spectrometers (SMPS) provide detailed information about the number-concentration, chemical composition, and mixing state of individual aerosol particles. Methods exist to convert the number-concentration to mass-concentration for a sampled aerosol. We used scaling factors to correct for instrumental size bias, and converted particle number to mass with an average density assuming spherical particles, to determine the total PM2.5 mass concentration in the vicinity of Northfield, MN. We compared the resulting mass concentrations to data from the Minnesota Pollution Control Agency, giving us the ability to examine the applicability of one set of scaling factors to an aerosol composed of differing particle sources and sampled under different ambient conditions. While compositional analysis and mass-concentration conversions have been applied to all four seasons, this work focuses on the results from the most recent spring and summer 2016 seasons.
This research was funded in part by Carleton's Towsley Endowment.

36. **Mothering across Species: Women and the Social Reproduction of Nurturance**
Erin Healy '17
Authors/ Contributors: Pamela Feldman-Savelsberg (Broom Professor of Social Demography and Anthropology, Director of African/African American Studies, Carleton College)
Summer 2016
Supervisor: Pamela Feldman-Savelsberg (Broom Professor of Social Demography and Anthropology, Director of African/African American Studies, Carleton College)
Middle-aged women occupy a notable presence in animal rescue circles, both as participants and as leaders of rescue efforts. Why are women drawn to rescue work at this time in their lives, and how does their rescue work reinforce gendered ideas of care and calling? Based on ethnographic fieldwork conducted over two months in North and South Carolina, this research explores how women involved in animal rescue work reflect on their own life histories, particularly how their socializations as women fostered their interest in rescue work. I suggest that interpretations of womanhood associated with nurturance and self-sacrifice serve as a key framework by which women animal rescuers understand their social roles and how their rescue work might serve to reproduce cultural values more in-line with an ethic of care. This research extends anthropological attention to middle-aged women animal rescuers, a population understudied by anthropologists to date.

37. **Analysis of MRI techniques (Adiabatic T1ρ, Continuous Wave T1ρ, RAFF, T1, T2) in Early Diagnosis of Hip Ischemia due to Perthes Disease**
Brandon Hilliard '18
Authors/ Contributors: Dr. Jutta Ellermann (Center for Magnetic Resonance Research, University of Minnesota)

Dr. Casey Johnson (Center for Magnetic Resonance Research, University of Minnesota)
Summer 2016
Supervisor: Dr. Jutta Ellermann (Center for Magnetic Resonance Research, University of Minnesota)
Dr. Casey Johnson (Center for Magnetic Resonance Research, University of Minnesota)
Perthes disease is a disorder known to affect children ages 4-10 and results in a decreased oxygen supply to the femoral head. Decreased oxygen levels in developing bones often lead to deformities in the hip joint and have been connected to long-term health effects such as femoral hip impingement or arthritis. Our research aims to test various MRI techniques for their ability to detect minor changes in tissue composition associated with early stages of ischemia and Perthes disease. Various developed MRI techniques were compared with commercially available techniques such as T1 and T2 for their ability to produce increased contrast in rendered images of oxygen-starved pig hips vs. controls.

38. Developing Visualization Schemes for Reconstructed Tumor Phylogenies
Michael Hoffert '18
Authors/ Contributors: Allie Warren '17, Quimeng Yu '18, Layla Oesper (Assistant Professor of Computer Science, Carleton College)
Summer 2016
Supervisor: Layla Oesper (Assistant Professor of Computer Science, Carleton College)
Cancer is the result of an evolutionary process involving the accumulation of mutations over time. Tumor phylogeny reconstruction algorithms are designed to infer the evolutionary history of tumors from DNA sequence data, constructing phylogenetic trees. The vertices of these trees represent clonal populations that have existed, and edges distinguish the ancestral relationships between populations. We develop a method of visualizing tree structures using Python and CytoscapeJS in order to streamline the comparison and analysis of phylogenetic trees from reconstructed tumors. We establish a framework for construction of interactive Web-based objects representing inferred phylogenetic trees, integrating anterior DNA sequence data and probabilistic analysis into the visualization. Constructed in Python and integrated with Cytoscape, the de facto biological network modeling tool, our method lays groundwork for large-scale comparison and generation of fully interactive phylogenetic tree objects across a variety of algorithms.
This research was funded in part by Carleton's Towsley Endowment.

39. The effect of long-term fertilization on salt marsh fungal community composition
Helen Hoyt '18
Authors/ Contributors: Patrick J. Kearns (PhD Candidate, Northeastern University), John H. Angell (Postdoctoral Faculty Fellow, Boston University), and Dr. Jennifer L. Bowen (Associate Professor, Northeastern University)
Summer, 2016
Supervisor: Dr. Jennifer Bowen (Northeastern University)
Salt marshes are highly productive coastal ecosystems that provide storm protection, nutrient removal, and carbon sequestration. These ecosystems often experience eutrophication from excess nitrogen in terrestrial runoff. Microorganisms, including fungi, play key roles in nutrient removal, but salt marsh fungal communities and their response to N-enrichment is poorly understood. To determine the effect of nutrient enrichment, seasonality, and habitat on fungal community composition we used high-throughput sequencing of the fungal internal transcribed spacer region (ITS). We analyzed samples from the N-enrichment project at the Plum Island Ecosystems Long-term Ecological Research Site in Rowley, MA. To capture temporal variability, we collected sediments over the course of two growing seasons. We sampled sediments from two areas of the marsh representing a high and low N-load habitat. We found that phylum Ascomycota dominated the fungal community, accounting for 95% of taxa. Fungal community composition varied among different habitats in the marsh, however no evidence of seasonality was present. Nutrient enrichment has a strong effect on fungal community composition, and increased community diversity. Regions of the marsh receiving the highest N-loads experienced greater shifts.

40. **Using Projection-Based Nodule Insertion to Determine Human Observer Performance in Lung Cancer Screening CT**
Isabelle Hu '17
Authors/ Contributors: Lifeng Yu (Associate Professor of Medical Physics, Mayo Clinic), Cynthia McCollough (Professor of Biomedical Engineering and Medical Physcis, Mayo Clinic), Chi Wan Koo (Assistant Professor of Radiology, Mayo Clinic)
Summer 2016
Supervisor: Dr. Lifeng Yu (Mayo Clinic)
Task-based image quality assessment using model observers is a promising approach to efficient, quantitative, and objective CT dose optimization. Before this approach can be reliably used in practice, its correlation with radiologist performance for the same clinical task needs to be established. Determining human observer performance for a well-defined clinical task, however, has always been a challenge due to the number of positive cases needed. In this study, we present a virtual clinical trial using a projection-based insertion technique and a low-dose simulation tool to determine radiologist performance on lung-nodule detection as a function of radiation dose, nodule type, nodule size, and reconstruction methods. The technique was proven to be able to generate flexible and realistic clinical cases under well-defined conditions. The results from this study will be used for developing model observers for lung nodule detection, as well as for dose and protocol optimization in lung cancer screening CT.

41. **Localizing Fast Radio Transients with Very Long Baseline Interferometry**
Yuping Huang '17
Authors/ Contributors: Aard Keimpema (Joint VLBI Institute ERIC), Benito Marcote (Joint VLBI Institute ERIC) and Zsolt Paragi (Joint VLBI Institute ERIC)
Summer 2016
Supervisor: Aard Keimpema (Joint VLBI Institute ERIC), Benito Marcote (Joint VLBI Institute ERIC) and Zsolt Paragi (Joint VLBI Institute ERIC)
The radio transient sky remains relatively unexplored in the sub-second timescale. Known forms of these transients include pulsars, Rotating Radio Transients (RRATs) and Fast Radio Bursts (FRBs). FRBs are extremely bright and short pulses of extragalactic but unknown origin, whereas RRATs are confirmed to be dying pulsars in our own galaxy. Very Long Baseline Interferometry (VLBI), combining the sensitivity of big (50m) dishes and the superior angular resolution of long baselines across continents, can help us advance our understanding of these phenomena significantly. We develop and test strategies to search for and localize single pulses with the European VLBI Network (EVN), the most sensitive VLBI instrument in the world. We conclude that such searches are indeed attainable with the EVN and milliarcsecond localization can be achieved, allowing us to identify the location of the transients within their host galaxies and perhaps resolve the mysteries around FRBs.

42. **Workhouse Archaeology: Uncovering the Material Culture of Workhouse Inmates**
Brittany N. Johnson '18
Authors/ Contributors: Elizabeth Budd '18, Austin Mason (Assistant Director of the Humanities Center for the Digital Humanities and Visiting Assistant Professor of History, Carleton College), Susannah Ottaway '89 (Professor of History, Carleton College)
Summer 2016
Supervisor: Austin Mason (Assistant Director of the Humanities Center for the Digital Humanities and Visiting Assistant Professor of History, Carleton College) and Susannah Ottaway '89 (Professor of History, Carleton College), Megan Dennis, Curator of Gressenhall Farm and Workhouse Museum
This summer, we traveled to Norfolk, England to conduct archaeological research into the material culture of the poor. We worked with Megan Dennis, curator of Gressenhall Farm and Workhouse Museum, to excavate a rubbish heap on site. Once the objects were excavated, we cleaned, sorted, catalogued, marked, photographed, and packaged our finds to the museum's standards. Although we determined that our finds were of 20th century date, the processes that govern material survival are relevant to earlier objects as well. Upon our return, we were able to apply our understanding of object survival to earlier eras. Then we worked with Professor Austin Mason to prepare and present a paper at the Midwest Conference on British Studies on the material culture of the workhouse and the difficulties of digital reconstruction of that material culture.

43. **Activism in the 21st Century: A Research Teaching Tool on 21st Century Spanish Fiction and Culture**
Lauren Kempton '18
Authors/ Contributors: Palmar Alvarez-Blanco (Associate Professor of Spanish, Carleton College), Christina Tarazi '18
Summer 2016
Supervisor: Palmar Alvarez-Blanco (Associate Professor of Spanish, Carleton College)
This is an ongoing project to create a website called "Artivism in the 21st Century". The website is an open archive (freely accessible and without charge) that is continuously updated and expanded. All pages are in both English and Spanish. There are three objectives: 1) to offer researchers a place to connect with the work of artists and cultural platforms, as well as with the artists themselves; 2) to offer teachers and professors models of workshops with these artists; and 3) to offer artists and cultural platforms a free space and up-to-date bibliography where others can access their work. This research provides an opportunity for us, as students, to engage with the community of professors and fellow students who are interested in art and activism, and to help create a useful educational resource.
This research was sponsored in part by the Humanities Center Student Research Fund.

44. **Printmaking and Castle Bravo**
Mairead Koehler '17
Authors/ Contributors: Fred Hagstrom (Rae Schupack Nathan Professor of Art, Carleton College)
Summer 2016
Supervisor: Fred Hagstrom (Rae Schupack Nathan Professor of Art, Carleton College)
My research this summer was twofold: I primarily focused on the technique of relief and screen printing in creating artist books. I worked with Professor Fred Hagstrom on his book "Bravo." We printed 31 copies by hand, with 3-4 layers of ink on each sheet of paper, totalling over 3,000 press runs. Through printing "Bravo" I also learned about Castle Bravo, the hydrogen bomb testing that the US Government organized in the Marshall Islands starting in the 1950s. The effects are staggering and continue to affect the Marshallese. "The total yield of the nuclear tests in the Marshall Islands was the equivalent of 1.7 Hiroshima shots every day for a period of 12 years."

45. **Luminosity Function and Faint Regions in M31**
Daniel Kupetsky '19
Authors/ Contributors: Cindy Blaha (Professor of Physics and Astronomy, Marjorie Crabb Garbisch Professor of the Liberal Arts, Carleton College), Galen Muller '18, and Nyla Worker '19
Summer 2016
Supervisor: Cindy Blaha (Professor of Physics and Astronomy, Marjorie Crabb Garbisch Professor of the Liberal Arts, Carleton College)
We categorized faint HII regions in M31 in order to explore the composition of the galaxy. By processing and analyzing H-α emissions from the galaxy as captured in images taken by the Kitt Peak National Observatory, we found the relative H-α flux values for faint regions of interest and compared these values with known standards to group the region into one of several categories of astronomical objects, which included supernova remnants and planetary nebulas. Using this collection of faint region luminosities, we generated a luminosity function exclusively for the faint regions of M31. The function suggested that the majority of the galaxy's faint regions had luminosities around 10^35.7 ergs per second. We also began exploring ways to automatize the identification of HII regions using the program SExtractor. Results were inconclusive, but the software shows promise for future research.

46. **Synthesis & NMR Experiments of Transition State Analogs for Mechanistic Studies of a Catalytic Enantioselective Reaction**
Clare Leahy '17
Authors/ Contributors: Gretchen Hofmeister (Associate Dean of the College, Professor of Chemistry, Carleton College), David Alberg (Professor of Chemistry, Carleton College), Fa Ngamnithiporn '15 , Connor Hodges '15, Nathan Rockey '16
Summer 2016
Supervisor: Gretchen Hofmeister (Associate Dean of the College, Professor of Chemistry, Carleton College), David

Alberg (Professor of Chemistry, Carleton College)
Reactions mediated by chiral organocatalysts can be used to generate chiral products from achiral precursor molecules, offering practical and inexpensive methods to prepare enantiopure building blocks for synthesis especially useful in the synthesis of pharmaceuticals. To gain a better understanding of how organocatalysts can provide high enantioselectivity in one reaction type, our group is interested in learning about the interactions between substrate and catalyst in the course of asymmetric desymmetrization (ASD) reactions of achiral cyclic anhydrides. Our group prepares transition state analogues (TSAs) that mimic the putative structure that several anhydride substrates adopt in the crucial transition states of these reactions. Here we describe preliminary studies of TSA-catalyst interactions for one TSA, using two-dimensional NMR spectroscopy. We also report on the synthesis and characterization of another TSA precursor.

47. **Does Remembering that 'We' Used to be 'Them' Improve Attitudes Towards Immigrants?**
Chris Leppink-Shands '19
Authors/ Contributors: Jea Eun Lee '16, Nina Muller '18, Margot Radding '18, Alice Welna 17', Yeon Yang 16' Alex Welna 16' Stefanie Simon (Professor of Psychology, Carleton College), Sharon Akimoto (Professor of Psychology, Carleton College)
Summer 2016
Supervisor: Stefanie Simon (Professor of Psychology, Carleton College) and Sharon Akimoto (Professor of Psychology, Carleton College)
How can we promote positive intergroup relations between US-born citizens and immigrants? The present research investigates the efficacy of reflecting on one's ancestry for improving attitudes towards immigrants and how this intervention varies by political orientation. In Study 1, participants were either asked to reflect on their family's history of immigration or to recall what they ate in the last 48 hours (control) before answering questions about immigrants. The results demonstrate that the reflection exercise improved participants attitudes towards immigrants to the extent that they identified as politically liberal. In Study 2, participants read a political speech that either reflected on how US was a nation of immigrants or a control speech before answering questions about Mexican immigrants. The pattern of results replicated those in Study 1 in that reading the political speech about immigrants improved participants' attitudes towards immigrants to the extent that they identified as politically liberal compared to conservative.
This research was funded in part by Carleton's Towsley Endowment.

48. **Diffusion Measurement with Transverse Beam Echoes**
Yuan Shen Li '17
Authors/ Contributors: Tanaji Sen, (Scientist, Fermilab)
Summer 2016
Supervisor: Dr. Tanaji Sen (Fermilab)
Diffusion is an important measure of stability in high intensity beams. Traditional methods of diffusion characterization (e.g. beam scraping) can be very time-consuming. In this study, we investigate the transverse beam echo as a novel technique for measuring beam diffusion. Numerical analysis of maximum echo amplitude was compared with theoretical predictions with and without diffusion. We succeeded in performing self-consistent measurements of the linear diffusion coefficient and also demonstrating the effectiveness of pulsed quadrupoles as a means to boost echo amplitude. Results from this study will support planned experiments at the upcoming IOTA ring at Fermilab.

49. **Correction of Hydrogen-α Line Emissions from M33 Using 24μm Infrared Data**
Gaston Lopez '17
Authors/ Contributors: Cindy Blaha (Professor of Physics and Astronomy, Marjorie Crabb Garbisch Professor of the Liberal Arts, Carleton College)
Summer 2016
Supervisor: Cindy Blaha (Professor of Physics and Astronomy, Marjorie Crabb Garbisch Professor of the Liberal Arts, Carleton College)
Energy from ionized hydrogen in space, is emitted in the form of hydrogen-α recombination line emissions (λ = 656

nm). These emissions inform us about the star populations of the Local Group galaxy M33 (Triangulum), particularly its rate of star formation and its development. However, interstellar dust and gas diminish our measurement of the emission flux. In order to account for this extinction due to dust, we can calculate the rate of extinction based on data from other emission sources. My project calculated extinction values from infrared emission fluxes at 24μm, and used them to derive corrected H-α emission flux values. Further analysis of six major H-α emitting-regions found our extinction values effective in accounting for the dust attenuation. The extinction values and corrected emission fluxes provide initial steps towards improving our understanding of star formation by providing knowledge of the interstellar medium.

This research was funded in part by Carleton's HHMI grant.

50. Investigating the Role of the Enzyme TabB in the Biosynthesis of Tabtoxin

Margot Manning '17
Authors/ Contributors: Chris Calderone (Assistant Professor of Chemistry, Carleton College)
Summer 2016
Supervisor: Chris Calderone (Assistant Professor of Chemistry, Carleton College)

Tabtoxin is a natural product produced by the bacterium Pseudomonas syringae pv. tabaci that targets glutamine synthesis in tobacco plants. Its structure consists of a dipeptide of threonine and Tabtoxinine-β-lactam; the tabtoxinine-β-lactam is very similar in structure to the common amino acid lysine. In addition, prior genomic screening has demonstrated that there are genes within the gene cluster for tabtoxin that contain similarities with enzymes involved in the biosynthetic pathway of lysine. The enzyme TabB, involved in the biosynthesis of tabtoxin, closely resembles the enzyme DapD, which acylates the intermediate THDPA in the lysine biosynthetic pathway. Research using spectrophotometric assays has demonstrated that both the enzymes DapD and TabB act as succinyltransferases in the acylation of THDPA. This indicates that the initial steps of tabtoxin biosynthesis are identical to those of lysine biosynthesis, and confirms that THDPA is a precursor to tabtoxin.

This research was funded in part by Carleton's Towsley Endowment.

51. Orientational Disorder in Epitaxially Connected Quantum Dot Solids

Arthur McCray '16
Authors/ Contributors: Ben Savitzky (Cornell University)
Summer 2016
Supervisor: Dr. Lena F. Kourkoutis (Assistant Professor and Rebecca Q. and James C. Morgan Sesquicentennial Faculty Fellow, Cornell University)

Lattices of fused PbSe quantum dots offer interesting possibilities for the manufacturing of films with tunable electronic properties, but theoretically predicted electronic properties are not yet realizable due to disorder in the films. Using STEM imaging techniques we analyze the orientational component of the disorder in these lattices. We characterize the misalignment between each dot's atomic lattice and the larger quantum dot superlattice as well as the atomic lattices of its neighbors. We find that the superlattice structure near highly misoriented dots is more disordered than in other parts of the lattice, and that individual dots prefer to align to the orientation of their neighbors rather than the superlattice. Furthermore, dots that are aligned well in the plane of the film occur in well-organized lattice sections, while a statistically significant fraction of dots which are misoriented from the film plane in two directions occur in and around more disorder in the lattice.

52. Exploring Growth Conditions of Eu-rich Europium Monoxide in High-vacuum Environments

Alexander McMurtry '17
Authors/ Contributors: Andrew Maris '19, Alexander McMurtry '17, Melissa Eblen-Zayas (Director, Perlman Center for Learning and Teaching, Associate Professor of Physics, Humphrey Doermann Professor of Liberal Learning, Carleton College)
Summer 2016
Supervisor: Melissa Eblen-Zayas (Director, Perlman Center for Learning and Teaching, Associate Professor of Physics, Humphrey Doermann Professor of Liberal Learning).

The broad applications of correlated electron materials present a valuable avenue of research, however their unstable nature oftentimes creates difficulties for researchers. Our work focused on fine tuning growth parameters of

the vapor deposition process used to create one such correlated electron material, non-stoichiometric europium monoxide (EuO1-x). Europium vapor was mixed with low-pressure oxygen in a high vacuum chamber (approximately 1x10-8 Torr) at high temperatures to grow samples on a polished silica substrate. Oxygen partial pressures and deposition rates were calibrated and varied to achieve non-stoichiometric EuO growth. Despite attempts to control growth conditions, several samples shown in this poster have non-uniform compositions. Resistivity measurements in a cryostat and x-ray diffractometry data provide insight into the differing composition grown over the course of summer 2016.

53. **Construction and Testing of an Inexpensive Spin Coater**
Keaton Mertz '19
Authors/ Contributors: Steven Drew (Charles "Jim" and Marjorie Kade Professor of the Sciences and Chemistry, Carleton College), Thomas Baraniak (Electronics & Laboratory Manager in Physics & Astronomy Instrumentation Electronics Specialist for the Sciences, Carleton College), Mark Zach (Instrument Project Manager, Carleton College), and Alex Battiste, 19'
Summer 2016
Supervisor: Steven Drew (Charles "Jim" and Marjorie Kade Professor of the Sciences and Chemistry, Carleton College)
Methylamonium lead halide (MALH) perovskite solar cells have recently gained a lot of attention as a possible future for commercial solar technologies. Unfortunately, the specialized equipment used to construct these solar cells is not within the means of most undergraduate institutions. The goal of this project is to assemble an inexpensive spin coater that can produce the thin uniform layers in the MALH perovskite solar cell. First, the circuitry need for the spin coater was designed and tested; then, the structure of the spin coater was designed in a 3D modeling program and constructed in the machine shop. The spin coater produced was inexpensive and capable of achieving the required speeds and reliability for inexpensive MALH perovskite solar cell construction. The next step is to test the spin coater in the construction of a MALH perovskite solar cell.
This research was funded in part by Carleton's Towsley Endowment.

54. **Characterization of Organic Thin Film Transistors**
Yuheng Miao '19
Authors/ Contributors: Sui-Dong Wang (Soochow University), Jie Liu (Soochow University), Chao Xu (Soochow University)
Summer 2016
Supervisor: Sui-Dong Wang (Soochow University)
Organic thin film transistors (OTFTs) are prospective electronic devices with a wide range of applications in fields like sensors, circuits, flat-panel displays, etc. The organic materials enable OTFTs to be flexible, wearable, portable and cost-effective so that they can be widely manufactured and used. In this project, a standard p-type OTFT was investigated and the device performance and I-V relationship of this OTFT were analyzed. Fluctuations of calculated mobilities of pentacene are observed and reasons for this phenomenon were explored. Although the device performance implied interesting behavior of pentacene in air and doping effects of organic materials, further exploration is needed to fully understand the performance of these devices.

55. **MAP-ping Land Occupation in Border Regions of Ancient Greece: Mazi Archaeological Project 2016**
Julia Miller '18
Authors/ Contributors: Alex Knodell (Assistant Professor of Classics, Co-Director of Archaeology, Carleton College), Chloe Bergstrand '16 (Educational Associate: STEM FOCUS Coordinator) , Alex Claman '17, Liza Davis '16, and teams from Texas Tech University, Brown University, University of Switzerland Geneva, and University of Nebraska-Lincoln.
Summer 2016
Supervisor: Alex Knodell (Assistant Professor of Classics, Co-Director of Archaeology, Carleton College)
This summer Alex Claman and I worked as student research assistants on the 2016 summer field season of the Mazi Archaeological Project in the Attic region of Greece, an ongoing study led by Alex R. Knodell (Carleton College), Sylvian Fachard (University of Geneva), and Kalliopi Papangeli (Greek Ministry of Culture). The project

uses survey archaeology methods to examine diachronic occupation and land usage in the area of the Mazi Plain, a valley on the border between ancient Attica and Boeotia (regions within Greece). This field season the project found a lot of useful diagnostic pottery, tile and lithic remains and started to map several Neolithic and Late Roman to Byzantine settlement areas.

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

56. Surprises in the Semiclassical-Classical Transition of Lyapunov Exponents

Moses Misplon '17

Authors/ Contributors: Arjendu Pattanayak (Professor of Physics, Carleton College)

Summer 2016

Supervisor: Arjendu Pattanayak (Professor of Physics, Carleton College)

We simulate the chaotic behavior of a semiclassical model of a quantum driven double-well Duffing oscillator. We consider the transition from semiclassical to classical behavior as the system scale parameter increases, with the scale invariance of the system's chaotic behavior (as measured by finite-time Lyapunov exponents) as our criterion for classicality. For different system parameters, we find diverse transition behaviors and critical scales, which do not exhibit any correlation with the known characteristics of the system, including measures of chaos in the classical and quantum limits. This contradicts assumptions and results of previous less detailed analyses.

57. Influence Numbers of Path and Grid Graphs

Sonia Moreno '19

Authors/ Contributors: Cyrin Ann Geluz (UCSD) '19, Monique Roman (Iona College) '18, Madison Jones (St. Mary's College of Maryland) '18

Summer 2016

Supervisor: Alan Jamieson (St. Mary's College of Maryland), Lindsay Jamieson (St. Mary's College of Maryland)

The influence number of a graph is a recent concept developed by computer scientists Daugherty, Lyle, and Laskar. It has applications in many areas including viral marketing, transmitters and receivers, and social networking. Two useful tools in such applications are the maximum influence number and the minimaximal influence set. These concepts allow us to maximize the amount of influence that one element of a particular set has on the other elements. For instance, we may want to maximize the signal strength that is sent from one source to another, perhaps while minimizing the size of the original source. Our findings show algorithms and equations to compute these values for path and grid graphs.

This research was funded in part by Carleton's HHMI grant and NSF-LSAMP grant.

58. Examining Traditional Medicinal Practices in Ethnic Villages of Northern Thailand and Southern Laos

Jeanne Moua '17

Authors/ Contributors: Deborah Gross (Professor of Chemistry, Carleton College), Keri Asp (Program Director of Career Counseling, Carleton College)

Summer 2016

Supervisor: Deborah Gross (Professor of Chemistry, Carleton College)

To understand practices of folk healing and medicinal plant usages, I traveled to Chiang Mai and Chiang Rai, Thailand as well as Vientiane, Laos for two months to study the usage of medicinal plants in folk healing practices in several Hmong, Karen, and Lisu villages. Isolated ethnic villages near mountainous terrains were found to heavily rely on herbal remedies as well as other folk healing practices such as Shamanism. There, parts of plants such as peppermint, turmeric, longevity spinach, fishwort, and many other herbs are used to treat natural ailments. Inaddition to herbalism, holistic healing was practiced in several ethnic villages as a way for community bonding and balancing health. By talking to traditional medicinal practitioners and village inhabitants, I hoped to create discussions of the intergration of western and alternative forms of medicine that spiritually, mentally, and physically have healed these societies.

This research was sponsored in part by the Professor Roy Grow Fellowship.

59. **Conflict and Collaboration in Crown Heights, New York: Gentrification and the Inescapable Past**
Josie Naron ’18
Authors/ Contributors: Pamela Feldman-Savelsberg (Broom Professor of Social Demography and Anthropology, Carleton College)
Summer 2016
Supervisor: Pamela Feldman-Savelsberg (Broom Professor of Social Demography and Anthropology, Carleton College)
My research examines gentrification and perceived loss of community in Crown Heights, New York, with regards to the impact of the historical on the contemporary. Within a neighborhood divided for decades by implicit lines of race and religion, contextualizing prior cycles of development, disinvestment, and displacement places the community's current housing crisis and identity politics in a nuanced historical framework. Though historical, racialized unrest within Crown Heights Chasidic, Caribbean, and White communities such as the 1991 race riots has been forgotten in the public transcript of neighborhood relations, the impact of such events reverberates across decades. Modern instances of coded conflict and collaboration, particularly in the context of housing, complicate an image of a neighborhood often reduced in the public imagination to a flashpoint of racial and religious tension.
This research was sponsored in part by the Class of 1963 Fellowship.

60. **Testing the Effects of Isoliquiritigenin and 4'-Hydroxychalcone on Osteoclast Differentiation**
Justin Nathan ’17
Authors/ Contributors: Aaron Broege (Visiting Assistant Professor of Biology, Carleton College), Sam West '16, and Ryann Shor '17
Summer, 2016
Supervisor: Aaron Broege (Visiting Assistant Professor of Biology, Carleton College)
Osteoclasts are bone-resorbing cells that maintain bone strength and ion homeostasis. Osteoclasts are vitally important in sustaining healthy bone, but they can become overactive in diseased states, such as osteoporosis or cancer metastasis. Thus, a thorough understanding of osteoclastogenesis is of great interest. Bone morphogenic protein (BMP) signaling has been shown to enhance RANKL-mediated osteoclastogenesis. Recently, Vrijens et al. identified two synthetic molecules, isoliquiritigenin and 4-hydroxychalcone, that activate BMP signaling in C2C12 cells. In the current study, we are testing whether these molecules enhance RANKL-mediated osteoclastogenesis. We induced osteoclast differentiation of primary murine bone marrow cells in conjunction with different concentrations of isoliquiritigenin and 4'-hydroxychalcone. Osteoclast differentiation was assessed by TRAP staining, and activation of the SMAD and MAPK pathways was assessed by western blot. Preliminary results indicate that isoliquiritigenin and 4'-hydroxychalcone inhibit osteoclastogenesis and MAPK signaling, suggesting that these molecules function differently in primary osteoclast cultures than in C2C12 cells.

61. **Investigating Hydroxylation Strategies in Bleomycin Biosynthesis**
Phuong Nguyen ’18
Authors/ Contributors: Chris Calderone (Assistant Professor of Chemistry, Carleton College)
Summer 2016
Supervisor: Chris Calderone (Assistant Professor of Chemistry, Carleton College)
This work is aimed at understanding a predicted hydroxylation reaction catalyzed through ORF1 during the biosynthesis of the anti-tumor drug bleomycin. Through this research, we hope to learn more about the biosynthetic origins of bleomycin, with the ultimate goal of applying this knowledge to synthesize more effective drugs and antibiotics. We cloned the ORF1 gene and overexpressed the corresponding protein. We performed various experiments utilizing high performance liquid chromatography (HPLC) to detect possible hydroxylation catalyzed ORF1. Ultimately, results from HPLC experiments did not demonstrate the predicted hydroxylation, likely due to the isolated protein being inactive. Future work will be focused on re-expressing the protein in its active form.
This research was funded in part by Carleton’s HHMI grant.

62. **Exosomes derived from fibroblasts depleted of Fidgetin-like 2 promote wound regeneration**
Murphy Nosanchuk '19
Summer 2016
Supervisor: Murphy D. Nosanchuk, Brian P. O'Rourke, David J. Sharp (Albert Einstein College of Medicine)
The complex process of wound healing is driven by the migration of a different cell types from the periphery of the wound into the wound zone. We previously demonstrated that the microtubule-severing enzyme, Fidgetin-like 2 (FL2), is a fundamental regulator of cell migration. In the present work, we evaluated whether exosomes harvested from fibroblasts subjected to small interfering RNA (siRNA) to Â FL2Â were able to promote wound closure and regeneration. Application of exosomes from FL2siRNA-treated cells induced fibroblast migration in tissue culture compared to untreated cells. In a murine injury model, treatment of excisional wounds with exosomes derived from FL2siRNA-treated cells significantly accelerated healing compared to control-treated wounds. Taken together, these results suggest that exosomes derived from FL2siRNA-treated cells participate in the process of wound regeneration, providing an additional mechanism in the efficacy of FL2siRNA and further expanding the promise of targeting this microtubule-severing enzyme as a therapeutic. Studies are currently underway to assess the proteomic changes in FL2siRNA-derived exosomes compared to control exosomes.

63. **Air-sea interactions in the Southeast Pacific: Mooring, ship, and float observations**
Sarah Ogle '19
Authors/ Contributors: Veronica Tamsitt (Scripps Institution of Oceanography), Lynne Talley (Scripps Institution of Oceanography), Sarah Gille (Scripps Institution of Oceanography), Sebastien Bigorre (Woods Hole Oceanographic Institution)
Summer 2016
Supervisor: Lynne Talley (Scripps Institution of Oceanography)
The atmosphere interacts with the ocean through a number of mechanisms. For example, shortwave radiation heats the surface waters, wind-driven turbulence inputs momentum to the upper ocean, and precipitation freshens the surface layer. These processes are especially challenging to measure in the Southern Ocean due to its severe storms. The Ocean Observatories Initiative (OOI) air-sea flux mooring, deployed in February 2015 at 55°S,90°W, provides the first extended time series of upper ocean measurements from the southeast Pacific. This poster focuses on heat fluxes and the effect of meteorological events on the surface ocean at the OOI mooring. The ERA-interim, OAFlux, NCEP, and the Southern Ocean State Estimate flux products are compared to data from the OOI mooring and from the December 2015 OOI deployment cruise on the R/V Palmer in the southeast Pacific.

64. **Site-directed Mutagenesis of ECF RpoE in Escherichia coli Using the no-SCAR CRISPR Protocol**
Kira Patterson '18
Authors/ Contributors: Carol Gross (Principal Investigator, UCSF), Horia Todor (Postdoctoral Researcher, UCSF), Natalie Baggett (Graduate Student, UCSF)
Summer 2016
Supervisor: Carol Gross (Principal Investigator, UCSF), Horia Todor (Postdoctoral Researcher, UCSF), Natalie Baggett (Graduate Student, UCSF)
Prokaryotic transcription is dependent on efficient binding of RNA polymerase to the promoter regions of genes. Sigma factor proteins, which associate with RNA polymerase to form the holoenzyme, are responsible for recognizing these promoter regions and initiating transcription. Alternative sigma factors (ECFs) are a subset of sigma factors that initiate the transcription of genes used in cellular stress responses. A previous screen of HrpL mutants (belonging to the ECF 32 subgroup in E.coli) revealed the comparable binding ability of lysine and arginine (wild type) at the -31 position in the promoter. To expand this observation in a biological system, the Arg171 position of chromosomal E. coli RpoE was mutated to a lysine residue using the no-SCAR CRISPR method. This mutation will enable a comparison between wild type and mutant RpoE when cells are subjected to stress in order to determine if there is an evolutionary advantage in having arginine at position 171 in the protein.
This research was funded in part by Carleton's Towsley Endowment.

65. **Solidarity in Mistrust: Exploring complex relationships among Salvadoran Immigrants in Milan**
Susie Perez '17
Authors/ Contributors: Constanza Ocampo-Raeder (Assistant Professor of Anthropology, Carleton College), Pamela Feldman-Savelsberg (Broom Professor of Social Demography and Anthropology, Carleton College)
Summer 2016
Supervisor: Constanza Ocampo-Raeder (Assistant Professor of Anthropology, Carleton College)
Since the mid-1970s, the population of Salvadorans in Milan's metropolitan area has increased to more than 40,000. These Salvadorans have become unified through various events and experiences resulting in well-established and organized communities. I have found that although women find clear and organized 'community' and solidarity through church masses, events, and community programming, women also inherently distrust most other Salvadorans. This tension between trust and mistrust contributes to a social hierarchy that aligns with the formal hierarchy within church community organizing, and takes its toll on interpersonal relationships. I aim to delve deeper into the ways relationships among Salvadoran women immigrants either help or hurt them when they really need support. Countering emphasis on the unequivocal advantages of social capital, I investigate if mistrust and the resultant social hierarchy serve as a disadvantage to the women who partake in the Salvadoran community of Milan.
This research was sponsored in part by the Independent Research Fellowship.

66. **New Routes to Group Transfer Reactions Using Low-Coordinate Cobalt**
Paul Peterson '18
Authors/ Contributors: Matt Whited (Assistant Professor of Chemistry, Carleton College)
Summer 2016
Supervisor: Matt Whited (Assistant Professor of Chemistry, Carleton College)
Carbon-nitrogen bonds are ubiquitous in pharmaceuticals and other specialty chemicals, but methods for their preparation are still underdeveloped. Using complexes of cobalt, we are working to develop new methods for constructing highly reactive cobalt-nitrogen multiple bonded species for utilization in C-N bond-forming catalysis. Our principal efforts have focused on silylamines as nitrogen-group donors, and we will present early studies on reactions of disilylamines with β-diketiminate- and bis(phosphine)-supported cobalt. Our preliminary results show limited reactivity with silylamines but suggests numerous further possibilities to catalytically transfer simple groups using reduced cobalt(I) or cobalt(0) complexes.

67. **In-text citations can increase belief in trivia claims**
Riley Phelps '17
Authors/ Contributors: Adam Putnam (Visiting Assistant Professor of Psychology), Riley Phelps '17
Summer 2016
Supervisor: Adam Putnam (Visiting Assistant Professor of Psychology)
Authors use in-text citations to provide support for their claims and to acknowledge work done by others. Do such citations increase the perceived truthfulness of an author's claims? One possibility is that readers (especially novices) might ignore citations as they read; another is that citations effectively serve as evidence for a claim. The latter would justify using them as a basis for a judgment of truth. In five experiments subjects saw true and false trivia claims of varying difficulty presented with and without in-text citations and rated the likelihood that each statement was true. The first four experiments failed to show any effects of in-text citations on truth ratings, but the last experiment revealed that in some contexts, in-text citations can increase the believability of trivia claims. We discuss the conditions necessary for this citation effect and how it differs from similar research showing that nonprobative photos can inflate truthiness ratings.
This research was funded in part by Carleton's Towsley Endowment.

68. **Hereditary vitreoretinopathy research with CRISPR/Cas-9**
Grace Pipes '18
Summer 2016
Supervisor: Dr. Jean-Michel Rozet, PhD, Dr. Isabelle Perrault, PhD, Dr. Lucas Fares Taie, PhD, Dr. Xavier Gerard, PhD
Hereditary vitreoretinopathies (VRPs) are a group of maladies that affect vitreous structure formation and/or the

retina due to a premature stop of vascularization of the peripheral retina. Wagner's disease, a rare autosomal dominant non-syndromic VRP, is characterized by premature degeneration of the vitreous and structural modifications of the vitreoretinal interface leading to chorioretinal degeneration and vision loss beginning in childhood. The syndrome is most commonly the result of a nucleotide substitution in intron 8 of the VCAN gene which leads to exon 8 skipping. This research is the first with evidence of a deletion of exon 8 of the VCAN gene for the syndrome. Rodent animal models of modified VCAN have hitherto failed to produce an abnormal ocular phenotype. This study hopes to produce the first animal model with the syndrome's phenotype by use of CRISPR/Cas-9 technology. This research is ongoing and the methods and work done this past summer will be presented.

69. Crystallization of Gly glycosyltransferase in the SecA2 System
Ernesto Polania-Gonzalez '17
Authors/ Contributors: Yu Chen (Post doctoral member), Tom A. Rapoport (Professor of Cell Biology, Harvard Medical School)
Summer 2016
Supervisor: Yu Chen (Post doctoral member)
Gram-positive bacteria possess SecA2-SecY2 system responsible for the export of select secretary proteins, including virulence factors. We are interested in the mechanism by which a protein is selected by this system instead of the canonical Sec system. Specifically, we are looking at one of the specific steps involving a glycosyltransferase (Gly), which tags a serine-rich region of the protein. The exact mechanism of the Gly protein is subject to debate. Through our analysis, we predict the Gly protein to have two glycosyltransferase domains. However, until an exact structure is determined, Gly will remain a mystery. We decided to take a crystallization approach to confirm whether Gly has two glycosyltransferase domains.
This research was funded in part by the Kolenkow-Reitz Fund for Undergraduate Research.

70. Using ShowerLLH to Determine Interference of Snow on Cosmic Ray Showers in IceTop
Julianne Pyron '19
Authors/ Contributors: Frank McNally (Visiting Assistant Professor of Physics and Astronomy, Carleton College)
Summer 2016
Supervisor: Frank McNally (Visiting Assistant Professor of Physics and Astronomy, Carleton College)
Since December 2010, the IceCube detector at the South Pole has been collecting data on cosmic-ray air showers. During that time, a considerable amount of snow has collected on the surface component of the array, IceTop. The snow affects the electromagnetic component of the air showers, skewing the data and not providing the most accurate information about the showers. By using likelihood methods with IceTop data, we can estimate the core position and primary energy of particle showers. Through simulation, we study how the reconstructed primary energy and core resolution change as a function of true energy or core position. Using these graphs, we can try to correct for the errors caused by snow on top of the detector.

71. T cell activation as a proxy for tumor antigen release: An assay in development
Jackson Raynor '17
Authors/ Contributors: Buck O'Flanagan (Junior Scientist, Shimizu Lab, Center for Immunology, University of Minnesota - Twin Cities)
Summer 2016
Supervisor: Dr. Yoji Shimizu (Distinguished University Teaching Professor, Department of Laboratory Medicine and Pathology Director, University of Minnesota - Twin Cities), Dr. Brandon Burbach (Senior Research Associate, Shimizu Lab, Center for Immunology, University of Minnesota - Twin Cities)
Generating anti-tumor immune responses requires the immune system to recognize and respond to tumor antigens. Tumor cells may be killed using focal techniques such as cryotherapy or heat shock therapy, causing the release of their contents including potential tumor antigens. One such antigen that has been well characterized in melanoma cancers is tyrosinase-related protein 2 (Trp2), a protein involved in melanin biosynthesis. As part of an effort to develop a novel strategy to vaccinate patients using their own tumors, we developed an in vitro T cell-based assay to measure the relative amount of immunogenic Trp2 protein released by different focal therapy strategies. We

identified Flt3L-derived bone marrow dendritic cells (bmDCs) as the most effective antigen-presenting cells to use in this model. This assay will be used in further experiments to identify the focal therapy that releases the most Trp2 protein from melanoma tumors.
This research was funded in part by the Kolenkow-Reitz Fund for Undergraduate Research.

72. Murder in a City of Shadows: Buenos Aires and the social evolution of Argentine detective stories
Jesse Rothbard '17
Authors/ Contributors: Humberto Huergo (Professor of Spanish, Carleton College)
Summer 2016
Supervisor: Yansi Perez (Associate Professor of Spanish, Carleton College)
The detective story genre in Argentina has undergone a vast transformation over the course of the twentieth century from a classic literary tradition centered on pulp entertainment and intellectual diversion to a potent form of social commentary whose authors aim to shatter all conventions and rules of the genre. Centered on Buenos Aires, my research is focused on the narratives and detective stories of three authors who lived in the city during different periods in its history: Roberto Arlt (1900-1942), Rodolfo Walsh (1927-1977?), and Ricardo Piglia (1941-present). Responding to the political and social pressures of the city, these three authors converted the porteo detective novel into a incisive form of criticism of wider modernity, human nature, and political oppression.
This research was sponsored in part by the Richard Salisbury Fellowship.

73. On the Generative Nature of Markov Chains
Josh Ruebeck '17
Summer 2016
Supervisor: Prof. James Crutchfield (Complexity Sciences Center, UC Davis), Ryan James (Complexity Sciences Center, UC Davis), John Mahoney (Complexity Sciences Center, UC Davis)
We present the minimal generators for all binary Markov chains and calculate their generative complexity. While this is in general a non-convex minimization that must be calculated numerically, we are able to find an analytical solution for this particular set of processes. We find that generically, but not universally, processes in this class have strictly less generative complexity than statistical complexity . We then examine other properties of the minimal generators, including their crypticity, oracular information, and gauge information, and compare the minimal generators to minimal predictors. These results, besides being interesting in their own right, also suggest properties of minimal generators that may generalize and aid in finding the minimal generators of more complex processes.

74. Classical and semiclassical vibrational energy harvesting mechanisms in a nonlinear Duffing oscillator
John Scott '18
Authors/ Contributors: Arjendu Pattayak (Professor of Physics Chair of Physics and Astronomy), Moses Misplon '17, Max Trostel '19
Summer 2016
Supervisor: Arjendu Pattayak (Professor of Physics Chair of Physics and Astronomy)
Vibrational energy harvesting is a promising means of recovering energy from random external excitation by coupling these to an electrical harvesting circuit via a mechanical oscillator. We have explored a model bistable vibrational energy harvester in detail to elucidate the dynamical mechanisms which lead to the best performance, especially as it relates to higher energy orbits and chaos. Further, recent advances in nanoelectromechanical systems engineering indicate that such systems could operate at a scale where quantum mechanical effects are non-trivial. Using a semiclassical approximation to quantum state diffusion model, we explore the effects of these quantum effects and find that these can lead to a substantial increase in the efficiency with which the harvester is able to convert energy.
This research was funded in part by Carleton's Towsley Endowment.

75. Effects of APOBEC3B on Breast Cancer Cell Line Sensitivity to Hormone, Targeted, and Chemo-therapy
Kaylee Shiao '17
Authors/ Contributors: Douglas Yee (Cancer Center Director, University of Minnesota), Kelly LaPara (Researcher, University of Minnesota), Anja Holtz '17 (University of Minnesota), Reuben Harris (Professor of Biochemistry, University of Minnesota), Emily Law (University of Minnesota)

Summer 2016
Supervisor: Dr. Douglas Yee (University of Minnesota) and Kelly LaPara (University of Minnesota)
The growth of estrogen-receptor positive breast cancer cells is promoted by estrogen produced by the ovaries and adrenal gland. ER+ breast cancers are difficult to treat when tumor cells develop resistance to standard endocrine therapies and/or chemotherapies. APOBEC3B, or A3B, is a DNA cytosine deaminase suspected to cause mutations in ER+ breast cancer cells and catalyze the genetic changes required for drug resistance and metastasis. The absence of A3B has been linked to enhanced drug resistance in cancer cells. In this study, we analyzed the sensitivity of breast cancer cell line MCF-7L parental cells (H) and A3B knockout clones (H24) to endocrine, targeted, and chemo-therapy drugs 5-fluorouracil (5-FU), palbociclib, and fulvestrant (ICI) over time. We used MTT colorimetric proliferation assays to quantitively compare drug sensitivity and resistance. Our data suggest that the A3B knockout cells are initially less sensitive, but previous data indicates that longer exposure time leads to a higher drug sensitivity relative to control cell lines.

76. Adipose-Derived Stem Cell Population and Function are not Fully Restored When Diabetes is Reversed
Ryann Shor '17
Authors/ Contributors: Melanie Rodrigues (Postdoctoral Fellow, Stanford University), Paul Mittermiller, MD (Research Associate, Stanford University), Geoffrey C Gurtner, MD (Principal Investigator, Stanford University)
Summer 2016
Supervisor: Melanie Rodrigues (Stanford University) and Dr. Goeffrey C Gurtner (Stanford University)
Adipose-Derived Stem Cells (ASCs) have important wound healing properties, including secretion of angiogenesis-supporting growth factors, and have demonstrated therapeutic efficacy in wound healing. ASC populations are depleted in Type 2 Diabetes, but little is known about their status after diabetes has been reversed. Using a diet-controlled diabetic mouse model, we demonstrate that ASC populations do not return in full with diabetes reversal, nor do they have the same beneficial gene expression as ASCs in a normal state. Excisional wound models demonstrate that wound healing speed remains dampened in reverse diabetic state. Combined, these data indicate that ASC populations in reverse diabetic state are neither as prevalent nor as capable in wound healing as ASCs under normal conditions.
This research was funded in part by the Kolenkow-Reitz Fund for Undergraduate Research.

77. Cyclic Transmetalation Mechanism in Stille Cross-Coupling Reactions
John-David Slaugh '17
Authors/ Contributors: Buck Taylor (Visiting Assistant Professor of Chemistry, Carleton College), Elianna Frank '18
Summer 2016
Supervisor: Buck Taylor (Visiting Assistant Professor of Chemistry, Carleton College)
Reactions forming carbon-carbon bonds are highly sought after for their utility in the synthesis of chemically useful compounds. In particular, the Stille cross-coupling reaction uses a palladium catalyst to form a carbon-carbon bond joining two organic fragments. Though the steps involved in the Stille reaction are well understood, the manner in which the new bonds form is relatively unclear. Consequently, the product's stereochemistry from the Stille reaction is not predictable in untested reactions. We attempted to elucidate the factors influencing the outcome of the Stille reaction through the use of a computational method called density functional theory (DFT). By computationally modeling the compounds in the Stille catalytic cycle, we were able to examine how favorable different reaction pathways are in order to gain insight into the predictability of novel Stille reactions. This will allow us to predict the stereochemical outcome of a particular Stille reaction.

78. Aerosol Particle Emissions 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
Supervisor: Deborah Gross (Professor of Chemistry, Carleton College)
Cooking is a source of indoor air pollution that causes negative climate impacts, health problems, and premature death. Ethiopian families use charcoal stoves indoors in both rural and urban areas. While more efficient cook stoves

have been made, they are far too expensive to be practical. The cookstove project seeks to create an affordable stove that will heat efficiently and have reduced emissions. We ran controlled cooking tests and water boiling tests on seven different Top-Lit Updraft stoves. The PM 2.5 concentrations were measured using TSI DustTrak DRX instruments and Aircasting AirBeam instruments inside and outside of an experimental test kitchen and aerosol particle composition measurements were made with a TSI Aerosol Time-of-Flight Mass Spectrometer.
This research was funded in part by Carleton's HHMI Grant and NSF-LSAMP grant.

79. Effects of Cortical Schemas on Memory Trace Competition
Anna Smith '17
Authors/ Contributors: Michael Yassa (Associate Professor, Neurobiology and Behavior, Neurology; Director, Center for the Neurobiology of Learning and Memory, University of California, Irvine) and Zacharaiah Reagh (5th year graduate student, University of California, Irvine)
Summer 2016
Supervisor: Michael Yassa (Director, Center for the Neurobiology of Learning and Memory, University of California, Irvine)
Given the fundamental importance of understanding how knowledge is acquired and transformed in the brain, developing a framework for the implicated processes has both clinical and educational applications. Competitive Trace Theory regards the fate of memories in the hippocampus, a medial temporal structure thought to underlie the binding of features and subsequent indexing of the memory traces. Their previous work found that repeated exposures to a stimulus lead to the degredation of detail memory for everyday objects. This is thought to result from incomplete overlap in activation patterns and competition among those features that were not central to the object. My research amended their behavioral task to investigate whether the same is true for abstract objects (Celtic knots), as they lack a body of prior knowledge with which the memory traces may compete. We hypothesize that more detail will be preserved with multuple exposures. Data collection is still in progress.
This research was funded in part by the Kolenkow-Reitz Fund for Undergraduate Research.

80. The European Migrant Crisis and the Limits of Liberalism
David Soper '17
Summer 2016
Supervisor: Laurence Cooper (Professor of Political Science, Carleton College)
The contemporary debate surrounding the European migrant crisis is principally informed by two liberal thinkers: Immanuel Kant and Thomas Hobbes. Much of the discourse of those supportive of refugee resettlement echoes the sentiments of Kant, with his focus on universal rights. This perspective includes prominent voices in the United Nations and the European Union. Those more critical of refugee resettlement, on the other hand, appeal to a Hobbesian emphasis on state security and sovereignty. In thinking about solutions to the crisis the community is paralyzed between a Kantian ethic of universal hospitality and Hobbesian ethic of security. By promoting notions of international human rights while simultaneously upholding state-centrism and state-sovereignty, liberalism necessarily produces this tension. Various premodern and postmodern thinkers offer alternative ways of understanding the state. These perspectives leave greater room for reinterpretation and are more useful when thinking about solutions.
This research was sponsored in part by the Dale and Elizabeth Hanson Fellowship in Ethics.

81. Dynamics of Phase Transition in Affordances of Ball Transporting Task
Laura Soter '17
Authors/ Contributors: Anthony Chemero (Professor of Psychology and Philosophy, University of Cincinnati), Patric Nordbeck (Graduate Student, University of Cincinnati)
Summer 2016
Supervisor: Anthony Chemero (Professor of Psychology and Philosophy, University of Cincinnati)
This research project, directed by University of Cincinnati graduate student Patric Nordbeck, focuses on the dynamics of phase transition between two stable states of task affordances. The task required participants to transport plastic balls from a staging area into a box across the room, constrained by regularly increasing or decreasing time intervals. In order to successfully complete the task, participants had to transition at some point

from walking/running the balls into the target box to throwing them as the speed intervals decreased (or the reverse, as it increased), to accommodate changing affordances. People's transition patterns showed patterns of critical point transitions, gradual shifts, and hysteresis. All these patterns are contained in the cusp catastrophe model, x=x3-bxa. Further analysis is needed to determine what defines the b variable, although the researcher predicts it will incorporate motivation and ability.

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

82. A Role for Ubc13 in Facilitating Accurate Macrophage Responses to Micro–environmental Signals

Malavika Suresh '18

Authors/ Contributors: Dr. Stephanie Watowich (Professor, Department of Immunology, The University of Texas MD Anderson Cancer Center), Dr. Huiyuan Zhang (Instructor, University of Texas MD Anderson Cancer Center), Emily Hillmer '15

Summer 2016

Supervisor: Dr. Stephanie Watowich (University of Texas MD Anderson Cancer Center)

Macrophages adopt a spectrum of phenotypes in response to local micro-environmental cues. These phenotypes range from M1, immunostimulatory macrophages, and M2, immunomodulatory macrophages. TAMs, tumor associated macrophages, adopt an M2 polarized phenotype, reflecting the immunosuppressive conditions that are most conducive to and present in tumor development. This study investigated the role of a protein, Ubc13, in regulating M2 polarization, and whether its suppression could lead to the M2 skewing of TAMs. When treated with LPS (M1 polarizer) and IL-4 (M2 polarizer), the resulting data showed a skewing of macrophage polarization opposite to that expected for each stimulant. This suggests that Ubc13 is involved in both the M1 and M2 polarization pathways, and that its suppression inhibits macrophages from reacting appropriately to local cues (LPS and IL-4). Future studies will focus on further clarifying the role of Ubc13 in tumor-associated macrophages and on means to reverse intra-tumor immunosuppression.

83. The Itinerary as Map: from the Alps to the Apennines in the 14th Century

Bard Swallow '18

Authors/ Contributors: Victoria Morse (Professor of History, Carleton College)

Summer 2016

Supervisor: Victoria Morse (Professor of History, Carleton College)

Professor Morse and I wanted to find out how people thought about space before the map craze in northern Italy in the 14th century. To investigate this, we read the Chronicle of Parma, identifying passages concerned with space, and find the most powerful strategies for describing spatial relationships. Like the Classical author Livy, the author of the Chronicle of Parma uses Latin to build itineraries, lists of places along a route. The itinerary form stresses human movement as the main paradigm for thinking about space. For the chronicler, however, itineraries are powerful enough that the language of itineraries bleeds over into realms that don't involve human movement. The itinerary form, whether describing human movement or not, provides a framework for our author in mapping ideas and events onto space.

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

84. Astrocyte-neuron communication in a PD mouse model

Ka Thao '17

Authors/ Contributors: Jack Reynolds-Clarkson '17, Ana Covelo (Post-doctoral Associate), Michael Lee (Professor, Department of Neuroscience, University of Minnesota), and Alfonso Araque (Professor, Department of Neuroscience, University of Minnesota)

Summer 2016

Supervisor: Ana Covelo (Post-doctoral Associate) and Alfonso Araque (Professor, Department of Neuroscience, University of Minnesota)

Parkinson's Disease (PD) is the second most common neurodegenerative disease in elderly populations. A hallmark of PD is accumulation of α-synuclein proteins in groups termed Lewy Bodies (LB). The function of α-synuclein is not known, but it is suggested to play a role in vesicular release. In PD, LB of α-synuclein disrupt vesicular release and lead to an inhibition of neurotransmitter release and selective neuronal cell loss. Recently, astrocytes have been

found to directly communicate with neurons during neuronal communication. We are investigating the astrocyte-to-neuron signaling activity that may be altered during pre-symptomatic pathogenesis of PD. We use a murine model that expresses a PD familial-associated mutated α-synuclein, A53T, and shows late onset progressive PD. We use Ca^{2+} sensitive indicators to detect intrinsic astrocytic Ca^{2+} oscillations and neuronal patch clamping to record direct astrocyte-to-neuron signaling in hippocampal, dorsal striatal, and somatosensory cortical slices of PD mice and their wild type littermates. We found that there are more Ca^{2+} oscillations in astrocytes and more slow-inward currents in neurons of transgenic mice, indicating that gliotransmission and astrocyte-to-neuron communication is increased in PD mouse model.

This research was funded in part by Carleton's HHMI grant.

85. Vesicle Characteristics of Glaciovolcanic Pillow Lavas from Undirhliar, SW Iceland

Anna Thompson '17

Authors/ Contributors: Michelle Orden '17 (Dickinson College), Ben Edwards (Associate Professor of Geology, Dickinson College), Meagen Pollock (Associate Professor of Geology, College of Wooster), Cameron Davidson (Professor of Geology, Carleton College), Cara Lembo '17 (Amherst College), Chloe Wallace '17 (College of Wooster), Benjamin Kumpf '18 (College of Wooster), Rachel Heineman '17 (College of Wooster), Carl-Lars Engen '17 (Beloit College)

Summer 2016, and ongoing

Supervisor: Ben Edwards (Associate Professor of Geology, Dickinson College), Meagen Pollock (Associate Professor of Geology, College of Wooster) and Cameron Davidson (Professor of Geology, Carleton College)

Pillow lavas are one of the most abundant lava morphologies on Earth, but are relatively inaccessible because of their submarine or subglacial eruption environments. Our research location in a former rock quarry in southwest Iceland provides a unique opportunity to view cross-sections through thousands of well exposed pillow lavas on land. From detailed analysis of exposed pillow cross sections, we have begun to identify the defining characteristics of vesicle rings, and hypothesized what they tell us about the environment during their emplacement. Our initial observations indicate that vesicle rings contain, on average, larger vesicles, a greater proportion of vesicle to rock, and vesicles that are less circular. These pillow lavas are the only lasting record of a preexisting englacial lake presumably formed during the eruption of the lavas, so understanding the details of their textures may provide new insights into the hydrology of the enclosing ice.

86. Creating a Microhabitat to Increase Squash Bug Parasitism

Madeline Topf '18

Summer 2016

Supervisor: Dr. Mary Cornelius (USDA-ARS)

Squash bugs (*Anasa tristis* and *Anasa Armigera*) are a major pest of straightneck squash (*Curcurbita pepo*). We propose that these pests can be controlled by inducing a microhabitat which attracts squash bug parasitoids *Trichopoda pennipes* and *Gyron pennsylvanicum*, as there is evidence that the use of buckwheat as a living mulch in squash fields can increase parasitoid populations. Field tests were conducted to determine if planting a buckwheat border around squash fields would significantly increase rates of adult squash bug and egg parasitism.

87. Computational Studies of Metal-Catalyzed Hydrogenation and CO_2 Activation

Michael Trenerry '17

Authors/ Contributors: Buck Taylor (Visiting Assistant Professor of Chemistry, Carleton College), Matt Whited (Assistant Professor of Chemistry, Carleton College), Kate DeMeulenaere '17.

Summer 2016

Supervisor: Buck Taylor (Visiting Assistant Professor of Chemistry)

Laboratory experiments are the most direct way of monitoring a chemical reaction, but in many cases provide limited insight into how and why the observed products are formed. Computational models, such as density functional theory (DFT), can help fill this void by elucidating the full reaction mechanism, or the steps that lead from reactants to products.

In collaboration with the Whited lab, we have used DFT to investigate the viability of several possible mechanisms for H_2 and CO_2 activation reactions performed in previous laboratory experiments using rhodium-silicon pincer

complexes. We have demonstrated that H_2 activation and catalytic hydrogenation of norbornene can occur by two competitive mechanisms that are now being probed by experiments. In a separate reaction, CO_2 activation has been shown to yield a siloxide carbonyl. Computations reveal that the reaction occurs via a (2+2) cycloaddition between rhodium, silicon, and CO_2. The full mechanism is the subject of ongoing computational and experimental studies.

88. Chaos in the Quantum to Classical Transition
Maximillian Trostel '19
Authors/ Contributors: Arjendu Pattanayak (Professor of Physics, Carleton College), Moses Misplon '17, and John Scott '18
Summer, 2016
Supervisor: Arjendu Pattanayak (Professor of Physics, Carleton College
The behavior of certain small mechanical devices can be modeled using the damped driven double-well Duffing oscillator. As these devices are made smaller in the laboratory, the question of how the behavior changes as quantum effects become more important is of fundamental and practical interest. We measure the level of chaos in simulated trajectories of the Duffing oscillator by numerically finding Lyapunov exponents across various values for Äf (an effective Planck's constant, which determines the quantumness of the system) and three other system parameters, driving strength, driving frequency, and damping. We find that increasing the level of quantumness from the classical limit Äf causes some classically stable regions in parameter-space to become chaotic semiclassically. This trend then reverses, so that trajectories become universally stable nearing the fully quantum system Äf.
This research was funded in part by Carleton's Towsley Endowment.

89. Investigating the Effects of Compost Tea on Nutrient Cycling on an Organic Blueberry Farm
Emma Velis '17
Authors/ Contributors: Emma Velis '17, Daniel Hernandez (Associate Professor of Biology), Aaron Wills, Delaney Vail '16
Summer 2016
Supervisor: Daniel Hernandez (Associate Professor of Biology)
Organic farmers are particularly interested in finding effective alternatives to inorganic fertilizer and manure for crop fertilization. Compost tea, a suspension of compost in water, is often described as having the ability to improve soil health. However, little research has assessed the effects of compost tea on soil nutrient cycling and plant tissue chemistry. We investigated the use of compost tea as a soil amendment applied directly to soil on an organic blueberry farm in Waterford, MN. In summer 2016, we brewed compost tea using several different methods, including heating, aeration, and control treatments, and applied it to blueberry plants at the farm. We are currently measuring soil microbial activity and leaf chemistry to assess the ecosystem consequences of the addition of compost tea and the use of different production methods.

90. Workhouses: Expectations of the English Poor
Alex Wachino '18
Authors/ Contributors: Susannah Ottaway (Professor of History, Carleton College), Madison Chambers '18
Summer, 2016
Supervisor: Susannah Ottaway (Professor of History, Carleton College)
Spinning skeins of worsted was a common work task of paupers living in the houses of industry surrounding Norwich. Paupers would be responsible for converting the raw fibers into yarn using spinning wheels and other machinery. Our research involved collecting data from account books that a number of workhouses kept in order to record weekly production and earnings at the institution. These documents provide a clear record of how much work was being completed by people of different genders and ages, allowing one to draw conclusions on how expectations for work might have differed for distinct groups. Our research and paper seek to understand the importance of labor within the workhouse, finding that workhouses were driven by profit rather than moral reform for the poor.

91. Elegit: Helping Students Learn Git
Eric Walker '17
Authors/ Contributors: Julia Connelly, '18, and David Musicant (Professor of Computer Science, Carleton College)
Summer 2016
Supervisor: David Musicant (Professor of Computer Science, Carleton College)
Version control systems are crucial tools for computer scientists, and the need for students to be fluent in them is well-recognized. However, Git and other version control systems (VCSs) are difficult to learn and use. We detail a new Git client that we created to help students learn how Git works while using it. We have a primary goal of helping students who use Elegit learn about how Git works in its own native way. We preserve standard Git terminology wherever possible, and place a high priority on not modifying the standard Git model. Simultaneously, we strive to make Elegit easy for beginners to use. We report on the process of designing the tool to do this, evaluation of the effectiveness of the tool, and improvements made based on this evaluation. We also discuss enhancements made based on our own learning of Git while developing the application.
This research was funded in part by Carleton's Towsley Endowment.

92. Redox Reactivity of Nickel(I) Silylamides
Xinran Wang '17
Authors/ Contributors: Matthew T. Whited (Assistant Professor of Chemistry, Carleton College)
Summer 2016
Supervisor: Matthew T. Whited (Assistant Professor of Chemistry, Carleton College)
Carbon-nitrogen bond formation is a useful and necessary process for drug discovery and organic synthesis. Nickel complexes have been shown to transfer nitrene groups to organic substrates through a nickel imido (Ni=NR) intermediate, but the reactivity of the relevant species precludes catalysis. We have worked to access these imido complexes via nickel silylamides, where the silyl substituent attenuates reactivity until deprotection during catalysis. Our recent studies have focused on one-electron oxidation of the silylamide complex using a variety of oxidants, and characterizing the products via NMR and crystallographic studies. While the crystallographic studies have so far been inconclusive, we have determined that we can use other techniques to characterize these oxidized products and efforts are underway to explore their reactivity.

93. LP-based Approximation Algorithms for s-t Path TSP
Shatian Wang '17
Authors/ Contributors: Dr. Joseph Cheriyan (Professor, University of Waterloo)
Summer 2016
Supervisor: Dr. Joseph Cheriyan (Professor, University of Waterloo)
The metric s-t path TSP is an important variant of the Traveling Salesman Problem. Given a complete graph with metric edge costs and two fixed vertices, s and t, the metric s-t path TSP asks for a min-cost Hamiltonian path from s to t. Since this problem is NP-hard, researchers resort to using approximation algorithms to approximate the exact optimal paths. The Christofides algorithm (1976) for the metric TSP can be extended to approximate the s-t path TSP, which results in a 5/3-approximation algorithm (Hoogeveen 1997). 5/3 was the best approximation ratio until An, Kleinberg and Shmoys (2012) used an LP-based algorithm, the randomized Christofides algorithm, to achieve an approximation ratio of 1.618. Our research focused on learning various LP-based approximation algorithms for the s-t path TSP and applying them to approximate solutions to the more general connected T-join problem.
This research was funded in part by the Kolenkow-Reitz Fund for Undergraduate Research.

94. Methods for Inferring Consensus Across Tumor Phylogenetic Histories
Allie Warren '17
Authors/ Contributors: Layla Oesper (Assistant Professor of Computer Science, Carleton College)
Summer 2016
Supervisor: Layla Oesper (Assistant Professor of Computer Science, Carleton College)
Tumors develop through an evolutionary process where mutations arising over time create distinct subpopulations of cells within a single tumor. Current computational research has produced many methods to infer the composition and phylogenetic history of tumors, but modeling this complexity is an uncertain process. Some methods produce

multiple possible tumor phylogenies. Furthermore, different computational approaches can produce contradicting phylogenies for the same dataset. Combining information across multiple tumor phylogenies may allow us to identify a phylogeny that better represents the true evolutionary history of the tumor. We formalize this problem as the Tumor Phylogeny Consensus Problem and propose two approaches to solve this problem. The first approach creates a phylogeny consisting of the ancestral and clustering relations found in the majority of input trees. The second approach uses a Markov Chain Monte Carlo method to explore the space of possible tumor phylogenies and identifies the phylogeny with minimal distance to the input trees. In tests with low variability simulated data we find that both consensus methods better approximate the true tree, in terms of topology and clustering, than the majority of input trees.

95. Effects of Promoter Deletions on Gene Expression in *C. elegans* Male Ventral Cord Neurons
Andrew Wheeler '18
Authors/ Contributors: Delroy Mangal '19, Jennifer Wolff (Associate Professor of Biology, Carleton College), Haley Abbot '16, Lori Barrientos-Sanchez '18, Anais Boyd '16, Sandy Carson '18
Summer 2016
Supervisor: Jennifer Wolff (Associate Professor of Biology, Carleton College)
Caenorhabditis elegans is a free living nematode and important model organism for biological research. We are interested in the development of sex specific neurons in male *C.elegans*. Previous research has shown that the ventral cord neurons in males are divided into three regions of differing gene expression defined by the Hox gene transcription factors LIN-39 and MAB-5. The neuronal reporters tph-1::mCherry, flp-21::gfp, and flp-22::gfp have characteristic expression patterns in the three regions.
To better understand the regulation of these reporter genes, we created several deletion constructs by cutting out different promoter regions using restriction enzymes. We then observed differences in reporter gene expression in the absence of these promoter regions. Our hope is to narrow down important segments of the promoter of these genes and identify transcription factor binding sites. Eventually this could provide detailed information about gene regulation in male.

96. Luminosity Function and Faint Regions in M31
Nyla Worker '19
Authors/ Contributors: Cindy Blaha (Professor of Physics and Astronomy, Marjorie Crabb Garbisch Professor of the Liberal Arts, Carleton College), Daniel Kupetsky, '19, Galen Moller, '18
Summer 2016
Supervisor: Cindy Blaha (Professor of Physics and Astronomy, Marjorie Crabb Garbisch Professor of the Liberal Arts, Carleton College)
We categorized faint HII regions in M31 in order to explore the galaxy and its content. By processing and analyzing H-alpha emissions from the galaxy as captured in images taken by the Kitt Peak National Observatory, we found the relative H-alpha flux values for faint regions of interest and compared these values with known standards to group the region into one of several categories of astronomical objects. Using this collection of faint region luminosities, we generated a luminosity function exclusively for the faint regions of M31. The function suggested that the majority of the galaxy's faint regions had luminosities around 10^35.7 ergs per second. We also began exploring ways to automatize the identification of HII regions using the program SExtractor. Results were inconclusive, but the software shows promise for future research.

97. Breathe Happy: β-Cyclodextrin Complexes as Potential Indoor Air Pollutants
Panhia Yang '17
Authors/ Contributors: Deborah Gross (Professor of Chemistry, Carleton College), Michael McClellan '13, Elizabeth Grubb '17, Jackie Dowling '17, Ernesto Polania-Gonzalez '17, Clarissa Smith '19
Summer 2016
Supervisor: Deborah Gross (Professor of Chemistry, Carleton College)
A new line of 'odor-eliminating' air fresheners relies on the sugar β-cyclodextrin to encapsulate pollutant molecules and render them scent-free. However, not much is understood about the sugar-pollutant complex or the possible health effects that it poses. Using aspirin as a model pollutant, we examined the sugar-pollutant interaction using

electrospray ionization-mass spectrometry (ESI-MS) techniques. We then began to characterize the complex in real world conditions using aerosol time-of-flight mass spectrometry (ATOFMS).

98. Detecting and Locating Whole Genome Duplications on Cancer using Integer Linear Programming
Qimeng Yu '18
Authors/ Contributors: Layla Oesper (Assistant Professor of Computer Science, Carleton College)
Summer 2016
Supervisor: Layla Oesper (Assistant Professor of Computer Science, Carleton College)
Tumor genomes are often highly rearranged. In fact, recent studies suggest that tumors may often undergo whole genome duplication (WGD) events at some point during their evolution. This research aims to investigate how WGD events may reliably be detected from DNA sequence data. Here we consider a related mathematical problem where we are given partial information about the history of the tumor and present an Integer Linear Programming approach to infer genomic aberrations, including WGD events, that occurred during the tumor's evolution. On small simulated datasets our approach successfully identifies 99.96% of simulated tumor histories without WGD events, and correctly detects and locates WGDs in 96.04% of simulations with one WGD event. While the accuracy of our method decreases as the size and complexity of the dataset grows, it has the potential to reveal important insights about the evolutionary history of a tumor.

99. Ru(II) chemistry: Modification of the silyl donor
Jia Zhang '18
Authors/ Contributors: Matt Whited (Assistant professor of Chemistry, Carleton College), Binh Nguyen '16
Summer 2016
Supervisor: Matt Whited (Assistant professor of Chemistry, Carleton College)
As part of a broader project exploring reactivity of metal-silicon bonds in silyl-pincer supported complexes, we have prepared a series of such complexes at ruthenium with increasing silylene (Ru=Si) characteristics: hydrosilyl, triflatosilyl, ether stabilized, and base free species. These complexes are unusual not only because of the double bond character between Si and Ru, but also because of the potential to activate small molecules such as H_2 and CO_2. Spectral data were collected, and X-ray crystallography results for hydrosilyl and triflatosilyl complexes were obtained. We have also found that the base-free silylene complex reacts readily with CO_2 and CS_2, likely to produce a formatosilyl complex (or its sulfur analogue), whereas the ether stabilized silylene is not reactive with these substrates. For the future, more spectral data are needed to confirm the proposed structure of CO_2/CS_2 products, and crystals will be grown for X-ray analysis.

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