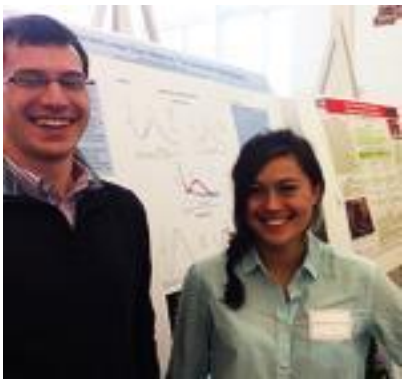


Carleton College
Student Research Symposium and Celebration

October 23, 2015

3:30-5:30 PM

Weitz Center for Creativity


October 23, 2015

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

Adrenergic Stimulation of Dorsal Crest Erection in Male "Anolis" Lizards
Ademi, Besim '16
Authors/Contributors: Matt Rand (Professor of Biology, Carleton College), Amanda d'Almeida '17
Summer 2015

Supervisor: Matt Rand (Professor of Biology, Carleton College)

Male lizards of the Anolis genus have the capability to erect a ridge of tissue along their neck and spine during aggressive encounters with other males. However, the underlying physiological mechanism and regulation of these crests remains unknown. Our previous research has successfully induced a crest through general beta and specific beta-2 adrenergic pathways. Most recently, we focused on unraveling the intracellular mechanism leading to crest erection through a variety of pharmaceutical experiments and also tried to locate the beta receptors with immunohistochemistry. We found that NKH-477, a hydrogen chlorine analog of forskolin, was systemically and locally successful in inducing a crest, suggesting that an increase of cAMP levels is involved in crest formation. After testing two distinct antibodies on the Anolis tissue, though, we were unable to locate beta receptors in the crest organ.

Blocking Notch to Determine the Cause of Squamous Cell Carcinoma
Amagai, Saki '18
Authors/Contributors: Dr. John Seykora (Perelman School of Medicine), Hiroshi Maeno,
Summer 2015

Supervisor: Dr. John Seykora (Perelman School of Medicine)

I primarily worked on cloning the DNMAML to block the Notch cell signal pathway to determine the cause of Squamous Cell Carcinoma (SCC) , the second most common skin cancer. Because the Notch activates the p21 tumor suppressor gene, we believe that blocking the cell signal pathway would cause spontaneous skin cancer for human, as it has been for mice. This is still an ongoing project but once the cloning of the DNMAML is succeeded, it will be transfected in the human HEK 293 cells and the consequences of disrupting the Notch will be determined.

Particle Mass Concentration Determined from Single-Particle Mass Spectrometry Number Concentrations: Stability of Number Scaling Factors Over Multiple Seasons
Au, Lisa '18
Authors/Contributors: Deborah Gross (Professor of Chemistry, Carleton College), Aurora Janes, Ernesto Polania-Gonzalez '17, Jumaanah Flowers '16, Elizabeth Grubb '17
Summer 2015

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

The Environmental Protection Agency regulates ambient air pollution due to particulate matter based on mass concentration of aerosol particles. Single-particle mass spectrometers (SPMS) provide detailed information about the number-concentration, chemical composition and mixing state of individual aerosol particles. Procedures exist to convert the number-concentration to mass-concentration for sampled aerosol. We applied these methods to reproduce the total PM2.5 mass concentration in the vicinity of Northfield, MN scaling factors to correct for instrumental size bias, converting the particle number to mass with an average density, and assuming spherical particles. We then 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. Results for the seasonal variation of the particle types observed, the reliability of the number- to mass-concentration scaling with a variety of particle-density selections, and apportioning of mass to different particle types identified through K-means clustering will be presented.

An Examination of the Effects of Uneven Labor Migration on Informal Village Structures in Myanmar

Bahn, Jackson '16

Authors/Contributors: Tun Myint (Associate Professor of Political Science, Carleton College), Kent Freeze (Assistant Professor of Political Science, Carleton College), Peter Sang '17

Summer 2015

Supervisor: Tun Myint (Associate Professor of Political Science, Carleton College)

Migration from villages has a dramatic and underinvestigated effect on the villages left behind. Structures that have historically helped guarantee the livelihoods of villagers such as informal lending, festivals and labor sharing may be abandoned by families who's newly diversified income does not need to be insured in the same way it had. These families enjoy better access to resources in the village because of their increased financial stability, and yet must participate less because they have alternate forms of informal insurance. This produces several issues at the village level, including the flight of agricultural labor (and accompanying increase in labor costs), as well as specific issues to non-migrant families such as a shrinking insurance pool. Research was conducted in conjuncture with Peter Sang and under the advising of Tun Myint and Kent Freeze in four villages in the Sagaing Region of Myanmar.

Making a Documentary: The Story of the Northfield Skate Park
Banner, Jillian '17
Authors/Contributors: Cecilia Cornejo (Visiting Assistant Professor of Cinema and Media Studies, Carleton College), Aaron Sala '16
Summer 2015

Supervisor: Cecilia Cornejo (Visiting Assistant Professor of Cinema and Media Studies, Carleton College)

Professor Cecilia Cornejo's film is a documentary about skateboarders trying to get a skate park built in Northfield. This summer I did research in the Northfield Historical Society, looking at the Northfield News for articles about the skate park. I also selected and color-corrected still images, in order to transform the research and other footage into a more cinematic format. For example, I went through footage of city council meetings, selecting stills and looking for ways to make footage of monotonous meetings more visually striking.

Assessing genetic diversity within the Bullsnake population in Minnesota
Bhatia, Shweta '16
Authors/Contributors: Matthew Rand (Professor of Biology, Carleton College), Stephan Zweifel (Professor of Biology, Carleton College), Shweta Bhatia '16
Summer 2015

Supervisor: Stephan Zweifel (Professor of Biology, Carleton College)

The Bullsnake (Pituophis catenifer) has recently been identified by the Minnesota Department of Natural Resources as a species of special concern due to habitat loss. The fragmentation of grassland habitats may reduce genetic diversity by decreasing gene flow among populations and by increasing inbreeding within small, isolated communities. This collaborative project with the DNR was designed to quantify the genetic diversity of three separate Bullsnake populations in Minnesota. To estimate the genetic diversity, we used microsatellite markers (short, variable, nucleotide repeats in regions of non-coding DNA). Using DNA fragment size analysis, we determined the diversity of genetic markers in the populations. We found the number of alleles per location ranged from 3 to 9 and the observed heterozygosity ranged from 40% to 100%. The results of this study provide baseline information for future genetic analyses and will help guide the conservation actions needed to protect Minnesota's Bullsnake populations.

Artivism in the 21st Century
Braun, Camille '16
Authors/Contributors: Palmar Alvarez-Blanco (Associate Professor of Spanish, Carleton College)
Summer 2015

Supervisor: Palmar Alvarez-Blanco (Associate Professor of Spanish, Carleton College)

This is a project to create a website called "Artivism in the 21st Century." It is an open archive (freely accessible and without charge), updated and expanding continuously. 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 said artists; and 3) to offer artists and cultural platforms a free space and up-to-date bibliography, where others can access their work.

Development of Chemically-Modified Norovirus VLPs for the Study of Binding and Entry into Intestinal Cells
Brookner, Brittany '18
Authors/Contributors: n/a
Summer 2015

Supervisor: Dr. Gabriel Parra (NIH/NIAID), Dr. Eric Levenson (NIH/NIAID),Dr. Dennise De Jesus Diaz (NIH/NIAID), Dr. Stanislav Sosnovtsev (NIH/NIAID), Dr. Kim Green (NIH/NIAID)

Human noroviruses cannot be efficiently propagated in cell culture, making it difficult to study virus-cell interactions. We studied viral entry due to its important role in viral replication. Virus-like particles (VLPs), formed through the self assembly of 180 copies of the major capsid protein VP1, are a crucial tool for viral research, however it is difficult to determine their presence within cells. Using Alexa-fluor 594, we chemically tagged VLPs so that their entry into small intestinal cells could be visible using flow cytometry. We also found that, due to the location of the binding of the Alexa-fluor molecules on the VLP, tagging the VLP does not alter their HBGA binding properties.

The effects of unc-55 and mab-9 on male-specific neurons in C. elegans
Carson, Sandy '18
Authors/Contributors: Jennifer Wolff (Associate Professor of Biology, Carleton College), Lori Barrientos Sanchez '18
Summer 2015

Supervisor: Jennifer Wolff (Associate Professor of Biology, Carleton College)

Sex-specific neuronal development is essential for reproduction in most organisms. In C. elegans, male-specific neurons of the head, tail, and ventral nerve cord are important for male-specific mating behaviors. We are interested in male-specific ventral cord neuronal development and function.

unc-55 and mab-9 are genes that have been shown to influence development of the nervous system in C. elegans: unc-55 is a gene that affects movement and male mating behaviours; mab-9 affects development of the tail in male worms. Their role in mediating function of ventral nerve cord neurons remains unknown. We crossed worms that contained mutations in unc-55 and mab-9 with male-specific neuronal reporters tph-1::mcherry, flp-21::gfp, and flp-22::gfp. Once we confidently had homozygous worms, we began to examine the expression of the reporters. We are currently in the beginning stages of data analysis and further research must be conducted to determine the effects these genes have on male-specific neurons.

The Experience of Collective Subjects During Disagreement
Chang, Alexandra '16
Authors/Contributors: Anna Moltchanova (Professor of Philosophy, Carleton College)
Summer 2015

Supervisor: Anna Moltchanova (Professor of Philosophy, Carleton College)

Our research focused on the issue of collective self-awareness. Collective self-awareness is a topic in the philosophy of mind, drawing on philosophy, psychology, neuroscience, and cognitive science to address questions of consciousness and subjectivity. Anna and I began by reading the general literature on the topic, before narrowing down our focus to cases of disagreement between subjects. Disagreement posed a particularly interesting case since it seems that when two parties disagree, they can no longer be experiencing a moment as a collective subject. However, as we discovered, there are several situations in which disagreement plays a constitutive part of a collective experience, to the extent that collective self-awareness is not lost during the disagreement. We explored accounts of representational theory, theories of consciousness, and specific cases of collective disagreement to support our claim.

Electromagnetic Field Generation Using a Multiphase Transport Model in Heavy-Ion Collisions
Chen, Tianen '17
Authors/Contributors: Che-Ming Ko (Texas A&M), Yifeng Sun
Summer 2015

Supervisor: Che-Ming Ko (Texas A&M)

We computed the electromagnetic fields generated in heavy-ion collisions by using a Multi-Phase Transport Model (AMPT) simulation. For our simulation, we examined Au-Au collisions at various energies from 15 GeV to 200 GeV. We compare results to the electromagnetic field characteristics generated from the Heavy Ion Jet Interaction Generator (HIJING) model. In particular, we studied how variations on time, impact parameter, and the Quark-Gluon Plasma (QGP) can affect the evolution of the electromagnetic fields. Additionally, we found the distributions of the electromagnetic fields for different events produced by the AMPT model. In a previous study done by Deng et al., the interactions between the electromagnetic field and the QGP were not included. Currently, the magnitude of the conductivity of the QGP is debated. However, if the conductivity is significantly large, the QGP will be greatly influenced by the electromagnetic field and in turn, the QGP will contribute to the original electromagnetic field. Our results indicate a general correlation between AMPT and HIJING results.

Molecular Markers Distinguish Hybridization Patterns in Castilleja
Cheung, Lisa '17
Authors/Contributors: Jeremie Fant (Chicago Botanic Garden), Andrea Kramer (Chicago Botanic Garden), Adrienne Basey (Chicago Botanic Garden)
Summer 2015

Supervisor: Jeremie Fant (Chicago Botanic Garden); Andrea Kramer (Chicago Botanic Garden)

Castilleja hispida, an Indian paintbrush species, is being used to restore habitat for an endangered butterfly; however, they are outcrossing with an endangered paintbrush species ,C. levisecta, which could cause the genetic swamping of C. levisecta. Our objective was to find presence of repeating DNA sequences between the two species and utilize those variances to distinguish a hybridization pattern in the flower heads. To do so, we had to extract, amplify, score, and analyze DNA from the hispida and hybrid samples. There was indeed a distinguishable difference between the two species and a noticeable mix of the two species in the hybrids. However, there did not seem to be any observable pattern in hybridization direction. In conclusion, not all hybrids are distinguishable and we believe that there is no pattern to hybridization inflorescence due to pollination being less specific and random. Thus, more research is necessary to identify hybridization patterns.

Collecting Data on Photopolymers: Prism Coupling and Fourier Transform Infrared Spectroscopy
Chosy, Madeline '18
Authors/Contributors: Marty Baylor (Assistant Professor of Physics, Carleton College), Mark Zach (Instrument Project Manager, Carleton College), Mason White '16, Benjamin Cerjan '16,
Winter Term/ Spring Term, Summer 2015

Supervisor: Marty Baylor (Assistant Professor of Physics, Carleton College)

Photosensitive polymers are an ideal material for fabricating integrated optofluidic devices because they allow optical and fluidic features to be made from a single material. These devices have applications ranging from spectrometry to the creation fo tunable laser sources. The resin used in this project was designed to be a combination of two monomer reactions that polymerize at different rates when exposed to UV radiation, and these reactions are carefully controlled in order to produce the optical and microfluidic features. To further optimize this photopolymer for the creation of optofluidic devices, it is important to know a number of the physical characteristics associated with the resin mixture. My research focused on measuring the bulk index of refraction of the polymerized resin via prism coupling, and designing a chamber that will eventually allow collection of information about the rate of conversion of monomer to polymer using Fourier Transform Infrared Spectroscopy.

Arduino Based Laser Waist Measurement

Diaz De Leon, Samuel '18
Authors/Contributors: Eric Hazlett (Assistant Professor of Physics, Carleton College), Mark Zach (Instrument Project Manager, Carleton College), Adam Rutkowski '17
Summer 2015

Supervisor: Eric Hazlett (Assistant Professor of Physics, Carleton College)

The purpose of this research was to find a inexpensive way to measure the waist of a laser beam. The approach we took to measure the beam waist was by using a laser, an optical chopper which was set securely atop a hard-drive motor being powered by a power source and operated by an Arduino, and a photodetector for collecting data. The data collected by the photodetector would then be analyzed by a second Arduino using a program which output the magnitude of the waist. Here we report on our current progress toward this goal. Preliminary results confirm that the use of our optical chopper waist measurement method yields the same results to the knife-edge method. This data shows that this device has promise to be a fast cost-effective way to measure the waist of laser beams. The motor for the optical chopper was harvested from an old hard drive. The laser waist is a key parameter that allows for the launching laser beams into optical fibers and manipulating atoms in optical traps. Being able to measure it quickly will allow for more effective research. With the low cost of the Arduino this expands the accessibility of optical chopper experiments for physics instruction with an apparatus that costs less than $100.

Analysis of Unusual Emission Line Image Features in M33
DiGiorgio, Brian '17
Authors/Contributors: Cindy Blaha (Professor of Physics and Astronomy, Carleton College)
Summer 2015

Supervisor: Cindy Blaha (Professor of Physics and Astronomy, Carleton College)

Anomalous oversubtracted regions in the central portion of M33 were examined in further detail. Their average fluxes were calculated and found to be lower than the background in both Hydrogen alpha and SII images yet appeared to be normal in continuum images. The same regions were examined in the continuum and not found to be significantly different than other typical regions at similar galactic radii. As of now their nature remains unknown. In addition, regions in the center of M33 that appeared dark in the continuum but were brighter than the background in narrowband images were examined. A small amount of them showed above background fluxes in Ha and SII with no apparent reason. These were catalogued for future study.

In Situ Hybridization With CAMK1D Probe in Chick (Gallus gallus) Embryos
Dizon, Jlor '16
Authors/Contributors: Bridget Jacques-Fricke (Visiting Assistant Professor of Biology, Carleton College)
Summer 2015

Supervisors: Dr. Laura Gammill (University of Minnesota), Bridget Jacques-Fricke (Visiting Assistant Professor of Biology, Carleton College)

Neural crest (NC) cells, which have stem-cell-like properties, arise and migrate away from the neural plate border. As development in chick embryos continue, NC cells differentiate into various tissues, like neurons, cartilege, and bone. Previous research has found a list of genes that need to be activated for NC development to occur. Of the genes previously found to be activated during NC formation, CAMK1D is highly implicated in neural crest migration after differentiation from the neural plate. The study of CAMK1D may have implications for cancer metastasis and other applications. Using a probe for CAMK1D mRNA, we performed in situ hybridization to visually determine the expression pattern of CAMK1D in developing chick embryo.

Cooperative Reactivity of Rhodium-Silicon Pincer Complexes
Donnell, Teddy '17
Authors/Contributors: Matthew Whited (Assistant Professor of Chemistry, Carleton College)
Summer 2015

Supervisor: Matthew Whited (Assistant Professor of Chemistry, Carleton College)

Due to complementary electronic properties of rhodium (electron rich, Lewis base) and silicon (electron poor, Lewis acid), the atoms have potential for cooperative reactivity when bonded together. We have explored systems where rhodium and silicon are held together by strong phosphine donors. With the two atoms unable to quench, they show heightened reactivity across the Rh-Si bond. We have shown that this bond allows for H2 activation across this bond, and the complex acts as an efficient hydrogenation catalyst for strained alkenes. We will show preliminary hydrogenation mechanism studies as well as plans for further mechanism clarification using a parallel pressure reactor. Finally, our system shows reactivity with CO2 to form a stable product suggestive of silicon insertion into the CO2.

Post-dam processes: assessing the geomorphic effects of dam installation in a Maple River wetland

Donovan, Sally '16

Authors/Contributors: Mary Savina '72 (Charles L. Denison Professor of Geology, Carleton College)

Summer 2015

Supervisor: Dr. Christy Dolph (University of Minnesota)

Dams have a significant impact on riparian ecology. By altering river flow paths, dam installation and operation impacts fluvial sediment regimes. This affects instream nutrient processes, river structure, and overall habitat. This study focuses on short term changes in nutrient dynamics and sediment loads within Public Water Wetland 82 (PWW82) after dam installation in 2002. From a Livingstone core, sediment samples were analyzed for organic content, magnetic susceptibility (MS), grain size, and soluble reactive phosphorus (SRP) in order to determine changes in sediment and phosphorus loading since dam installation. While there was no significant change in SRP or MS, the core reveals an increase in grain size and decrease in organic content with depth. There are significant geomorphic and ecological changes as a consequence of the PWW82 dam, and further studies are required to determine downstream implications of dam installation.

Reactions of Marine-Derived Organic Compounds with an Urban Air Pollutant

Dowling, Jackie '17

Authors/Contributors: Dr. Kimberly Prather (CAICE, University of California San Diego), Dr. Vicki Grassian (CAICE, University of Iowa), Christopher Lee '19, Jonathan Trueblood, Holly VanMetre, Armando Estillore

Summer 2015

Supervisor: Dr. Kimberly Prather (CAICE, University of California San Diego), Dr. Vicki Grassian (CAICE, University of Iowa)

Crashing sea waves emit aerosol particles that are rich in both sea salt and organic material. It is well known that HNO3 gas, an important air pollutant, heterogeneously reacts with aerosolized NaCl particles. Recent work has shown that HNO3 can react with certain organic compounds that often co-exist with NaCl in aerosol particles emitted from the ocean surface. In collaboration with other model studies using substrate-deposited particles, this study investigated the reaction of a marine-derived organic compound, lipopolysaccharide (LPS), with HNO3 while suspended in air. LPS can undergo an acid-base reaction with HNO3 at a concentration comparable to what is present in Southern California. Chemical analysis of individual particles by mass spectrometry allowed CAICE to demonstrate the atmospheric relevance of this reaction. This reaction mechanism may be especially important in urbanized costal environments. It is crucial to invesitgate how anthropogenic actions are affecting aerosols, coulds, and the global climate.

More than just Dylan: Minnesota's Folk Music in the 1960s
Easton, Abby '16
Authors/Contributors: Melinda Russell (Professor of Music, Carleton College)
Summer 2015

Supervisor: Melinda Russell (Professor of Music, Carleton College)

Little is known about the folk music revival in Minneapolis and St. Paul beyond the documentation of the period Bob Dylan spent in Dinkytown. Professor of Music Melinda Russell has been conducting a long-term research project investigating and telling the story of this moment in music history. This August, I worked with Melinda to help further her research on the emergence of folk in the Twin Cities. My efforts have included investigating and documenting the emergence of folk music in a mainstream Minneapolis newspaper (The Minneapolis Tribune) by tracking concert advertisements, features, want ads, critic reviews, and venue information, specifically in 1962.

Truncated Discard Fraction Likelihood Function Can Affect Stock Status Estimates in Fisheries Stock Assessments
Emmet, Robbie '16
Authors/Contributors: Robbie Emmet '16
Summer 2015

Supervisor: Elizabeth Councill (University of Washington School of Aquatic and Fishery Sciences)

Discard data are an important data source in fisheries stock assessments, since discarding can affect fish population dynamics. Currently, discard fraction likelihood is described in Stock Synthesis (SS) by a normal distribution cut off at 0 and 1. This specification can inflate or deflate cumulative probability of discarding and bias model results. We adapt a truncated normal distribution to describe SS's discard fraction likelihood that is scaled to control cumulative probability of discarding, test its performance on three U.S. west coast groundfish species recently assessed using discard fraction data, and find that the new likelihood function can produce lower and more precise estimates of management quantities for some species. We conclude that this function can change management decisions if it is applied to assessments of these species, and that the properties of the discard fraction likelihood in integrated assessments are worth examining due to their potential to change results.

Association between Malaria & Polymorphisms in the IL-10 Promoter
Fireside-Ostergaard, Elly '16
Authors/Contributors: Dr. Prasanna Jagannathan (UCSF)
Summer 2015

Supervisor: Dr. Margaret Feeney (UCSF)

Malaria, caused by Plasmodium falciparum, is a leading cause of death amongst African children primarily in Sub-Saharan Africa. IL-10 is an potent anti-inflammatory cytokine that has important implications for malarial infection and immunity. Polymorphisms in the IL-10 gene have been shown to impact IL-10 production, and different IL-10 haplotypes have been associated with incidence of clinical malaria in young children. We investigated the relationship between IL-10 single-nucleotide polymorphisms (SNPs), cytokine production, and incidence of clinical malaria in children from Tororo, Uganda. We genotyped 3 SNPs in the IL-10 promoter, -1082, -819, -592 , constructed haplotypes and performed genomic analysis, and found associations between polymorphisms and cytokine production by CD4+ T tells, including IL-10 and TNF-a using Stata. There was a significant relationship between -1082G and IL-10 production (p=0.03844) and haplotype -1082G/-819C/-592A and TNF-a (p=0.006528). We propose an indirect mechanism through which -1082G/-819C/-592C downregulates TNF-a, leading to the upregulation of IL-10 in CD4+ T cells.

Phase Transfer Catalysis: An Investigation of the Asymmetric Catalytic Capacities of 10,11-Didehydro-Coupled Cinchona Alkaloids in the [2,3]-Wittig Rearrangment
Fox, John '16
Authors/Contributors: Dr. Scott E. Denmark (Professor, UIUC), Kevin Robb (Graduate Student, UIUC)
Summer 2015

Supervisor: Dr. Scott E. Denmark (University of Illinois Urbana-Champaign)

While asymmetric phase transfer catalysts (APTC) have been used for intermolecular alkylations for decades, examples of their application in intramolecular rearrangements are virtually nonexistent. Using the highly capable cinchona alkaloids cinchonine and cinchonidine as catalyst scaffolds, we endeavour to report the enantioselectivity of the 10,11-didehydro-coupled cinchonas in catalyzing the [2,3]-Wittig Rearrangement. We predicted that cinchonine might produce better enantiomeric ratios due to a hypothesized interaction between the C9 hydroxyl and the 10,11-coupled moiety. This hypothesis was refuted as enantiomeric ratios for both the cinchonine and cinchonidine catalyst series were poor relative to the uncoupled alkaloids. The best coupled-catalyst was from the cinchonidine series and achieved an enantiomeric ratio of 61:39. Further work in this field will investigate the effect of various steric moieties at the 10,11-position and a complete set of quaternizing agents in order to fully understand the structure-activity relationships of this series of catalyst.

Identifying Possible Pollution Sources Affecting Air Quality in Northfield, Minnesota
Grubb, Elizabeth '17
Authors/Contributors: Deborah Gross (Professor of Chemistry, Carleton College), Jumaanah Flowers '16, Elizabeth Grubb '17, Lisa Au '18, Ernesto Polania-Gonzalez '17, Aurora Janes,
Summer 2015

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

Northfield, Minnesota is exposed to a variety of atmospheric pollutants linked to agricultural, industrial, and natural sources. Therefore, it offers a unique and complex environment to conduct aerosol research. Single-particle mass spectrometry can provide information about the particle composition. Efforts to identify the source of the particles observed in Northfield air require combining the single particle mass spectra with information about the particle size and the past history of the air from which the particles were sampled, which can be obtained through back-trajectories. By combining these data, we are able to suggest sources for the particle that are consistent with the measurements. Particle sources include dust, biomass combustion, vehicle exhaust, and others.

Effects of the Specialist Aphid, Aphis echinaceae, on Overall Herbivory of Echinacea angustifolia by Chewing Herbivores
Hatch, Gina '17
Authors/Contributors: Dr. Stuart Wagenius (Chicago Botanic Garden)
Summer 2015

Supervisor: Dr. Stuart Wagenius (Chicago Botanic Garden)

The recent discovery of Aphis echinaceae, an aphid species specializing on the native prairie plant, Echinacea angustifolia, has raised questions about how the presence of the aphid and its tending ants may impact remnant Echinacea populations in the increasingly fragmented landscapes of North America. The top-down effects of aphids on their hosts is an area in which empirical study has been relatively lacking. In order to determine how A. echinaceae influence rates of herbivory on host plants by other chewing herbivores, I manipulated and recorded aphid populations among two treatment groups of E. angustifolia. An addition group had aphids regularly added, while an exclusion group had all aphids regularly removed. At the end of the season, I assessed foliar herbivory among the treatment groups based on the proportion of chewed leaves per individual plant. The results suggest that there is a negative association between aphid load and herbivory, however the differences were smaller compared to similar studies in past years. Additionally, the negative association evidenced in this manipulative study is opposite that found in similar observational studies, and so may not speak to the relationship between aphids and herbivory rates under natural distribution patterns.

U-Hauls, Television and Turkey Basters: The 'Gayby Boomers' Construct Kinship
Hornor, Hart '16
Authors/Contributors: Hart Hornor '16
Summer 2015

Supervisor: Constanza Ocampo-Raeder (Asisstant Professor of Antrhopology, Carleton College)

Through kinship systems, certain relationships appear as 'given.' From prime time television to the supreme court, recent developments in kinship have captivated anthropologists. Previous research has focused on lesbian moms, and neglected the unique perspectives of their children. Based on 15 in-depth interviews, my data reveal how children produce and reproduce kinship norms.

Raman Spectroscopy of Electronic Devices with Applied Electrical Bias
Hu, Isabelle '17
Authors/Contributors: Professor Mildred Dresselhaus (Massachusetts Institute of Technology), Shengxi Huang (phD candidate, Massachusetts Institute of Technology)
Summer 2015

Supervisor: Professor Mildred Dresselhaus (Massachusetts Institute of Technology), Shengxi Huang (phD candidate, Massachusetts Institute of Technology)

Raman spectroscopy has been used as a powerful tool for the study of low dimensional materials. This method can yield rich information when applied to sp2 nanocarbons and transition metal dichalcogenides. We currently are interested in the Raman spectra of a variety of electronic devices made of 2D materials when they are applied with electrical bias. I designed and built an experimental setup for this project that accommodates the requirements for measurement, including vacuum environment, optical quality, lens working distance, etc. The setup has proven to be fully functional. We started the project by investigating the Raman spectra of a graphene p-n junction under applied voltage bias. Given the poor condition of the old device, the result of our Raman measurement did not perfectly agree with theoretical expectations. However, the system is ready for use once new devices are fabricated.

Characterization of Surface Relief Grating for Photopolymer
Huang, Kai '16
Authors/Contributors: Josh Noble (University of Colorado Boulder); David Glugla (University of Colorado Boulder); Dr. Robert McLeod (University of Colorado Boulder)
Summer 2015

Supervisors: Josh Noble (University of Colorado Boulder); David Glugla (University of Colorado Boulder); Dr. Robert McLeod (University of Colorado Boulder)

Photopolymers have been given increasing attention for one's ability to tune the physical characteristics of the polymer by varying the chemical formulation. They have wide applications in holographic data storage, perfectly aligned micro-lenses with no aberrations, surface coatings, and so on. Using laser light to form an interference pattern and shining that pattern on the photopolymer, we can create periodic changes in the index of refraction in the polymer forming a grating. Shrinking of the polymer in the higher-index regions of the grating compared to the lower-index regions of the grating creates a periodic change in the height of the surface of the polymer which is called a surface relief grating (SRG). The relief height further increases when the monomers in the lower-index regions diffuse to the higher-index regions. This project investigates the variables influencing the surface relief height, including the pitch spacing of the interference pattern and the monomer concentration.

Memory Testing and Social Thinking in Tamarins
Ibiboi, Isabella '16
Authors/Contributors: Lydia Henderson '16, Kate Wagner '16, Zach Rubin '16, Alexandria Carlsen '17, Grace Sassana '16
Summer 2015

Supervisor: Julie Neiworth (Professor of Psychology, Carleton College)

Our group trained monkeys to respond in reciprocal ways to gain rewards in a game, and to respond to indicate whether an object matched a test item to test memory for multiple items in the future. The experiments evaluate the social thinking of tamarins as they consider others and fairness, and their memory as they age.

Urns and Broaches of Anglo-Saxon England
Kalkowski-Farrand, Maureen '17
Authors/Contributors: Austin Mason (Robert A Oden Jr. Postdoctoral Fellow for Innovation in the Liberal Arts and Digital Humanities in History, Carleton College)
Summer 2015

Supervisor: Austin Mason (Robert A Oden Jr. Postdoctoral Fellow for Innovation in the Liberal Arts and Digital Humanities in History, Carleton College)

This research focuses on broaches and urns from museums in Scunthorpe, Cambridge, and West Stow. Because there are few high quality photos of urns, and most of the time historians must rely on line drawings, our understanding of the burial ritual is limited. In fact, when viewing the pot from above, there is a similarity to Anglo-Saxon annular broaches. This project was to explore these similarities by making three-dimensional models of various broaches and urns. To do this, we used a technique called photogrammetry. We took pictures of the object, and then used a computer program called Photoscan to make three-dimensional models from the two-dimensional pictures. Once the objects are rendered in three-dimensions, it is much easier to closely examine them. Focusing on the significance of the markings on the urns and broaches allows a deeper understanding of how death and burial rituals functioned for the Anglo-Saxons.

Instrumental Errors of H-alpha Emission Regions in M33
Khan, Zeenath '17
Authors/Contributors: Cindy Blaha (Professor of Physics and Astronomy, Carleton College), Matthew Maclay '18
Summer 2015

Supervisor: Cindy Blaha (Professor of Physics and Astronomy, Carleton College)

In this research, I examine the instrumental errors that arise in the measured flux values of H-alpha regions between the three different frames in M33, the Triangulum Galaxy. Such errors can arise from a number of factors including the time and day the images were captured and the position of the image on the CCD detector. I also consider more subjective errors that are caused by human measuring methods. By computing these errors, the variances in measured flux values can be

accounted for and then compared with the existing luminosity values in our main Emission Line Survey catalog. This allows us to recount the number of H-alpha emission regions in each luminosity interval and determine a more accurate luminosity function to analyze the star-formation history of M33.

Regulation and activity of EZH2 in alveolar rhabdomyosarcoma
Kim, Joyce '17
Authors/Contributors: Dr. Sebastian T. Balbach (Boston Childrens Hospital/Dana Farber Cancer Institute), Dr. Stuart H. Orkin (Boston Childrens Hospital / Dana Farber Cancer Institute)
Summer 2015

Supervisors: Dr. Sebastian T. Balbach (Boston Childrens Hospital/Dana Farber Cancer Institute); Dr. Stuart H. Orkin (Boston Childrens Hospital / Dana Farber Cancer Institute), Dr. M. William Lensch (Harvard Stem Cell Institute), Dr. William Anderson (Harvard Stem Cell Institute)

The most common soft-tissue sarcoma (malignant tumor of connective tissue) in children is rhabdomyosarcoma (RMS). One of the subtypes of RMS, which is highly malignant and has the least favorable prognosis, is alveolar rhabdomyosarcoma (aRMS). Histone methylation plays a key role in cellular processes, such as stem cell differentiation and oncogenesis. In aRMS, EZH2 (gene responsible for histone H3 lysine 27 trimethylation) is overexpressed. The overexpression of EZH2 inhibits tumor suppressor genes and promotes cancer cell proliferation. However, the regulation and functional role of EZH2 in tumor formation remains unknown. This project aims to identify the genes regulating and regulated by EZH2. Short hairpin RNA (shRNA) is used to knock down EZH2 in aRMS cells to quantify the differences in gene expression via microarray. Future prospects include identifying the proteins that bind to EZH2 promoter to understand its mechanism in tumor formation.

Functional Characterization of ORF7 in the ECO-0501 Biosynthetic Pathway
Kingston, Natalie '16
Authors/Contributors: Chris Calderone (Assistant Professor of Chemisty, Carleton College), Demi Liu '16
Summer 2014, Summer 2015

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

ECO-0501 is a secondary metabolite produced by the bacteria Amycolatopsis orientalis. It has shown antibiotic properties against several broadly resistant pathogens. Via prior genomic scanning of the ECO-0501 biosynthetic cluster, it was predicted that ORF7 acts as a flavoenzyme in the ECO-0501 pathway and ORF5 acts as an N-methyltransferase. We tested the activity of ORF7

biochemically in order to confirm its functional assignment. Using high performance liquid chromatography (HPLC), a DNPH ketone assay, and a hydrogen peroxide assay, it was determined that ORF7 converts arginine into an α-keto acid. The α-keto acid product we observed differs from the ORF7 product needed for the biosynthesis of ECO-0501. As a result, we predict that the proper substrate for ORF7 is methylated arginine. Therefore, we predict that ORF5 acts prior to ORF7 in the ECO-0501 biosynthetic pathway.

The Making of the Moroccan Resistance Culture: Identity and Politics in the Age of Independence

Koppe, Celeste '16

Authors/Contributors: Thabiti Willis (Assistant Professor of History, Carleton College), Adeeb Khalid (Jane and Raphael Bernstein Professor of Asian Studies and History, Carleton College), Yaron Klein (Associate Professor of Arabic, Carleton College)

Summer 2015

Supervisor: Adeeb Khalid (Jane and Raphael Bernstein Professor of Asian Studies and History, Carleton College)

The newspaper, Al- Alam, was established in 1946 by the Istiqlal (Independence) Party and remains today as one of the most widely read newspapers in Morocco. As the first news source available in Arabic, this newspaper embodies the Arab elite's struggle against French control throughout the country. This research focuses on the archives of Al-Alam to better understand how the Istiqlal Party of Morocco shaped their nationalist agenda through the revival of the Arabic language and traditional Islamic culture. The focus is specifically on the periodicals from 1946- 1956, in which I investigate how leaders of the nationalist movement employed certain identities to liberate their country from French rule.

The Effect of Dominant Grass Seeding and Native Soil Inoculation on Restored Prairie Communities

Krumholz, Julia '16

Authors/Contributors: Daniel Hernandez (Associate Professor of Biology, Carleton College), Mark McKone (Towsley Professor of Biology, Research Supervisor of Cowling Arboretum, Carleton College), Jared Beck (Educational Associate in Biology, Carleton College), Morgan Vought '17, Cameron Shorb '16, Lauren Pflughoeft '17

Summer 2015

Supervisors: Daniel Hernandez (Associate Professor of Biology, Carleton College), Mark McKone (Towsley Professor of Biology, Research Supervisor of Cowling Arboretum, Carleton College)

Restored prairies tend to be lower in diversity than native prairies, perhaps due to dominance of C4 grasses or changes to the soil microbial activity during agricultural use. To test these mechanisms, we conduncted an experiment in the Carleton Arboretum in which we examined the effects of grass dominance and native soil inoculation on a restored prairie community. We established experimental plots in a prairie planted in 2012, consisting of seven blocks with four treatments per block and containing combinations of dominant C4 grass presence/absence and with or without the addition of native soil inoculation. We measured grass cover and individual species cover in order to measure the effect of dominant grasses and native soil inoculation on plant species richness and diversity.

Enantioselective Catalysis - Synthesis & Resolution of Transition State Analogs
Leahy, Clare '17
Authors/Contributors: Fa Ngamnithiporn, Connor Hodges, Gretchen Hofmeister (Professor of Chemistry, Carleton College), David Alberg (Professor of Chemistry, Carleton College)
Summer 2015

Supervisor: Gretchen Hofmeister (Professor of Chemistry, Carleton College), David Alberg (Professor of Chemistry, Carleton College)

Organocatalysis provides inexpensive and practical routes to introduce chirality into achiral molecules, which is particularly important for the efficient preparation of chiral molecules in the pharmaceutical industry. To gain a better understanding of how these organocatalysts enable high enantioselectivity and efficiency, our group focuses on studying the interactions between the substrate and catalyst in the asymmetric desymmetrization (ASD) of cyclic anhydrides. Based on prior mechanistic studies, we identified phosphonate transition state analogs (TSAs) that mimic these interactions without forming final products. Here, we describe the synthesis and characterization of a TSA precursor, which is prepared by a Diels-Alder reaction. Ultimately, we will study the TSA-catalyst interactions by two-dimensional NMR spectroscopy.

Ion-Powered Rotary Mechanism of ATP Synthase
Ledsky, Clara '16
Authors/Contributors: Rahul Uppal '16, Ryan Steed (Visiting Assistant Professor of Chemistry, Carleton College)
Summer 2015

Supervisor: Ryan Steed (Visiting Assistant Professor of Chemistry, Carleton College)

ATP synthase is a protein complex that catalyzes the synthesis of ATP, the universal energy currency of life. This molecular machine consists of two coupled rotary motors that power the synthesis of ATP--the cytoplasmic F1 sector and membrane-embedded F0 sector. The F0 sector converts an electrochemical proton gradient into rotary motion via a largely unknown mechanism involving the interaction between a stator (subunit a) and a rotor (subunit c). Understanding the rotor-stator interface is key to elucidating the mechanism of torque generation. In this study, we biochemically characterized a set of F1F0 complexes in which amino acids on the surface of the rotor were mutated to determine their mechanistic importance. Our results suggest that two distinct regions mediate proton transport and the rotor-stator interaction. Additionally, we began a cysteine crosslinking study to locate a missing structural component of the rotor-stator interface.

Spotting the Gel Point of Photopolymers

Lee, Jack '16
Authors/Contributors: Marty Baylor (Assistant Professor of Physics, Carleton College), Gretchen Hofmeister (Professor of Chemistry, Carleton College)
Summer 2015

Supervisors: Marty Baylor (Assistant Professor of Physics, Carleton College), Gretchen Hofmeister (Professor of Chemistry, Carleton College)

Spotting when a polymer goes from liquid to solid during polymerization is necessary when working with certain optically cured polymers used to fabricate optofluidic devices that contain both optical and microfluidic features. Through the use of nuclear magnetic resonance (NMR) it may be possible to determine when the transition from liquid to solid, called the gel point, occurs. In examining the proton longitudinal relaxation time for one species of monomers in our polymer mix, our data shows as the polymer cures the relaxation time increases. By examining this data we were able to extract a time to gel point that was within the margin of error of another accepted but slower method of experimentally determining the gel point. Outlined here is the basic explanation behind why longitudinal relaxation is applicable to studying polymerization, and how we are using the data to attempt to extract the gel point.

Sequencing and Analysis of the Mitochondrial Genome of Pituophis catenifer sayi (Squamata: Colubridae)

Lele, Abhimanyu '16
Authors/Contributors: Abhimanyu Lele; Matthew Rand (Professor of Biology, Director of Neuroscience, Carleton College), Stephan Zweifel (Professor of Biology, Carleton College)
Summer 2015

Supervisor: Stephan Zweifel (Professor of Biology, Carleton College)

The goal of this project was to sequence the mitochondrial genome of the Bullsnake (Pituophis catenifer sayi), family Colubridae, subfamily Colubrinae, a species of conservation concern in Minnesota. PCR primer sequences were developed by aligning mitochondrial genomes of 9 other snakes within the subfamily Colubrinae, and using highly conserved sequences as the basis for our primers. Each of the overlapping fragments was sequenced at least twice. The Bullsnake mitochondrial genome consists of 17,193 bp, containing 22 tRNA coding sequences, 2 rRNA coding sequences, 12 protein coding genes, and 2 identical control regions. This genome will be used to better understand the functional role of the duplicate control region found in all snakes, as well as to clarify colubrid phylogeny.

Thin Film Deposition in the Study of Colossal Magnetoresistance (CMR) in Eu-rich EuO
Li, Yuan Shen '17
Authors/Contributors: Melissa Eblen-Zayas (Associate Professor of Physics, Carleton College)
Summer 2015

Supervisor: Melissa Eblen-Zayas (Associate Professor of Physics, Carleton College)

Colossal magnetoresistance (CMR) in Eu-rich EuO remains largely unexplained by current theoretical models based on perovskite manganites. Using thin film deposition, we synthesized Eu-rich EuO samples under a range of growth parameters, such as oxygen partial pressure and Eu deposition rate, with the goal of investigating their effect on the CMR properties of the material. In addition, a mechanical shutter was installed to give finer control over the deposition process. However, the shutter produced an unforeseen impact on sample surface homogeneity and chemical stability. Further investigation revealed that the sudden spike in Eu deposition rate, caused by opening the shutter, was a primary factor contributing to the instability of the samples. We concluded that the mechanical shutter was unsuitable for use during the deposition process.

Modeling the Effects of Hypoxia on Oligodendrocytes Using Nanofibers
Lim, Jeong '16
Authors/Contributors: Dr. Byung Gon Kim (Ajou University School of Medicine), Dr. Yuexian Cui (Ajou University School of Medicine)
Summer 2015

Supervisors: Dr. Byung Gon Kim (Ajou University School of Medicine), Dr. Yuexian Cui (Ajou University School of Medicine)

Progressive white matter (WM) injuries are associated with neurological dysfunctions such as ischemic stroke. Demyelination and oligodendrocyte (OL) loss are prominent features of ischemic WM injury. Previous studies on ischemic WM injury have demonstrated the detrimental effects of hypoxia (a state of oxygen deficiency) on axons and myelin. However, the specific effects of hypoxia on myelin and OL remain unknown. Recent methods for culturing OL on nanofibers have introduced new ways to study OL processing. My project aims to model and observe the effects of hypoxia on myelin by culturing OL on poly-l-lysine nanofibers and exposing them to prolonged periods of hypoxia. Administering hypoxia to these cell cultures for periods of 2, 4, and 8 hours induced gradual recession in OL processing.

Investigation of the Mammalian SRP-SR Interaction
Liu, Demi '16
Authors/Contributors: n/a
Summer 2015

Supervisor: Dr. Shu-ou Shan (California Institute of Technology)

The signal recognition particle (SRP) provides strict coordination between protein synthesis and translocation, and the interaction between SRP and its receptor (SR) is required for the initial targeting of the ribosome-nascent chain complex to the ER, ensuring proper protein biogenesis. We aim to accurately describe the kinetics and thermodynamics of the mammalian SRP-SR interaction. Here we establish Forster Resonance Energy Transfer (FRET) assays that enable us to monitor individual molecular interactions in the SRP pathway at high resolution. We found that ribosome is required for accumulation of the SRP-SR complex in the presence of GTP, but is not necessary when GTP hydrolysis is blocked. We propose that the ribosome could stimulate SRP-SR assembly and/or inhibit GTP hydrolysis that drives its disassembly.

Kinetic Studies of Serine Mischarging by Alanyl tRNA-Synthetase
Livingston, Nate '16
Authors/Contributors: Joe Chihade (Professor of Chemisty, Carleton College), Christopher Francklyn (University of Vermont)
Summer 2014 - Summer 2015

Supervisor: Christopher Francklyn (University of Vermont)

Alanyl tRNA-synthetase (AlaRS) catalyzes the fundamental, two-step reaction required to form alanyl-tRNA for protein synthesis. The primary active site can also accommodate the non-cognate amino acid serine presenting a potential source of error in translation. AlaRS utilizes a separate

editing domain to increase translational fidelity. Crystal structures of the AlaRS and tRNA complex indicate that a formidable amino acid barrier separates the two active sites. In other sythetase systems, the tRNA acceptor stem can easily translocate between the aminoacylation and editing domains without first separating from the enzyme. We are investigating the possibility that AlaRS must release and "resample" charged tRNA. Our methodology includes using a mutant AlaRS protein as a probe to bind charged tRNA before resampling occurs. We also aim to understand the differences in kinetic parameters between the alanine and serine substrates through Michaelis-Menten steady state studies and pre-steady state experiments.

Testing a New Meson-Exchange Current Scattering Model with the MINERvA Experiment
Lopez, Gaston '17
Authors/Contributors: Lucy Albin '16
Summer 2015

Supervisor: Dr. Richard Gran (University of Minnesota-Duluth)

Neutrinos are smallest in mass-energy of the elementary particles in the standard model and they interact weakly with matter. The MINERvA experiment at Fermilab seeks to improve understanding of neutrino interactions with nucleons, thus further improving the precision of neutrino interaction models for current detectors. An emerging model for meson exchange-current (MEC) scattering from anti-neutrino interactions suggest a type of reaction producing neutron-neutron pairs in carbon nuclei. To prepare for understanding this case, our research involved visually scanning neutrino interactions from MINERvA data (and Monte Carlo simulations) from a different process. Through applying scan rules to data from the web-based visual event display Arachne, we found an average number of neutrons per event of 0.85 for actual data, compared to 0.83 for Monte Carlo data, confirming that Monte Carlo simulations model the neutrino mode, non-MEC process well. We expect to develop an algorithm for actual anti-neutrino data and search for the MEC process.

Simulating Anomalous Chaos in a Quantum Duffing Oscillator
Lynn, Walter '16
Authors/Contributors: Arjendu Pattanayak (Professor of Physics, Carleton College), Moses Misplon '17
Summer 2015

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

We simulated a driven double double well oscillator with coupling to the environment (with coupling strength given by a parameter ɣ). We search for the existence of chaos in the problem by calculating the lyapunov exponents (which measure the divergence between initially nearby trajectories) using classical, semi-classical, and quantum simulations for a large range of dissipations and effective Planck's constant Ä§. For certain coupling strengths ɣ we showed that this system becomes chaotic as we changed system size from classical to quantum (hence changing effective Planck's constant), which is contrary to the standard intuition.

The bacterial wilt disease of plants: studies of bacterial effector proteins and plant root responses to Ralstonia solanacearum
Maaneb de Macedo, Khuaten 2016
Authors/Contributors: Raka Mitra (Assistant Professor of Biology, Carleton College), Marie Schaedel (Educational Associate for Biology, Carleton College), Ka Thao ’17, Calvin Phan ‘17
Summer 2015

Supervisor: Raka Mitra (Assistant Professor of Biology, Carleton College)

The phytopathogen Ralstonia solanacearum causes bacterial wilt disease in hundreds of plant species including tomato, potato, and eggplants. Ralstonia delivers an array of effector proteins directly into the plant cell. One of these conserved effectors, Rsp1281/PopS, is required for full virulence on several plant hosts. This summer, we performed yeat two-hybrid analysis to identify potential tomato protein targets of PopS. A yeast two-hybrid library created from Ralstonia- and mock-inoculated susceptible (Bonny Best) and resistant (Hawaii 7996) tomato plants was used. We fused the full-length PopS effector on the N-terminal of the Gal4 DNA binding domain and the tomato targets on the activation domain. If PopS bound to a target, this binding would activate downstream gene expression which allowed yeast to grow in the absence of certain essential nutrients. From this screening, we collected 25 tomato proteins that potentially interact with PopS. However, 19 of the results came back as a protein that produces Uracil, which was one of the nutritional requirements used in our selective media, suggesting that this growth is not due to PopS-target binding. We are in the process of determining the sequences of the other identified proteins.

Dust Correction of Hydrogen-alpha regions in M33
Maclay, Matt ‘18
Authors/Contributors: Cindy Blaha (Professor of Physics and Astronomy, Carleton College)
Summer 2015

Supervisor: Cindy Blaha, (Professor of Physics and Astronomy, Carleton College)

M33 is a neighboring galaxy to our own Milky Way. All galaxies are composed of stars, dust, and gas, which contribute to their spectra and observable properties. When looking at the observed flux of M33's ionized Hydrogen regions, it is crucial to correct for the effects of the dust in the galaxy. The dust extincts brightness and gives us misleading values of a region's flux. In this project, I analyzed data of different wavelengths -taken with different observatories- and wrote a series of programs to correct for this dust-attenuation.

Designing and Creating an Educational Git Client
Maki, Kiley '16
Authors/Contributors: Dave Musicant (Professor of Computer Science, Carleton College), Graham Earley '17
Summer 2015

Supervisor: Dave Musicant (Professor of Computer Science, Carleton College)

The purpose of this project is to design a functional and user-friendly Git client for use in classrooms by students new to version control. Version control software is a necessary tool, but difficult to learn with most existing clients aimed at experienced coders. This project involves examination of current techniques for teaching Git as well as several usability studies in order to design an interface that is educational while also being both simple and powerful. The goal is to fully implement this design and produce a tool for educators to better their students' understanding of and effectiveness when using Git and other version control software.

The Internet of Things: Examining Privacy and Security Challenges in a Booming Industry
Martinez, Nayely '16
Authors/Contributors: N/A
Summer 2015

Supervisor: Professor Amy Csizmar Dalal (Professor of Computer Science, Carleton College)

Referring to the network of physical objects ("things") embedded with sensors and network connectivity in order to collect and exchange data, the Internet of Things (IoT) allows objects to be sensed and controlled remotely across networks. Traditional computers and smartphones are no longer the only devices capable of connecting and transferring information over internet networks — now "smart" TVs, cars, houses, and even whole cities are beginning to turn to IoT as a way to automatize previously manual tasks. Currently, an estimated 10 billion devices are connected to the cloud. By 2020, experts estimate the number of connected IoT devices will near 50 billion

However, the flourishing IoT industry also faces major security and ethical challenges on an unprecedented level, as the growing number of connected devices continues to yield an even greater need to safeguard against security breaches by designing stable, scalable IoT solutions.

Â¿CÃ³mo encontramos la salud?: How Trujillo Working-Class Members Choose their Health Care
Martinez, Olgaby '16
Authors/Contributors: Independent Research
Summer 2015

Supervisor: Pamela Feldman-Savelsberg (Broom Professor of Social Demography and Anthropology, Director of African/African American Studies, Carleton College)

The coastal city of Trujillo, Peru has a diversity of health care options available that ranges from Western biomedicine to traditional healing methods. Previous studies in this region have focused on the impact of Western medicine on traditional ways of healing and have neglected uncovering the complexity of healing processes, especially in a setting where healing is considered a social and cultural practice. When people have a variety of health care options to choose from, how do they determine which to pursue in times of illness ("therapy management")? I conducted interviews and participant observations to investigate the contexts in which people choose. The collected data suggests the most influential factors in therapy management were regional culture and social relations.

Telecoupling of Unconventional Resource Development in the Great Lakes Basin
McKinley, David '18
Authors/Contributors: Dr. Jianguo Liu, Dr. William Taylor, Dr. Heather Triezenberg,
Summer 2015

Supervisor: Dr. Jianguo Liu (Michigan State University); Dr. William Taylor (Michigan State University); Dr. Heather Triezenberg (Michigan State University)

North America's early twenty-first century boom in Unconventional Resource Development (URD) is due primarily to increased use of hydraulic fracturing, horizontal drilling, and crude bitumen mining technologies. Rapid growth in production has altered the political and economic outlook for the United States and Canada's oil and gas sectors. Although the Great Lakes Basin is not an area of high volume resource extraction, increased use of its hydrocarbon transport infrastructure (e.g., pipelines, rail networks, storage facilities, etc.) exposes the region to multifaceted effects of URD. To assess these industries' impact on the Great Lakes Basin from a spatially and temporally aware perspective, this project employs the telecoupling framework, which analyzes coupled

human and natural systems (CHANS) in the context of international markets and politics. We find that although unconventional oil and gas afford some short-term benefits to Great Lakes economies, these are disproportionate to immediate and long-term environmental and economic risks.

Segregation and Surveillance: Challenges of Interracial Activism in 20st Century Los Angeles
Melendez, Kathryn '17
Authors/Contributors: William North (Associate Professor of History, Carleton College), Nancy Cho (Professor of English, Carleton College)
Summer 2015

Supervisors: William North (Associate Professor of History, Carleton College), Nancy Cho (Professor of English, Carleton College)

My work seeks to examine the ways Latino, Asian American, and African American activists engaged in cross-racial organizing in Los Angeles during the Cold War. I'm particularly interested in how women activists engaged with multiple racial/ethnic communities, and how anti-capitalist and anti-racist campaigns thrived in a Cold War period that labeled them as communists.

This summer, I turned to the diverse works of sociologists, California historians, and researchers in ethnic studies to identify moments of interracial and inter-ethnic organizing that would serve as the foundation for my continued research. By doing a survey of POC activism from the 1920s-1970s, I discovered that the city's segregated housing and proliferation of anticommunist campaigns largely defined who people of color chose to work with. As black, Mexican, Japanese, and Jewish Americans became increasingly concentrated on the eastside of LA, striking tensions and exceptional collaborations arose between them.

Building a Better Chinese Suburb
Middeleer, Sawyer '16
Authors/Contributors: Shaohua Guo (Assistant Professor of Chinese, Carleton College)
Summer 2015

Supervisor: Shaohua Guo (Assistant Professor of Chinese, Carleton College)

My research this summer engaged the emergence of environmentally conscious suburbanization in Hangzhou, China. Scholars of architecture in China in the past decades have primarily studied metropolises like Beijing and Shanghai, where China's emergence as a world economic superpower has had a profound influence on the construction of urban space. I focused on a suburb in Hangzhou called Liangzhu New Town, seeking to broaden my understanding of how suburbanization in China relates to a larger urban trend. Over six weeks, I collected promotional materials and conducted interviews with residents as well as those who were involved in

community planning and development. I examin Liangzhu as a product primarily of China's corporate growth beginning in the 1980s. However, the environmental and social consciousness that makes Liangzhu unique originates from the efforts of an early generation of internationally trained Chinese architects who hope to revolutionize land development practice in China from within.

Simulating Anomalous Chaos in a Quantum Duffing Oscillator
Misplon, Moses '17
Authors/Contributors: Arjendu Pattanayak (Professor of Physics, Carleton College), Walter Lynn '16
Summer 2015

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

We simulated a driven double double well oscillator with coupling to the environment (with coupling strength given by a parameter Ɣ). We search for the existence of chaos in the problem by calculating the lyapunov exponents (which measure the divergence between initially nearby trajectories) using classical, semi-classical, and quantum simulations for a large range of dissipations and effective Planck's constant Ä§. For certain coupling strengths Ɣ we showed that this system becomes chaotic as we changed system size from classical to quantum (hence changing effective Planck's constant), which is contrary to the standard intuition.

2D and 3D Fluorescence Lifetime Correlation Spectroscopy with Pulse Interleaved Excitation
Mizuno, Hikaru '16
Authors/Contributors: n/a
Summer 2015

Supervisors: Kunihiko Ishii, Ph. D (RIKEN); Tahei Tahara, Ph. D (RIKEN)

Fluorescence lifetime correlation spectroscopy (FLCS) combines fluorescence correlation spectroscopy with time-correlated single photon counting to examine fluctuations of fluorescence lifetimes at the single molecule level. Fluorescence lifetime is an intrinsic property that is dependent on the molecule's environment. By tagging a molecule of interest with two fluorophores that constitute a FRET (Forster resonance energy transfer) pair, structural information can be obtained. Conventional FLCS is measured with a single excitation wavelength. In this project, a FLCS system with dual-color pulse interleaved excitation (PIE) using a supercontinuum light source was developed. Fluorescence lifetimes were measured for complementary DNA strands that were labeled with a FRET pair. Donor fluorophore decay traces

for different species were obtained by creating a 2D excitation-emission delay correlation map. Eigendecomposition and 3D FLCS analysis of photon data were also performed to obtain species-specific decays.

Smoke of the Fatherland: Repression, Cremation, and Memory in the Former USSR
Moree-Sanders, Almeda '16
Authors/Contributors: Diane Nemec Ignashev (Professor of Russian, Carleton College), Anna Dotlibova (Senior Lecturer in Russian, Carleton College), Laura Goering (Professor of Russian), Gretchen Fernholz '16; Kaylin Land '15, James Browning '15
Summer 2015

Supervisor: Diane Nemec Ignashev (Professor of Russian, Carleton College)

Burial practices in the Russian Empire were closely linked to the Russian Orthodox Church, so after the Bolshevik revolution of 1917, there was a movement to promote cremation as a "communist" alternative to the traditional funeral. By the 1930s, however, cremation had shifted from ideological to practical: Stalin's political repressions were creating a surplus of bodies that needed to be dealt with as quickly and discreetly as possible. During 2014-2015 a group of Carleton Russian majors translated Lidia Golovkova's book about this topic, Ð"Ð´Ðµ Ñ‚Ñ‹ (Where Are You), from Russian into English. During the summer, we traveled to Moscow and St Petersburg to meet with Golovkova and visit sites that figured prominently in her book. Using this information, we are building a website with cultural and geographical context for American readers of our translation and other English speakers who want to learn more about these places and their history.

A novel means of producing stable lasers for atom trapping
Nelson, Brandon '16
Authors/Contributors: Eric Hazlett (Assistant Professor of Physics, Carleton College)
Summer 2015

Supervisor: Eric Hazlett (Assistant Professor of Physics, Carleton College)

Atom trapping has lead to countless scientific discoveries about strange properties of matter found at ultra cold temperatures. A fundamental aspect of cooling and trapping atoms is having a stable laser source to resonate with the target atom energy. However, standard lasers have wide energy bandwidths that quickly drift out of resonance due to external disturbances. Our work on atom trapping has lead to the construction of an External Cavity Diode Laser (ECDL) that controls laser output to within atomic resonance using electrical and optical feedback. Using this laser we have resolved the atomic spectra of Rb87. By using polarization-rotation spectroscopy we can use this

spectrum to stabilize our laser frequency to the Rb87 resonant energy. To expand on this work we have designed a novel 3D-printed extended cavity laser module that is easily produced and attached to standard laser devices to produce an affordable and effective ECDL for high precision applications in the research and instructional lab setting.

Synthesis and Characterizations of Unusual Ruthenium (II) Complexes with PSiP Pincer-type Ligands
Nguyen, Binh '16
Authors/Contributors: Matt Whited (Assistant Professor of Chemistry, Carleton College)
Summer 2015

Supervisor: Matt Whited (Assistant Professor of Chemistry, Carleton College)

As part of our big project to devise novel late-metal systems for cooperative small molecule activation and catalysis, we have previously prepared and characterized a series of ruthenium (II) complexes with tridentate bis(phosphine)/hydrosilyl ligands. Exploring the reactivity of these complexes upon hydride abstraction using with reactive trityl salts has afforded a series of ruthenium (II) complexes with evidence of the formation of a structurally unique ruthenium silylene with a pincer-type ligand. Preliminary studies have also revealed a reaction of these ruthenium complexes with carbon dioxide. Current efforts are directed at full characterizations of these ruthenium (II) complexes and a thorough exploration of their reactivity with CO2 and other small molecules.

Ecosystem Service Analysis for Addis Ababa, Ethiopia
Nootenboom, Chris '16
Authors/Contributors: Tsegaye Nega (Associate Professor of Environmental Studies, Carleton College), Wei-Hsin Fu (GIS Specialist, Environmental Studies, Carleton College)
Summer 2015

Supervisors: Tsegaye Nega (Associate Professor of Environmental Studies, Carleton College), Wei-Hsin Fu (GIS Specialist, Environmental Studies, Carleton College)

Humanity receives tremendous benefits from its surrounding ecosystems. These benefits, termed ecosystem services, are often monetized to provide economic incentives for conservation and ecosystem restoration. The city of Addis Ababa, Ethiopia is undergoing rapid development, converting its grasslands, forests, and agricultural land into urban environments. However, without an estimate of the ecosystem services rendered by these natural areas, the city risks losing money by failing to plan development around its existing natural capital. Using the Natural Capital

Project's InVEST Ecosystem Service modeling suite, we gathered and processed data to determine the projected urban growth's effects on water purification, sediment retention, and carbon sequestration. The scale of the data required—including soil, carbon, nutrient, climatic, elevation, land use, and economic figures—forced the research to continue into the fall. Our results are forthcoming.

Generation of a B Cell Line With the Flp-FRT Recombination System to Study the Mixed Lineage Leukemia 1 (MLL1) Protein

Park, Nathan '16
Authors/Contributors: Weiwei Yang, Yufei Chen, and Dr. Patricia Ernst (University of Colorado, Anschutz Medical Campus)
Summer 2015

Supervisor: Dr. Patricia Ernst (University of Colorado, Anschutz Medical Campus)

The mixed lineage leukemia gene (MLL1) is a proto-oncogene that is ubiquitously expressed in all tissues. Onset of infant leukemias and adult acute myelogenous leukemia are known to be associated with alterations in MLL1. Previous research from our lab has indicated that MLL1 is critical for B cell lymphopoiesis, with loss-of-function studies revealing B cell-specific MLL1-regulated genes. The native MLL1 complex possesses methyltransferase activity, and its targets include genes involved in hematopoiesis, whereas its truncated variants are associated with leukemogenic fusion proteins. Further elucidating the functions of wild-type MLL1 would increase our understanding of the MLL1 fusion protein-mediated hematopoietic transformation. We generated a B cell line that could be stably transfected with single-copy cDNAs such as MLL1. Methods involved bacterial transformation with retroviral plasmids containing flippase recognition target sites, retroviral transduction of mammalian cells, and monoclonal cell isolation. Future studies that include biochemical experiments that complement our genetic studies will provide further insight into MLL1's role in B cell lymphopoiesis.

Acid Mine Drainage Simulated Leaching Behavior of Goethite and Cobalt Substituted Goethite
Penprase, Shanti '16
Authors/Contributors: Dr. Bryn Kimball (Whitman College), Jason Anthony (Whitman College), Samantha Schonberger (Beloit College)
Summer 2015

Supervisor: Dr. Bryn Kimball (Whitman College)

Acid Mine Drainage (AMD) is an Fe-oxide rich pollutant that is often released from sulfide mining. Treatment of AMD includes neutralizing pH to facilitate precipitation of dissolved minerals (such as goethite (FeOOH)) and Trace Metal Substituted (TMS) forms of known minerals. We conducted a leach experiment using pure (Gt) and cobalt-substituted (CoGt) goethites. Leached solids were characterized using X-ray diffraction (XRD) and scanning electron microscopy (SEM). Solutions were analyzed with Inductively Coupled Plasma Mass Spectroscopy (ICP-MS). Compared to leaching of pure Gt, CoGt generated significantly higher pH, higher conductivity, and less dissolved Fe. The differences in leaching behavior between pure and TMS goethite suggest that trace metals coprecipitated with Fe-oxides may not be stable in the long term.

The Influence of Dominance on Subordinate Species in Tallgrass Prairie
Pflughoeft, Lauren '17
Authors/Contributors: Julia Krumholz '16, Cam Shorb '16, Morgan Vought '17, Jared Beck (Educational Associate in Biology, Carleton College), Daniel Hernandez (Associate Professor of Biology, Carleton College), Mark McKone (Towsley Professor of Biology, Carleton College)
Summer 2015

Supervisor: Daniel Hernandez (Associate Professor of Biology, Carleton College), Mark McKone (Towsley Professor of Biology, Carleton College)

The presence of dominant species in a community may affect biodiversity, either through competition or facilitation of subordinate species. Restored prairies are dominated by C4 grass species and often have lower diversity than native prairies. To examine the effect of grass dominance on prairie species, we established a prairie restoration in the Carleton College Cowling Arboretum in 2012. Experimental plots either included or excluded dominant C4 grasses, Andropogon gerardii and Sorghastrum nutans, in the seed mix. After four growing seasons, plots with dominant grasses added had high grass cover. Plots where these species were excluded were dominated by a common prairie forb, Solidago altissima. To determine the impact of dominant species on plant biodiversity, we measured the occurrence and percent cover of all species across all treatment plots. We compared the effect of dominant grasses and the dominant Solidago species on other species' abundances to investigate how dominance influences biodiversity.

Ideas of the Environment in Caribbean Political Discourse: A Case Study of Jamaica's Cockpit Country
Phillips, Sacha '17
Authors/Contributors: Kimberly Smith (Professor of Environmental Studies and Political Science, Carleton College)
Spring & Summer 2015

Supervisor: Kimberly Smith (Professor of Environmental Studies and Political Science, Carleton College), Bill North (Associate Professor of History, Carleton College)

The Cockpit Country is a geological novelty in northwestern Jamaica. It is composed of limestone bedrock eroded over millions of years. The erosion formed star-shaped valeys which provide an ideal habitat for endangered species in Jamaica's largest preserved primary forest. This locale also holds strong cultural and historical significance for the people of Jamaica. What is concerning is the lack of substantial legislative protection this national treasure has against harmful anthropogenic activities particularly, bauxite mining. My research focuses on how environmental issues are framed through historical, cultural and social lenses and how this framing influences the formation of effective policies. I attempt to unearth ideas about the environment and consider their effect on: (i) the urgency with which environmental issues are considered, (ii) the stakeholders involved in the policy making process and (iii) the policy and legislative soultions chosen to contribute to the nation's larger development goals.

Probing the Movements of a Molecular Machine
Raffray, Morgan '16
Authors/Contributors: Ryan Steed (Visiting Assistant Professor of Chemistry, Carleton College), Dr. Hassane Mchaourab (Vanderbilt University), Kevin Jagessar
Summer 2015

Supervisor: Ryan Steed (Visiting Assistant Prodessor of Chemistry, Carleton College),Dr. Hassane Mchaourab (Vanderbilt University)

The project was designed and remotely supervised by Ryan Steed from Carleton College and was supervised at Vanderbilt University by Dr. Hassane Mchaourab.

ATP, the energy currency of life, is synthesized by discharging a proton electrochemical gradient through the ATP synthase protein complex. Proton passage through the membrane-embedded subunit a generates torque on a ring of c subunits, and the energy of this rotation is used for ATP synthesis. The conformational dynamics of subunit a, driven by proton passage and resulting in ring rotation, remain unclear. In this study, we developed a spectroscopic strategy to assess subunit a dynamics via site-directed spin labeling and electron paramagnetic resonance (EPR). We purified and spin-labeled cysteine-substituted E. coli ATP synthase complexes, assessed their biochemical activity, and probed the protein environment around the spin labels using continuous wave EPR experiments. Although purification and labeling were successful, spectroscopic data indicated that the preparation rendered subunit a unstable. Further optimization of this strategy will be necessary to detect protein dynamics during operation of the ATP synthase complex.

Analysis Through Diffracted Light of Fabricated Refractive Index Gratings

Robinson, Anna '17
Authors/Contributors: Kai Huang '16, Marty Baylor (Assistant Professor of Physics, Carleton College)
Summer 2015

Supervisor: Marty Baylor (Assistant Professor of Physics, Carleton College)

Optofluidic devices are instruments that include optical features such as fluid channels. In this research we use a special photopolymer designed to simplify the fabrication of the devices to build an optofluidic spectrometer. Refractive index gratings, which are a necessary feature of optofluidic devices, are periodic variations in the index of refraction within a material. We create the gratings by interfering two 405 nm laser beams within a thin sample of photo-sensitive polymer. A 632.5 nm laser beam is then used to interact with the grating to produce a diffracted beam that can be studied. The intensity of the diffracted beam depends on the amplitude of the refractive index variation. Therefore by monitoring the diffracted beam strength of the gratings and its development over time we are able learn about the gratings and their behavior. This poster presents results from our initial studies of gratings in our photopolymer.

NMR Experiments of Transition State Analog for Mechanistic Study of Catalytic Enantioselective Reaction

Rockey, Nathan '16
Authors/Contributors: Di Wang '15, Lucas Morrill '14, David Alberg (Professor of Chemistry, Carleton College), Gretchen Hofmeister (Professor of Chemistry, Carleton College)
Summer 2015

Supervisor: David Alberg (Professor of Chemistry, Carleton College), Gretchen Hofmeister (Professor of Chemistry, Carleton College)

Enantioselective catalysis by small organic molecules is an important and inexpensive tool in organic synthesis that introduces chirality into achiral molecules. While effective organocatalysts have been developed, more information is needed to elucidate the mechanism for enantioselectivity. Our goal is to synthesize stable, phosphorus-based transition state analogues (TSAs) that mimic the proposed transition states of organocatalytic asymmetric desymmetrization (ASD) reactions of cyclic anhydrides in order to provide insight on the intermolecular interactions between substrate and catalyst in the transition states of these reactions. Understanding the mechanism for enantioselectivity will ultimately enable the development of improved catalysts. After a TSA has been synthesized NMR spectroscopy is used to study the interactions between each enantiomer of a TSA and the catalyst. This poster outlines the NMR experiments on a specific

TSA that mimics the proposed transition state of the methanolysis of a particular cyclic anhydride.

'Nos Han Olvidado': De-legitimization of Poverty in a Peruvian Fishing Community
Rodriguez, Luisa '16
Authors/Contributors: Constanza Ocampo-Raeder (Assistant Professor of Anthropology, Carleton College)
Summer 2015

Supervisor: Constanza Ocampo-Raeder (Assistant Professor of Anthropology, Carleton College)

In Mancora Peru, the two main industries are fishing and tourism. Unfortunately, the industries coincide such that both peak during the Peruvian summer, and both decline significantly during the winter. Though the community never starves, they are plagued by insecurity caused by fluctuations in income coupled with the dangers of the fisherman lifestyle. Because the government's poverty measurement instrument privileges deprivation of material possessions, fisherman households are often labelled as 'socioeconomically stable.' Based on participant observation supplemented by thirty semi-structured interviews, I explore the effects of this denial of poverty-status: first, I examine the extent to which fishermen households that should benefit from government assistance are excluded from the welfare system; second, I consider the additional harm caused by the delegitimization of their suffering. I conclude that these harms contribute to the perpetuation of suffering in Peruvian communities whose plight is not captured by the country's poverty assessment instrument.

Imaging Techniques for Kerogen in the 3.5 Ga Coucal Fm
Ross, Emily '17
Authors/Contributors: Ellie Hara (University of Southern California)
Summer 2015

Supervisor: Kenneth Williford (NASA Jet Propulsion Laboratory), Ellie Hara (University of Southern California)

Extensive reworking of rocks older than 3.5 billion years creates a scarcity of sedimentary samples available from the Early Archean for study. The Coucal Formation of the Coonterunnah Subgroup in Western Australia, the oldest known sedimentary carbonate, is therefore a rare and exciting formation to examine. Samples from the formation are valuable to NASA as potential Mars analogues for the development and testing of Mars 2020 rover instruments and in preparation for future Mars sample return. Previous work has suggested evidence of preserved kerogen in the Coucal, but this result is controversial due to the high likelihood of sample contamination, and has not been reproduced. In this research, a thin section from core depth 352.44m is analyzed using

light microscopy, scanning electron microscopy (with electron-dispersive spectroscopy), and x-ray fluorescence mapping. So far no kerogen has been located, but a thorough methodology has been established for locating areas of interest across instruments at the Jet Propulsion Laboratory's Astrobiogeochemistry Lab in Pasadena, California.

2-Qubit Entanglement and its Connection to Classical Dynamics for the Kicked Top
Ruebeck, Josh '17
Authors/Contributors: Jie Lin, Arjendu Pattanayak (Professor of Physics, Carleton College)
Summer 2015

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

The dynamics of an angular momentum subject to a periodic impulsive force (a 'kicked top') has been a subject of study for 20 years due to its exhibition of entanglement (in the quantum version of the system) and chaos (in the classical limit). The two quantities have been in most cases found to be correlated, with arguments relating to classical-quantum correspondence. We show that a) this seeming correlation exists even at the 2-qubit level, where there should be no classical-quantum correspondence, b) the phase-spaces appear similar even when chaos is not present and c) that in fact the two quantities are anti-correlated for many choices of parameters and initial conditions. Rather, the geometrical similarities between the respective phase spaces are due to the symmetries shared by both systems, as organized around the classical periodic orbits and the quantum eigenstates. We also include discussion of recent results from an experimental group carried out with 3 superconducting qubits.

Creation of Laguerre Gaussian Laser Modes Using Computer Generated Holograms and a Digital Micromirror Device
Rutkowski, Adam '17
Authors/Contributors: Eric Hazlett (Assistant Professor of Physics, Carleton College)
Summer 2014

Supervisor: Eric Hazlett (Assistant Professor of Physics, Carleton College)

Different solutions of the paraxial wave equation give rise to a number of different modes of laser light that can resonate stably in a cavity. The most common and well known mode of laser propagation has an intensity profile and electric field described by a Gaussian function. A separate set of solutions to the paraxial wave equation can be found by using Laguerre polynomials. These beams are cylindrically symmetric, and the photons within the beam have orbital angular momentum in addition to their spin angular momentum. These beams can be used in applications including optical tweezers, interferometry, and manipulation of Bose-Einstein condensates. In this

project we utilized a digital micromirror device along with computer generated holograms to create Laguerre-Gaussian beams modes of different order. To investigate the mode structure of these beams we built a Fabry-Perot interferometer cavity. By using a Pound-Drever-Hall locking method on this cavity we can filter out undesired modes, leaving only the desired pure Laguerre-Gaussian mode to propagate.

Meta-Analysis of Studies Investigating Immune Response to Seasonal Influenza Vaccination
Salazar, Brittany '16
Authors/Contributors: n/a
Summer 2015

Supervisor: Dr. Sandeep Sanga (Station X Inc), Dr. Sanchita Bhatticharya (UCSF), Ravi Shankar (UCSF)

GenePool (Station X Inc) is a Software-as-a-Service platform that enables analysis of patient-derived genomics datasets and has applications in research and clinical settings. ImmPort is a database of data collected from immunology clinical studies funded by the NIAID. I had three objectives: develop a protocol for making ImmPort data compatible with GenePool, validate the data by reproducing the results of a published ImmPort study, and potentially find novel results. I developed a step-by-step protocol for transforming the ImmPort data for compatibility with GenePool, which may be used to mirror the entire ImmPort repository within GenePool. I reproduced some key results from the paper "Systems biology of vaccination for seasonal influenza in humans" by Nakaya et al. (2011), and identified some novel results.

Synthesis and Reactivity of Nickel Silylamides
Schaff, Margaret '16
Authors/Contributors: Lisa Qiu '16, Matthew Whited (Assistant Professor of Chemistry, Carleton College)
Spring 2014-Summer 2014

Supervisor: Matthew Whited (Assistant Professor of Chemistry, Carleton College)

Metal silylamides, which contain a metal-nitrogen single bond and a silicon functional group, have been shown to exhibit novel reaction pathways with normally inert molecules like CO2, CS2 and CO due to facile cleavage of the N-Si bond. Inspired by this surprising reactivity, we have proposed a catalytic cycle using nickel(I) species with the long-term goal of oxidative carbon-nitrogen bond formation via nickel imide (Ni=NR) intermediates. Though nickel imides have not yet been

synthesized by this pathway, I will present findings about the electrochemical properties of three nickel silylamide derivatives under study, as well as results from chemical oxidation attempts on these species. Our results suggest that silicon may play a privileged role in facilitating the proposed catalysis in these nickel species.

Automata in the Holy Roman Empire.
Scheer, Noah '18
Authors/Contributors: Jessica Keating (Assistant Professor of Art History, Carleton College)
Summer 2015

Supervisor: Jessica Keating (Assistant Professor of Art History, Carleton College)

This summer I worked on Professor Jessica Keating's book All Wound Up: Automata, the Holy Roman Empire, and the Early Modern World. Automata, clockwork figures often made from expensive materials have been consistently understood by scholarship as purely decorative objects that were intended to delight a courtly audience. By examining the objects' imagery, movement, and the political or religious opinions of the rulers who owned and commissioned them, the book argues instead that they reflect the larger religious and political issues that the Holy Roman Empire faced during the early modern period. These issues include the demise of the notion of a universal Christian monarchy, the Reformation, the Counter-Reformation, the enroachment of the Ottoman Empire, and global trade.

Sex-Marker Identification in Green Sea Turtles
Schulberg, Anne '16
Authors/Contributors: n/a
Summer 2015

Supervisor: Dr. Tom Schultz (Duke Marine Lab), Dr. Richard Forward (Duke Marine Lab)

A barrier in the conservation and protection of sea turtles has been difficulty in monitoring population dynamics. One key parameter for understanding populations is the sex ratio, which cannot be phenotypically determined in juveniles. Use of restriction site-Associated DNA (RAD) sequencing to identify candidate sex-specific markers was explored in Chelonia mydas. 21 female-specific markers were identified out of 4849 possible loci, where the 21 markers occurred in 32 or 31 females and 0 males. The presence of mostly female-specific sex-identification markers suggest that C. mydas utilizes a ZZ/ZW sex determination system where females are heterozygotic. Identification of genetic markers capable of distinguishing between sexes in sea turtles would aid in conservation efforts providing the ability to monitor population dynamics from samples collected non-invasively.

Combined Effects of AAV-TrkB and BDNF-MSC Treatment on Functional Recovery after Cervical Spinal Hemisection

Sekar, Preethiya '18
Authors/Contributors: Heather M. Gransee, Ph.D., Wen-Zhi Zhan M.D., Carlos B. Mantilla, M.D., Ph.D. (Mayo Clinic); Gary C. Sieck Ph.D. (Mayo Clinic)
Summer 2015

Supervisors: Carlos B. Mantilla, M.D., Ph.D. and Gary C. Sieck Ph. D. (Depts. of Physiology and Biomedical Engineering and Anesthesiology at Mayo Clinic, Rochester, MN)

Unilateral spinal hemisection at C2 (SH) results in loss of descending premotor drive to phrenic motoneuronsand paralysis of the ipsilateral diaphragm muscle (DIAm). Spontaneous recovery of rhythmic DIAm activity occurs over time, which can be attributed to neuroplasticity. Brain-derived neurotrophic factor (BDNF) acting through full-length tropomyosin related kinase receptor subtype B (TrkB.FL) plays an important role in neuroplasticity following spinal cord injury. Previous research has shown that intrapleural AAV7-mediated transduction of phrenic motoneuronswith TrkB.FLas wekk as intraspinaltransplantation of BDNF-expressing MSCs (BDNF-MSC) enhance functional recovery after SH. However, these studies focused on eupneic breathing, which recruits only a relatively small fraction of the phrenic motor unit pool. Higher force, non-ventilatory behaviors (e.g., sigh, occlusion, sneezing) recruit more motor units and could be a better indicator of functional recovery.

Differential responses of prairie rodents to edge effects from recreational trails

Shorb, Cam '16
Authors/Contributors: Daniel Hernandez (Associate Professor of Biology, Carleton College), Laura A. Freymiller
Summer 2015

Supervisor: Daniel Hernandez (Associate Professor of Biology, Carleton College)

Edge effects are a common phenomenon in which an ecological variable changes with respect to distance from a habitat edge. Recreational trails may constitute a habitat edge for prairie rodents because of increased human presence, increased predator presence, or reduced shelter from predators compared to the prairie core. Despite the prevalence of trails in conservation parcels, their effect on wildlife distributions remains largely unstudied. For the second consecutive summer, we used infrared motion-sensing cameras to record the relative amount of time rodents spend at different distances from trails in the Cowling Arboretum. The results varied between taxa: voles (Microtus pennsylvanicus) avoided trail edges, mice (Peromyscus spp.) did not respond to

trail proximity, and thirteen-lined ground squirrels (Spermophilus tridecemlineatus) seemed to prefer intermediate distances. These species-specific effects of trails on rodents may have consequences for habitat connectivity and the distribution of populations.

The Role of Kinase Fusion DNAJB1-PRKACA in Fibrolamellar Hepatocellular Carcinoma
Shui, Bing '16
Authors/Contributors: Angela L. Gregor '16, Sanford M. Simon, Lewis R. Roberts, Dr. Ying Peng (Mayo Clinic), Dr. Yi Guo (Mayo Clinic)
Summer 2015

Supervisor: Dr. Ying Peng (Mayo Clinic), Dr. Yi Guo (Mayo Clinic)

Fibrolamellar hepatocellular carcinoma (FL-HCC) is a rare type of liver cancer. DNAJB1-PRKACA fusion is detected in at least 80% of FL-HCC cases and is considered a potential oncogenic factor. However, the causality between DNAJB1-PRKACA fusion and FL-HCC is not yet established. This study aims at investigating the function of DNAJB1-PRKACA fusion in FL-HCC oncogenesis using Drosophila and murine in vivo models. DNAJB1-PRKACA, when expressed in Drosophila eye progenitor cells, induced proliferation and differentiation phenotypes. For modeling the potential oncogenic fusion in mouse hepatocytes, CRISPR/Cas9 genome engineering was used. Co-transfection of a pair of effective gRNAs successfully generated a 360kb chromosomal deletion on chromosome 8 in mouse hepatocytes. Therefore, DNAJB1-PRKACA fusion is mimicked in vitro to further examine its oncogenicity.

Scalable Boson Sampling with Partially Distinguishable Photons
Slote, Joseph '16
Authors/Contributors: Tyler Keating (CQuIC, University of New Mexico), Dr. Ivan Deutsch (CQuIC, University of New Mexico), Arjendu Pattanayak (Professor of Physics, Carleton College)
Summer 2015

Supervisor: Dr. Ivan Deutsch (CQuIC, University of New Mexico)

Quantum computing is a theoretical computing paradigm that promises to perform certain computational tasks exponentially faster than the computers we have now. However, because quantum computing requires fine control at the atomic scale, a number of engineering challenges stand in the way of realizing a universal quantum computer. In the meantime, researchers have proposed special purpose quantum devices that are practical to build but still demonstrate the computational superiority of quantum technology. One such device, the Boson Sampler, relies on the complicated behavior of photons in a network of beamsplitters to produce an output

probability distribution that can't be efficiently calculated by classical methods. To explore the feasibility of constructing such device, the present research analyzes how error in the optical components propagates to output error. We determine that these error sources require only polynomial improvement to preserve the sampler's computational ability as problem size grows.

Examination of Pediatric Radiation Dose Delivered After Cervical Spine Trauma
Somppi, Laura '17
Authors/Contributors: n/a
Summer 2014-2015

Supervisor: Dr. Anupam Kharbanda '93 (Children's Hospitals and Clinics of Minnesota)

Pediatric Cervical Spine Injuries (CSIs) are rare injuries which are difficult to diagnose. In addition, pediatric CSIs have high morbidity rate, with many resulting in death or neurological deficits. Suspected CSIs are often x-rayed first; however, due to cervical x-ray's poor sensitivity, Emergency Department physicians often obtain cervical CTs and/or MRIs as well. During CT scans, the thyroid gland receives a dose of radiation that has been shown to increase rates of hard tissue cancer in pediatric patients, and this radiation has been attributed to 10-70 new cancer cases per 10 000 scans. Given this information, the goal of this project was to analyze Children's Hospitals and Clinics of Minnesota's Minneapolis Pediatric Level 1 Trauma Center's prevalence of pediatric CSIs and to determine the sensitivity and specificity of the current imaging methods used. With this information, the results will provide clinicians with concrete information with which to compare the risks and accuracy of cervical CT radiation against the risk of a CSI.

Color Morphology in Lizards and Snakes
Song, Ximou '16
Authors/Contributors: Matt Rand (Professor of Biology, Director of Neuroscience, Carleton College), Stephan Zweifel (Professor of Biology, Chair of Biology, Carleton College)
Summer 2015

Supervisor: Stephan Zweifel (Professor of Biology, Chair of Biology, Carleton College)

Previous research has shown that MC1R is important in melanin production. It encodes a protein known as the melanocortin1 receptor which is found on the surface of melanocytes. Studies on reptiles have had conflicting results. Sequences of the MC1R gene in lizards have shown no relationship between color morphology and differences in the coding region of the MC1R gene. Here we attempt to sequence the MC1R coding region in the bullsnake using three color morphs, amelanistic, wild type, and hypomelanistic. The closely related black pine snake was also

sequenced in order to study MC1R in a hypermelanistic phenotype. The gene POMC has also been implicated in melanin based polymorphisms in snakes, and we attempted to replicate the results of previous studies in our bullsnakes. Ultimately we found polymorphisms in the MC1R gene but were unable to associate them significantly with specific color morphs. Seqencing in POMC was inconclusive and may need further research to determing its role in bullsnake melanin production.

Mediterranean Rivers: Chained and Unchained
Spaeth, Tyler '16
Authors/Contributors: Victoria Morse (Professor of History, Carleton College), Mary Savina '72 (Charles L. Denison Professor of Geology, Carleton College), Laurel Bradley (Director and Curator in the Perlman Teaching Museum, Carleton College), Christina Chang (Interim Director & Curator of the Perlman Teaching Museum, Carleton College), George McAneny '16
Summer 2015

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

In the exhibit "Mediterranean Rivers: Chained and Unchained," we explored the variety of ways a person could think about and visualize rivers. Our project examined a wide range of sources to answer this question; engineering texts demonstrated how the river could be exploited to do important work, while astronomers mapped metaphorical rivers onto the sky. In the end, we concluded that rivers prompted responses of fascination, appreciation, and terror. Communities — both in 16th- century Italy and Northfield today — have always sought to understand, visualize, and "chain" rivers for their own practical and cultural ends.

Mazi Archaeology Project
Sundberg, Elaine '17
Authors/Contributors: Alex Knodell (Assistant Professor of Classical Languages, Carleton College), Alex Claman '17, Liza Davis '16, Charlie Linneman '17
Summer 2015

Supervisors: Alex Knodell (Assistant Professor of Classical Languages, Carleton College), Sylvian Fachard (Senior Research Associate, University of Geneva)

The Mazi Archaeological Project (MAP) of 2015 was an intensive pedestrian survey of the Mazi Plain in northwest Attica, Greece, focusing primarily on a diachronic study of the human occupation and land use of the area. MAP operated under the auspices of the Ephorate of Antiquities of West Attica, Piraeus, and the Islands, and the Swiss School of Archaeology in Greece. We conducted fieldwork in three primary zones of the plain; the project involved fieldwalking over

carefully plotted survey units, counting and collecting notable artifacts on the ground. These artifacts included lithics, generally from prehistoric periods, and ceramics (pottery and tile) mostly from Classical, Roman, and Byzantine eras. Several other modes of investigation were also employed, including photogrammetric documentation of archaeological features and geologic coring and soils analysis. Data collected in this field season has helped to establish visible patterns of long-term human settlement and land-use throughout the Mazi Plain.

The bacterial wilt disease of plants: studies of bacterial effector proteins and plant root responses to Ralstonia solanacearum

Thao, Ka '17
Authors/Contributors: Raka Mitra (Assistant Professor of Biology, Carleton College) Marie Schaedel '15 (Educational Associate for Biology, Carleton College), Calvin Phan '17, Khuaten Maaneb de Macedo '16
Summer 2015

Supervisor: Raka Mitra (Assistant Professor of Biology, Carleton College), Marie Schaedel '15 (Educational Associate for Biology, Carleton College), Jennifer Wolff, Associate Professor of Biology, Director of Neuroscience, Carleton College)

The phytopathogen Ralstonia solanacearum causes bacterial wilt disease in hundreds of plant species including tomato, potato, and eggplants. Ralstonia delivers an array of effector proteins directly into the plant cell. One of these conserved effectors, Rsp1281/PopS, is required for full virulence on several plant hosts. This summer, we performed yeat two-hybrid analysis to identify potential tomato protein targets of PopS. A yeast two-hybrid library created from Ralstonia- and mock-inoculated susceptible (Bonny Best) and resistant (Hawaii 7996) tomato plants was used. We fused the full-length PopS effector on the N-terminal of the Gal4 DNA binding domain and the tomato targets on the activation domain. If PopS bound to a target, this binding would activate downstream gene expression which allowed yeast to grow in the absence of certain essential nutrients. From this screening, we collected 25 tomato proteins that potentially interact with PopS. However, 19 of the results came back as a protein that produces Uracil, which was one of the nutritional requirements used in our selective media, suggesting that this growth is not due to PopS-target binding. We are in the process of determining the sequences of the other identified proteins.

An Inevitable Clash: Mismatched Values in the Medical Field and Supreme Court
Tilton, Emily '17
Authors/Contributors: Larry Cooper (Professor of Political Science, Carleton College), Daniel Groll (Associate Professor of Philosophy, Carleton College)
Summer 2015

Supervisor: Larry Cooper (Professor of Political Science, Carleton College)

As the medical field switched from a paternalistic approach to an approach that respected the autonomy of patients, it became necessary to lay out which abilities patients needed to have in order to be deemed capable of making important health decisions. In order to solve this discord that arose between medical awareness and religious belief, the Supreme Court often had to step in to defend the religious freedom of the patients by setting precedents. As more precedents were set and the requirements were refined, the courts and doctors seemed to be getting on the same page. This paper aims to make clear that scholars' and doctors' conception of capacity and the precedents set by the Supreme Court do not reflect the same values, and argues that the formulation of capacity must be changed because it is not only misguided, but perhaps immoral in its handling of religious beliefs.

Mechanisms of Concussion and Recovery Outcomes
Totten, Douglas '16
Authors/Contributors: Dr. Scott Zuckerman (Vanderbilt University Medical Center), Dr. Gary Solomon (Vanderbilt University Medical Center), Andrew Kuhn (University of Michigan)
Summer 2015

Supervisor: Dr. Scott Zuckerman (Vanderbilt University), Dr. Gary Solomon (Vanderbilt University)

Popular opinion on concussions has grown in recent years, primariliy due to debate in professional athletics. However, young athletes are the most prone to concussions and have the fewest resources. This study examined the mechanism of concussion in adolescent athletes and their recovery patterns in an attempt to identify correlations. With adolescent brains and futures ahead of them -- mostly outside the realm of athletics -- young athletes are also the most at-risk athletes. The study performed at Vanderbilt University Medical Center surveyed nearly 300 young athletes, primarily in the Middle Tennessee region, who had sustained concussions over the past three years and examined correlations between methods of sustaining concussion, symptoms, family history and recovery patterns. Football, soccer and basketball have significantly more concussions than other sports, and females sustain concussions more easily than males. More analysis will illuminate further risk factors for prolonged concussion recovery.

Investigating the Effect of Compost Tea on Organic Crops
Vail, Delaney '16

Authors/Contributors: Daniel Hernandez (Associate Professor of Biology, Carleton College)
Summer 2015

Supervisor: Daniel Hernandez (Associate Professor of Biology, Carleton College), Aaron Wills (Little Hill Berry Farm), Andrew Ehrmann (Spring Wind CSA Farm)

Compost tea is the process of straining compost and using the liquid as a fertilizer to directly transfer beneficial microbes to plants. We designed two experiments on local organic farms to examine the effect of compost tea on plant chemistry and soil microbial activity. The first experiment examined blueberry plants at Little Hill Berry Farm to determine whether variety and/or age would affect the response of plants or soil to compost tea applications. In the second experiment we investigated five crop species (potato, carrot, broccoli, tomato, spinach) at Spring Wind CSA Farm and their responses to compost tea. We samples leaves, soil, and fruits, which will be analyzed in fall 2015 for C:N ratio, leaf carbon quality, and soil extracellular enzyme activity. We expect our findings will go directly to the farmers to help them decide whether compost tea is a worthwhile and efficient fertilizer for their crops.

Optimization of MCMC Sampling for Diagnosing Algebra Misunderstandings
Vinitsky, Sam '16
Authors/Contributors: Anna Rafferty (Assistant Professor of Computer Science, Carleton College)
Summer 2015

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

When watching a student solving an algebra problem, a teacher is usually able to determine the student's understanding of various algebra rules based on student's mistakes. Previous work has automated this process using Bayesian inverse planning, an algorithm that uses patterns in a person's observed actions to determine that person's beliefs about the world. Inverse planning requires computing an intractable integral which is approximated used MCMC sampling, which is often slow. The goal of our research was to customize this sampling algorithm in order to improve its running time for the specific application of using a student's worked solutions to determine her knowledge. We explored the effect of various parameters on the performance of the algorithm. Through optimization and parallelization, we were able to increase the running time from 4 hours to about 10 minutes, without negatively impacting the quality of the results.

Targeted Notch Activation Therapeutically Induces Cell Death in B-ALL (B-cell Acute Lymphoblastic Leukemia)

Wiersma, Becca '17
Authors/Contributors: Sankaranarayanan Kannan, PhD. (Anderson Cancer Center), Srinivas Somanchi, Lizhi Zeng, and Patrick Zweidler-McKay, MD/PhD (MD Anderson Cancer Center)
Summer 2015

Supervisor: Sankaranarayanan Kannan, PhD. (Anderson Cancer Center), Patrick Zweidler-McKay, MD/PhD, MD (Anderson Cancer Center)

The Notch pathway has been shown to act as a tumor suppressor in B-cell Acute Lymphoblastic Leukemia (B-ALL), one of the most prevalent forms of cancer in children. We aimed to therapeutically activate Notch signaling in B-ALL via targeting the Notch ligand DLL1 to B-cells using a chimeric protein. Human B-ALL lines were treated with this protein, and expression of Notch target gene HES1 and effects on cell survival were measured. Exposure of B-ALL cells to the protein led to increased Notch signaling and decreased Notch surface receptor expression. Importantly, exposure of the B-ALL lines to the chimeric protein led to decreased cell counts. Therefore, we suggest that this soluble DLL1 chimera is a potential therapeutic approach for B-ALL, warranting further testing.

Virtual Experiences of 18th Century English Workhouses

Wong, Florence '16
Authors/Contributors: Susannah Ottaway (Professor of History, Carleton College), Austin Mason (Robert A Oden Jr. Postdoctoral Fellow for Innovation in the Liberal Arts and Digital Humanities in History, Carleton College), Graham Earley '17, Jeremy Fisher '16
Summer 2015

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

Before the New Poor Law of 1834, workhouses were institutions established to relieve poverty in 18th century England by providing accommodation and work for the impoverished, infirmed, elderly, and disabled. Our Virtual Workhouse project examines historic architecture and furniture, while drawing from archival documents to re-create digital versions of the atmosphere and experience of 18th century workhouses. We use Google SketchUp and Blender to create 3-D architectural and object models, and Unity to combine the virtual models into a walkthrough experience.

On our research trip to England, Professor Susannah Ottaway, Graham Earley '17 and I visited various locations that offered information on workhouse experience and surroundings: museums and archives, as well as former workhouse buildings re-purposed for other uses. We photographed documents and historic sites for references and textures for modeling, and documented archival sources in preparation for a class in the winter taught by Susannah Ottaway and Austin Mason.

The Construction of a Gal4-ERT/UAS System to Study The Role of Wnt9b in Kidney Regeneration
Wu, Ivy '16
Authors/Contributors: Wenyue Wu
Summer 2015

Supervisor: Dr. Caramai Nana Kamei, Dr. Iain Drummond (Massachusetts General Hospital)

The ultimate cure of end-stage renal diseases at the moment is kidney transplantation, but at the moment the donor sources is very limited. Therefore, a stem cell based therapy becomes an active area of research. Zebrafish serves as a good model to study kidney regeneration because of their capacity to regenerate nephrons, the basic functional unit of a kidney, from progenitor cells after acute injury, and mammals cannot do so. Thus, understanding the exact molecular mechanism of kidney regeneration in zebrafish becomes crucial. Our lab specifically studied the role of Wnt9b in zebrafish nephron regeneration. We found that Wnt9b is highly expressed in the existing tubular epithelia after injury and a universal overexpression of this molecule right after injury leads to more nephron formation. We are also developing a new zebrafish transgenic line that is able to overexpress/inhibit Wnt9b in a tissue specific manner using the GAL4-ERT:UAS system.

The Role of Cyp26 Enzymes in Cardiac Development and Possible Implications for HLHS
Yang, Andrew '16
Authors/Contributors: Charles Eyermann '16, Katherine Campbell, Timothy Nelson, Taylor Wells
Summer 2015

Supervisor: Dr. Katie Campbell (Mayo Clinic)

Hypoplastic left heart syndrome (HLHS) is a congenital heart defect characterized by a severely underdeveloped left ventricle. We propose that HLHS is caused by reduced expression of the cytochrome p450 26 enzyme family (CYP26). This imbalance results in high concentrations of retinoic acid (RA), impaired endocardial cushion formation, valve defects, irregular blood flow, and ultimately HLHS. Azole compounds have been implicated in the inhibition of CYP26, and some retinoids regulated by CYP26, such as isotretinoin, are known teratogens that can adversely affect

endocardial cushion formation. There has been no published work investigating the potential relationship between CYP26 and HLHS. A greater understanding of CYP26's involvement in retinoid signalling may shed light on novel treatment options for HLHS.

Neonatal Iron Deficiency Perturbs Neuronal Oxidative Stress Response
Yeker, Richard '16
Authors/Contributors: Thomas Bastian; Dr. Michael Georgieff (Center for Neurobehavioral Development at U of Minnesota), Phu Tran, Ph.D (Center for Neurobehavioral Development at U of Minnesota)
Summer 2015

Supervisor: Dr. Michael Georgieff (Center for Neurobehavioral Development at U of Minnesota), Phu Tran, Ph.D (Center for Neurobehavioral Development at U of Minnesota)

Iron deficiency causes cognitive and socio-emotional abnormalities in adulthood despite prompt iron repletion in childhood. We sought to determine if iron deficiency permanently alters the mechanism that mediates the neuronal response to oxidative stress, thereby reducing the ability of neurons to cope with external stressors. We used deferoxamine (DFO) to induce iron deficiency in an immortalized neuronal cell line (HT-22) derived from embryonic mouse hippocampus. Iron deficient (ID) and FID cells were analyzed for expression of genes along the NRF2-mediated oxidative stress response pathway. Compared to iron sufficient (IS) control, ID and FID HT-22 cells showed alterations in expression of molecules along the NRF2-mediated stress response pathway. Our finding confirms the diminished oxidative stress response in adult FID hippocampal neurons.

Rethinking Theater in a Multimedia Culture
Yu, Phoebi '16
Authors/Contributors: n/a
Summer 2015

Supervisor: Roger Bechtel (Professor of Theater, Carleton College)

The principal characteristic of theater is often considered to be its "liveness." Film and video production, in contrast, are considered mediatized. Yet, more and more theater productions incorporate film and video projection not just as scenery, but as an important part of the performance. This trend is a call to both theater and film professionals to rethink the boundaries and natures of these two mediums. This project examines filmic projections on stage through the lens of a trilogy done by contemporary performance group Temporary Distortion. Through performance analysis, this project argues that when different mediums are integrated as a unified whole to such an extent that the existence of any medium depends on others, the discussion of the ontology of any single medium is insufficient, because any given medium is altered by other mediums in atomic or reconstructive ways.