COLLEGE OF THE
Holy Cross

# Twenty-Eighth Annual Symposium

# Dr. Charles S. Weiss Summer Research Program

September 9, 2022
Hogan Ballroom

*Dear Members of the Holy Cross Community,*

*Welcome to the 2022 Dr. Charles S. Weiss Summer Research Symposium. Now in its 28th year, the symposium is a college-wide event, bringing together faculty and students from all disciplines at Holy Cross and providing an opportunity to celebrate their accomplishments over the summer of 2022. It also affords an occasion for students to witness the breadth of research possibilities both on and off campus, and to open a dialogue with members of the faculty about conducting research during the upcoming academic year and summer.*

*The program and symposium are named after Charles "Chick" Weiss who joined the psychology faculty in 1975 with a Ph.D. in neurobiology and physiology from Ohio University. An esteemed professor, mentor and scholar, Weiss served as the chair of the psychology department from 1984 to 1989. He also served the College as Coordinator of Grants and Research (1989-95), the Director of the Office of Grants and Corporate and Foundation Giving (1995-2003), and the Director of Strategic Initiatives and Corporate and Foundation Relations from 2003 until his retirement in 2016. Weiss was integral to bringing major projects to life, most notably the College's Integrated Science Complex, Brooks Concert Hall and the Summer Research Program.*

*We hope you enjoy the impressive collection of scholarship on display today.*

*Daniel Bitran, College Science Coordinator, Director Summer Research in Natural Sciences and Mathematics*
*Anthony Cashman, Director Summer Research in Humanities, Social Sciences, and Arts*
*Daniel Tortorice, Director Summer Research in Economics*

*In recognition of those whose financial contributions have made this research possible:*

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National Science Foundation grant, Research Experience for Undergraduates, Department of Mathematics, University of Virginia

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## Presenting Authors / Abstract Number

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## Poster 1

### Worcester's Lost History: Investigating the Dairy Industry*

*A. Berard, M. Hartnett, and D. Harvey*
*Department of Sociology and Anthropology, College of the Holy Cross*

Worcester is quite well known for its role in the industrial revolution. With both the Blackstone Canal and the Providence and Worcester Railroad it was the epicenter of industrialization in New England. There is much scholarly work about this time. There is, however, little known about the period immediately prior. Before Worcester industrialized, there were other industries present, most notably the dairy industry. Unbeknown to many, Worcester County had many prominent dairy farms scattered throughout Worcester--areas that are now hospitals, high schools, and parking lots. These farms facilitated the industrialization of Worcester. The goal of our project is to uncover and piece together the history of Worcester's 19th-century dairy industry. To do so we partnered with the Greater Worcester Land Trust (GWLT) to tell the story of the people and places important for Worcester's dairy industry. Through archival research ranging from biographies of various New England families to cattle show records, government documents, censuses, and reports from local historical societies, we have been able to produce a clearer picture of what this period looked like. Some of the outcomes of our work have been a website with write-ups of prominent farms of the time as well as photo galleries, maps, and other features that will be published on the GWLT website. We are also in the process of developing informational signs for trail paths at Sibley Farm, a former dairy located in Spencer that the GWLT maintains. Finally, we have created a podcast that details the rise and fall of the dairy industry in Worcester, which hikers can listen to as they explore the Sibley Farm trail or as they peruse the GWLT website which features other informational graphics and stories of conserved sites in Worcester.

This research was made possible by the Weiss Summer Research Program.

## Poster 2

### Investigation of Wormholes using Numerical Relativity

*B. Fay and B. Kain*
*Department of Physics, College of the Holy Cross*

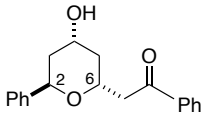
Einstein-Rosen bridges, commonly known as wormholes, are hypothetical structures that emerged from general relativity in 1935 and have since occupied a prominent position in relativistic research and popular science. The study of numerical relativity, using numerical methods to study wormholes and other relativistic phenomena, is comparatively novel, and we focused our research on using numerical relativity to study the evolution of specific wormhole systems in time. We partitioned our research with two separate gauges, one of which I focused on. I wrote Python code to simulate the evolution of wormholes using both a real and complex scalar field and compared my results against previous work. I introduced pulses of energy to study how this impacted wormhole behavior. First, I simulated a pulse of energy entering the system, and noted how the throat of the wormhole expanded or collapsed into a black hole depending on the sign of the amplitude of the pulse. Since ascertaining the exact location of the "event horizon" – the boundary of the resultant black hole – is impossible, I instead simulated an approximate boundary known as an "apparent horizon" and the path of light rays as they either escaped the boundary of the black hole, or did not. I also simulated the introduction of standard matter – in contrast to the exotic matter that composes wormhole systems – and examined how the system and the matter evolved in time. I used multiple numerical methods to confirm that the results I obtained were valid solutions.

We thank the Summer Research Scholarship in Mathematics for financial support.

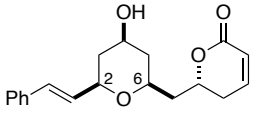
**Poster 3**

## Synthesis of Tetrahydropyran Natural Products

*H. G. Ford and K. J. Quinn*
*Department of Chemistry, College of the Holy Cross*




diospongin B




cryptoconcatone H (proposed)

Tetrahydropyrans, six-membered oxygen-containing heterocycles, are common substructures of biologically and chemically important natural products. Diospongin B, an anti-osteoporotic, and cryptoconcatone H, an anti-bacterial, are examples of tetrahydropyran natural products that are isolated from different plant species. One important difference between these two molecules is the stereochemical relationship between the substituents at the 2- and 6-positions. On this poster, we will describe two different strategies that allow access to both the thermodynamically preferred 2,6-*cis* orientation present in cryptoconcatone H and the less synthetically available 2,6-*trans* orientation of diospongin B. Specifically, we report a three-step synthesis of the proposed structure of cryptoconcatone H exploiting its hidden symmetry in which the 2,6-*cis* tetrahydropyran ring is constructed via Prins cyclization. We also report an approach to diospongin B employing an intramolecular oxa-Michael addition to produce an advanced stage bicyclic lactone intermediate, possessing the requisite 2,6-*trans* stereochemistry, that may be transformed into the target in just one step. We believe these strategies will be broadly applicable for the synthesis of a wide range of tetrahydropyran natural products.

We gratefully acknowledge the American Chemical Society Division of Organic Chemistry for funding this work through a Summer Undergraduate Research Fellowship awarded to H.G.F.

**Poster 4**

## Beyond the Cabin in the Woods: Exploring Transcendental Influence on Visual Culture in Nineteenth-Century New England

*J. Anastasi, G. Moscardelli, and M. Geisler-Trafton*
*Department of Visual Arts, College of the Holy Cross*

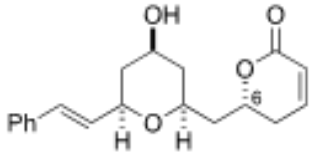
The new, American philosophy of Transcendentalism emerged in New England during the first half of the nineteenth century. Ralph Waldo Emerson, often regarded as the father of the movement, published his canonical essay “Nature” in 1836, asserting that there exists a certain harmony between human beings and the natural world. Many scholars have previously investigated the ways in which the visual characteristics of landscape painting illustrate the sentiments presented by contemporary Transcendentalist intellectuals. Our exhibit, however, extends beyond the fine arts and explores how the rise in popularity of the philosophy influenced a wider array of nineteenth-century cultural representations, its themes reaching the general public through newspapers, periodicals, magazines, poems, subscription-based organizations, and annual gift-book keepsakes. Identifying five key terms that we feel encapsulate the trajectory of our research, we reviewed archival publications such as *The Dial, The Western Literary Messenger,* and *The Crayon* and analyzed cataloged records of publicly exhibited artwork to investigate how the popularity of the Transcendentalist movement spread to different components of the visual culture of the period.

We thank the J.D. Power Center and Weiss Summer Research Program for financial support.

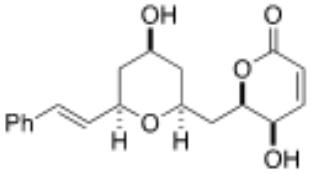
**Poster 5**

## Concise Synthesis of Cryptoconcatone Natural Products Exploiting Hidden Symmetry

*J. B. Choi, C. J. Terranova, and K. J. Quinn*
*Department of Chemistry, College of the Holy Cross*




cryptoconcatone H




cryptoconcatone K

The cryptoconcatones are a family of natural products isolated from *Cryptocarya concinna*, a species of plants found in China, of which several members exhibit antibiotic activity. On this poster, we report a synthesis of the proposed structure of cryptoconcatone H and its C6 epimer using an efficient strategy that relies upon our recognition of hidden symmetry present in the two oxygenated rings. Our synthesis commenced with a symmetric diol, which was desymmetrized by Mitsunobu esterification with crotonic acid. In a second step, a highly diastereoselective Prins cyclization was employed for the preparation of the all-*cis*, left-hand, tetrahydropyran ring. Ring-closing metathesis resulted in formation of the right-hand dihydropyranone ring and completed the synthesis. Our three-step route greatly improves upon previous syntheses that each required greater than ten steps. As a result, we hope to leverage this approach to the synthesis of more complex analogues, such as cryptoconcatone K, and verify their stereochemical compositions.

Funding of this work by the Weiss Summer Research Program and a Robert J. Stransky Foundation Research Fellowship in the Sciences is gratefully acknowledged.

**Poster 6**

## Studying Wormholes using Numerical Methods

*K. Calhoun and B. Kain*
*Department of Physics, College of the Holy Cross*

Over the course of this summer, we used numerical methods to study the behavior of wormholes. A wormhole is a bridge between space and time at two locations. To simulate the wormhole's behavior through time, we used equations describing matter, gravity, and spacetime, and evolved these sets of equations through both space and time with Runge Kutta formulas in Python. The matter describing the wormhole is known as a 'ghost' scalar field (as opposed to 'real') because the kinetic energy of the system is set to a negative value. The most physical of our variables represents the size of this 'bridge' and is known as the wormhole throat radius. At the center, if the throat radius is nonzero then a wormhole exists. Through monitoring this variable, we were able to see the resulting behavior in different scenarios. We had a static case where we set up the initial conditions for a wormhole and not much changed through time. The next case was with a perturbation, which involved sending in a pulse of either real or ghost energy described by another matter field (separate from that which makes up the wormhole). Depending on different values of the energy pulse and the different kinds of matter sent through, the wormhole either expanded, with the throat radius increasing at the center, or a black hole formed, with the throat radius collapsing.

We thank the George Alden Trust Excellence in Career Related Undergraduate Education for financial support.

## Poster 7

### An Ecumenical Treatment of the Christological Controversies

*C. S. McCormick and P. Fritz*
*Department of Religious Studies, College of the Holy Cross*

The author's long-standing concern with conflicts and splits between different Christian churches led him back to the fifth-century CE when these rifts first arose during controversies over how to articulate belief in Jesus Christ. The project primarily concerns the Council of Chalcedon (451 CE), the Christological disputes that it was called to settle, and the ongoing controversies that continued after it. Key to these debates was concern for God's real involvement in the human story through the truly human experience of Jesus Christ on earth, as well as concern to defend Jesus Christ's singleness of person (which, for many in the fifth century, connected back to that aforementioned direct Divine involvement). Recent ecumenical dialogue between the Christian churches that came out of those fifth century rifts proves that both sides of this rift share those key concerns, and in fact both defend those key concerns, though emphasising different things and using different terminology. Many key metaphysical terms used in the Christological debates of the fifth century and after never had standardised definitions. Instead, their meanings were fluid; different people using the same key terms meant different things when they used them. Having surveyed the impact of this teminological miscommunication on these debates, this research has found that the rift caused by those debates was not caused by a fundamental disagreement about faith in Jesus Christ, but rather by misunderstanding caused by the difficulties of translating complex theology across linguistic and culturalborders.

We thank the J. D. Power Center and Weiss Summer Research for financial support.

## Poster 8

### Ethnographic Discoveries: Weaving Together Art and Craft

*G. Trznadel and S. Rodgers*
*Department of Sociology and Anthropology, College of the Holy Cross*

As a studio art major working in drawing and painting, archiving the work of Refugee Artisans of Worcester (RAW) has expanded my definition of art and has made me question the English language divide between art and craft. From a Western point of view, craft often gets pushed aside and put below art found in museums. Craft is regarded as a hobby to make functional items, while art is held up as more creative and expressive, but how do we distinguish between the two? How do the labels we put on works inform our perspectives of them? Do the stereotypes that we project onto them limit our perception? RAW artisans work with bamboo, rattan, plastic strips, and thread to make their works, which some observers consider to be craft. Drawing on ethnographic interviews (Ong, *Buddha is Hiding: Refugees, Citizenship, the New America*, 2003; Rodgers, S., *Museum Anthropology,* 44: 24-37, 2021) with artisans this summer for the archive, in contrast to the Oxford English Dictionary definitions, we have discovered RAW artisans' work as examples of how items described as craft can actually be art. In this dictionary, art is "the expression or application of human creative skill and imagination, typically in a visual form such as painting or sculpture, producing works to be appreciated primarily for their beauty or emotional power" (OED Online, www.oed.com/view/Entry/11125). But RAW crafts take skill and mastery, show much creativity, and are appreciated for their aesthetics and impact on the viewer and artisan. The line between the two is blurred in resettled refugee communities in Worcester.

We thank the Weiss program for financial support, Ellen Ferrante and Joan Kariko of RAW, and the Rodgers and Umunna booklet *Path to Empowerment: Refugee Artisans of Worcester* (Holy Cross 2017)

## Poster 9

### Application of the Finite Element Method to Quantum Systems

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*Department of Physics, College of the Holy Cross*

Our research focused on solving the Time-Independent Schrödinger Equation (TISE) using analytical and numerical methods. Analytical solutions exist only for a few special cases, but the Finite Element Method (FEM) can be used for any potential. In FEM, we divide the domain into small regions, called elements. In each element, the wave function is approximated as a sum of $5^{th}$ degree polynomials; these functions are joined smoothly at the element boundaries to ensure that the wave function is continuous. We first solved the 1D Simple Harmonic Oscillator (SHO) analytically; this served as a test case for the FEM C++ code. Next, we obtained analytical solutions for the bound states and scattering states of the asymmetric well. We derived an analytical condition for the existence of bound states as a function of the barrier heights. We also proved that the transmission coefficient for particles scattering off the asymmetric well is *independent* of the direction of the incident wave. These results were verified by FEM calculations. Finally, we extended FEM to 2D. Our test case was the isotropic 2D SHO. Because the potential is separable in $x$ and $y$, we were able to obtain analytical solutions; the symmetry of the potential results in degenerate energy levels. The FEM code reproduced both the energy levels and degeneracies. We then used the 2D FEM code to examine the effect of adding a non-separable perturbation to the potential. As expected, the perturbation removed the degeneracy of the energy levels.

We thank the Patricia McGovern Hill ‘82 P12 and Peter J. Hill ‘82 P12 Family Summer Research Scholarship fund that made this work possible.

## Poster 10

### Cut, Copy, Paste: Mobile Genes in Archaea

*E. B. Proffitt, K. R. Poon, C. E. Quinn, M. N. Yurchick, and K. V. Mills*
*Department of Chemistry, College of the Holy Cross*

We are interested in studying mobile genes, called inteins, found in haloarchaea. Inteins are genes that interrupt coding segments of DNA and are transcribed and translated into self-excising portions of proteins. Within these inteins is a homing endonuclease enzyme - a DNA cutting enzyme that specifically digests DNA sequences lacking an intein at sites where other genes contain an intein. The double stranded break that results from this cleavage is repaired by homologous recombination and utilizes an intein-containing allele as a template thus reinserting the intein gene. To test the sequence specificity of the homing endonuclease, we observed whether the intein from one organism could facilitate intein homing into the intein-less gene of the same or similar species. In our lab, we observed whether *Haloferax volcanii*’s (Hvo) intein, located in its DNA Polymerase B gene, would cleave a plasmid containing intein-less genes from *Halobacterium salinarum* (Hsa) and from Hvo. As a negative control we also introduced a scrambled Hsa gene lacking the conserved sequence for cleavage. To test the success of intein insertion into our plasmid DNA, we used PCR to amplify the gene from cultures isolated from plates grown on minimal media and ran the product on an agarose gel. The size of the PCR product reveals whether the intein has been inserted. A larger PCR product would indicate the intein inserted while a smaller PCR product would suggest that the intein did not insert.

We thank the National Institutes of Health, NIGMS (Grant 1R15GM132817-01) for supporting our research.

## Poster 11

### Splice and Dice: Nuclease Activity of Halophilic Inteins

*C. E. Quinn, M. N. Yurchick, K. R. Poon, E. B. Proffitt, and K. V. Mills*
*Department of Chemistry, College of the Holy Cross*

Halophiles, or organisms that live in high salt environments, contain mobile genetic elements called inteins. Inteins facilitate protein splicing, the process by which inteins remove themselves from a segment of protein and join the exteins. Embedded in an intein is a homing endonuclease. The homing endonuclease is a DNA-cutting enzyme that digests only specific target sequences. The homing endonuclease digests the site in a gene where an intein gene has been lost or is absent. The resulting double-stranded break is repaired by homologous recombination using an intein-containing allele as the template, propagating the intein into the gene. We are interested in the sequence specificity and order of digestion of two homing endonucleases from inteins that interrupt minichromosome maintenance (MCM) protein from the halophile *Halobacterium mediterranei.* We have purified the two enzymes after over-expression of the intein genes in *E. coli* and purification via affinity chromatography. We have optimized the amplification of the target gene sequence by PCR. Finally, we have begun to determine conditions to facilitate *in vitro* DNA cleavage.

We thank the National Institutes of Health, NIGMS (Grant 1R15GM132817-01) for support of our research.

## Poster 12

### "Bringing the Holy Land Home" permanently: Using online archives to preserve in-person exhibition experiences indefinitely

*B. Hendershott and A. Luyster*
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The Cantor Gallery at the College of the Holy Cross hosts temporary exhibitions throughout the year. Some of these, including Spring 2023's "Bringing the Holy Land Home," require years of work, substantial funding, and many people's efforts to bring them to fruition. Sadly, once a temporary exhibition closes, often little of this momentous effort remains. In many instances, the only record of the exhibitions exists in the printed catalog, secluded in select academic libraries, and largely inaccessible to the public. I have built a comprehensive and publicly available website to record the five years of scholarship behind "Bringing the Holy Land Home". The exhibition centers on a digital reconstruction of the Chertsey tiles: a destroyed medieval tile floor that depicts Richard the Lionheart's Crusade. This online resource includes a brief history of Chertsey Abbey and the Crusades in the context of the Third Crusade and Richard the Lionheart, analysis of each of the 12 reconstructed floor tiles for the exhibition, an object archive with deep dives into particular objects on loan for the exhibition, and a wide array of videos about these topics. We used examples of other successful exhibitions from institutions such as the Worcester Art Museum, the De Young Museum, and National Geographic to inform our materials' content and tone. We have aimed to make these resources accessible to all potential visitors of the exhibition and will incorporate the produced videos into the physical exhibition through QR codes. The object archive will also be added to a database of art historical resources for K-12 educators hosted by Harvard University.

We thank the Weiss Summer Research Program in Humanities, Social Sciences, and Arts for financial support.

## Poster 13

### ‘Burning’ British Sentiment: Press Coverage of Anti-Catholic Populism, Papal Aggression, and the Resurgence of Guy Fawkes Fears in Victorian Britain

*J. Kazlauskas and M. Conley*
*Department of History, College of the Holy Cross*

Guy Fawkes Day, now known as Bonfire Night, is a popular celebration in England that commemorates the discovery of the Gunpowder Plot, a failed treason plotted by Catholics to blow up Parliament in 1605. Evocations of Guy Fawkes were perhaps never as violent nor as anti-Catholic than in the period of Catholic conciliation and coercion in Victorian England, particularly in the decade following Pope Pius IX’s reinstation of the Catholic hierarchy through *Universalis Ecclesiae* in 1850, pejoratively referred to as “Papal Aggression.” We believe that sectarian violence took on a different, and often overlooked, composition in mid-Victorian Britain due to the press’ intense critique of the Catholic progress associated with the expansion of rights, the rise of Irish Catholic immigration, and the increase of Irish nationalism. For this study, we focused particularly upon how the press reacted to *Universalis Ecclesiae* and to its aspersions of Papal Aggression, while tracing the ways in which the press deployed Guy Fawkes as a rhetorical bogeyman to stoke fears of Catholic advancement as a part of a larger Catholic conspiracy to undermine British sovereignty. To conduct this study, we focused upon a close study of four different local and national publications including the “Birmingham Daily Post,” “Manchester Courier and Lancashire General Adviser,” “The London Times,” and “The Illustrated London News.” Through this refined press study of the 1850s and 1860s, we realized that Guy Fawkes emerged in a different fashion to signal populist fears of a Catholic resurgence that would undermine British Protestant identity in a myriad of ways. The press not only had a role in covering events such as Guy Fawkes Day, but also had a role in depicting the character of Guy Fawkes in a rhetoric that helped to enflame anti-Catholic sentiments and encourage anti-Catholic demonstration in mid-Victorian Britain.

We thank the Weiss Summer Research Program for financial support.

## Poster 14

### Populist leadership: A comparative study between Argentina, Greece and the United States

*A. Papacharalampous and M. Rodrigues*
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In recent years, populism has gained global appeal; this research determines when and how populism may appear in a nation. This research shows that populist politicians may arise when three criteria converge: 1) The political system is in disarray, and people must no longer feel that established institutions are representing them; 2) Economic instability or cultural backlash must exert pressure on the political environment; and 3) A political leader emerges who is able to "sell" their image as an “outsider” to voters through successful use of traditional and social media. Evidence was drawn from three case studies of populist leaders in three different countries. Throughout the 20th century, Juan Peron was a right-wing populist in Argentina. In 2015 Alexis Tsipras rose as prime minister in Greece and is currently the head of the left opposition, Donald Trump emerged in the United States in 2018 as a successful right-wing populist.

We thank the Weiss Summer Research Program for financial support.

## Poster 15

### Comparing the Visitor Impact of Events at Professional Sports Facilities

*V. Matheson, R. Baumann, and J. Muldowney*
*Department of Economics and Accounting, College of the Holy Cross*

This research estimated the economic impact on local economies from hosting sporting and other cultural events in stadiums and arenas primarily used by sports teams in the five major sports leagues (NFL, MLB, NHL, MLS, NBA). Daily hotel data on revenue and room occupancy gathered from Smith's Travel Research was used to isolate and estimate the effect that visitors in town for events at sports venues would have on the local economy. The hotel data and the event data were gathered from five cities: Cleveland, Denver, Houston, Minneapolis/St. Paul, and Pittsburgh. The research finds that it is rare for sports stadiums to host non-sporting events, with the exception of those built for primary use by NBA or NHL teams. However, these events, particularly large concerts, have larger tourism impacts than sporting events. Furthermore, use in these stadiums by the primary tenant during the regular season generates small amounts of tourism benefits, with the exception of MLB. Finally, mega-events like the Super Bowl or Final Four have significant observable impacts, but are very rare.

We thank the Weiss Summer Research Program in Economics for financial support.

## Poster 16

### Derivatives of GGA inhibit Beta-Sheet Formation Associated with Neurodegenerative Disease in a 1:1 Ratio.

*I. Raso and S. Petty*
*Department of Chemistry, College of the Holy Cross*

There are several neurodegenerative diseases associated with the misfolding of proteins into beta sheets. The formation of beta sheets results in aggregation that causes deposits of insoluble protein in the brain. A loss of the protein's native structure prevents the protein from functioning properly. Past research has shown that the disordered tri-peptide GGA (found in the alpha-synuclein, a protein whose misfolding is associated with Parkinson's disease) has the ability to reverse beta-sheet formation and return proteins to their native structure (disordered, in the case of alpha-synuclein). Current research is focused on changing one amino acid in the peptide sequence GGA to see if the new sequence still has the ability to break apart beta-sheets. Specifically, we are interested in looking at the peptides GGG and GAA. Samples were analyzed using infrared spectroscopy to monitor the Amide I peak, which is associated with the stretching of the carbonyls in each amino acid of the peptide. First, GGG and GAA were analyzed alone to ensure that they were disordered. Then, the disordered peptides were mixed with AVV, an amyloidogenic peptide sequence, to determine whether they could break apart beta sheets in AVV. The frequency of the Amide I peak in the IR provides information about the resulting structure of the peptide mixture. Comparison between these experimental spectra and the spectra created by mathematical averaging of the spectra of the individual peptides provides information about the effect of the disordered peptides on AVV. In a 1:1 ratio, GGG and GAA are successful in breaking apart beta sheets formed by AVV. In a 1:7 ratio of 0.025M GGG/GAA and 0.175M AVV, GGG and GAA are not successful in breaking apart beta sheets formed by AVV. There is no difference between GGG and GAA in terms of ability to break apart the beta sheets.

The authors thank the Robert J. Stransky Foundation Research Fellowships in the Sciences for financial support.

## Poster 17

### Transcript Stability and Translational Control of *De Novo* Gene *saturn* in Drosophila

*E. J. Gualdino, P. H. Patel, and G. D. Findlay*
*Department of Biology, College of the Holy Cross*

*De novo* evolved genes are derived from previously non-coding DNA regions. In numerous animal species, these genes are often expressed in the testes, suggesting they could evolve essential roles in male fertility. Our lab has shown that four *de novo* genes are essential for fertility in the fruit fly, *Drosophila melanogaster*. One such essential gene, *saturn*, is first transcribed in pre-meiotic testis cells, but the protein it encodes is not detectable until after meiosis. This observation prompted us to study the post-transcriptional control of *saturn* expression. We found that a *saturn* rescue construct under control of only the gene's upstream regulatory sequence was insufficient for male fertility, suggesting that the gene's downstream region is necessary for correct expression. Because *saturn*'s downstream region is predicted to bind several testis-expressed RNA binding proteins (RBPs), we used RNA interference to begin to evaluate whether any of these RBPs is necessary for *saturn* expression. Knockdown males showed widespread male sterility, which correlated with morphological defects in the testes. We are currently evaluating Saturn protein localization in the absence of these RBPs and using RT-PCR to determine whether *saturn* expression levels are perturbed. We are also creating additional rescue constructs that contain various parts of the *saturn* downstream regulatory region to identify the specific sequences required for proper post-transcriptional control. These results highlight additional evolutionary steps that may be important for newly evolved genes to acquire essential functions.

We thank the National Science Foundation for financial support.

## Poster 18

### Functionality of a *De Novo* Evolved Gene Across *Drosophila* Species

*B. McCormick, S. Metri, P. Patel, and G. D. Findlay*
*Department of Biology, College of the Holy Cross*

*De novo* evolved genes emerge from non-protein-coding DNA. Some can become useful to the organism and evolve essential functions. Our lab has identified several *de novo* genes in *Drosophila melanogaster* that are essential for male fertility. One gene, *saturn*, is required for maximal sperm production and sperm motility. We previously found that the Saturn protein sequence evolved rapidly and adaptively across fly species, suggesting the possibility that this novel protein's function is still being refined. To test this idea, we examined how well different species' copies of *saturn* function in *D. melanogaster*. Saturn proteins from closely related species *D. simulans* and *D. yakuba* function well in *D. melanogaster*, but the ortholog from a more divergent species, *D. ananassae*, fails to allow any sperm production. Our summer research involved: 1) testing the function of the *saturn* ortholog inferred to be present in the common ancestor of *D. melanogaster, simulans* and *yakuba*; 2) evaluating the conservation of a nuclear localization signal in the Saturn protein that may be critical for its cellular activity; 3) creating a mutant version of *D. melanogaster* Saturn that lacks a nuclear localization signal; and, 4) testing the function of Saturn from *D. eugracilis*, an ortholog of intermediate phylogenetic distance predicted to lack a nuclear localization signal. We are also developing an antibody to *D. ananassae* Saturn to examine that ortholog's localization in its native species. Collectively, these experiments will illuminate the evolutionary steps and protein sequence features that were required for this novel gene to evolve its essential role in current-day *D. melanogaster.*

We thank the National Science Foundation for financial support.

**Poster 19**

## Synthesis of 6,5-Fused Ring Systems

*Z. Tympanick and A. K. Isaacs*
*Department of Chemistry, College of the Holy Cross*

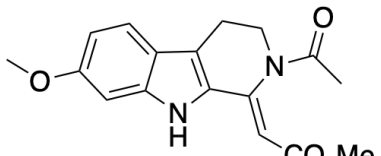
Ketenimines are synthetic intermediates that react highly with various nucleophiles. Our research group forms ketenimines through "click chemistry." Through Copper(I)-Catalyzed Azide Alkyne Cycloaddition (CuAAC), a terminal alkyne reacts with tosyl azide to form a 1,4-disubstituted 1,2,3-triazole that decomposes into the reactive ketenimine intermediate due to the electron withdrawing tosyl group. This intermediate in turn can form various nitrogen heterocycles when it engages with a nucleophile. We utilize this ketenimine intermediate in an intramolecular [4+2] cycloaddition in order to synthesize a 6,5-bicyclic all-carbon ring system. The successful creation and optimization of this sequence can lead us to develop a method for gaining rapid access to the framework of relevant organic structures such as steroids. We have developed a reproducible synthesis for our model substrate and will test the viability of this approach in the future.

We thank Jacqueline H. and George A. Paletta, Jr., M.D. '84 P15 for financial support.

**Poster 20**

## Synthesis of Pegaharmine F

*O. Afifi and A. K. Isaacs*
*Department of Chemistry, College of the Holy Cross*




**Pegaharmine F**

*Pegaharmine F* is a naturally occurring molecule found in the *Peganum harmala* flower seeds which were traditionally used to treat alimentary tract cancer and malaria in northwestern China. Our primary interest in this molecule stems from it containing an indole group and that it has never been synthesized before. We hope to accomplish the total synthesis of *Pegaharmine F* in three steps. Our current work involves using tryptamine as a model substrate, due to its commercial availability and lower cost, to develop the synthesis. The key step of our synthesis is a Bischler-Napieralski cyclization with a subsequent acylation and isomerization. Our current efforts have proven that this is a viable method. Immediate goals include optimization of our key step.

We thank the National Science Foundation grant to Notre Dame University's Center for Computer-Assisted Synthesis for their financial support of this project.

## Poster 21

### Synthesis of Novel *N*-Heterocycles via Copper-Catalyzed Diels-Alder Reactions

*C. Kerr Abraham and A. K. Isaacs*
*Department of Chemistry, College of the Holy Cross*

Our research group utilizes "click chemistry" to form synthetic intermediates called ketenimines. These compounds are versatile and capable of novel transformations due to their highly reactive nature. We synthesize ketenimines through the reaction of an alkyne with tosyl azide in a copper-catalyzed process to form 1,4-disubstituted 1,2,3-triazoles which naturally decompose to form ketenimines. In the presence of a nucleophile, the ketenimine is capable of forming various nitrogen heterocycles. We utilize the ketenimine intermediate as a dienophile with a tethered diene, allowing an intramolecular Diels-Alder reaction to occur. This reaction forms a 6,5-bicyclic system that can be used as a potential building block in the synthesis of compounds of interest to the synthetic community. Preliminary results show that this process is viable and our future work involves optimization of the reaction conditions.

We thank Janna L. Murgia-Hoppin '98 and John W. Hoppin, Ph.D. '98 for the financial support.

## Poster 22

### Investigating the Spinal Muscular Atrophy (SMA) Gene *mog-4* in the Insulin-Signaling Response to a High-Glucose Diet in *C. elegans*

*G. Bode and M. A. Mondoux*
*Department of Biology, College of the Holy Cross*

Spinal muscular atrophy (SMA) is a neurodegenerative, genetic disease in humans caused by a mutation to the SMN-1 gene. Our lab identified the C. elegans ortholog *smn-1* as a potential glucose-specific insulin-signaling regulator. *smn-1* interacts with other genes in C. elegans, forming the "SMA network". One of these "SMA network" genes is *mog-4*, which was also identified as a potential glucose-specific insulin signaling regulator. My aim here was to explore *mog-4*'s role in regulating insulin-signaling. It is known that a high-glucose diet prevents *daf-2* insulin receptor mutants from entering the dauer alternative life stage. Since entry into dauer is a result of low insulin signaling, this suggests that a high-glucose diet increases insulin signaling. By testing dauer formation, our lab's previous results suggested that *mog*-4 knockdown prevented an increase in insulin signaling in the presence of glucose. Other than decreasing dauer formation, increased insulin signaling leads to decreased healthspan (healthy period of an organism's life) and lifespan. We predicted that the decrease in insulin signaling due to *mog-4* knockdown would result in an increase of healthspan and lifespan. We assessed the effects of *mog-4* knockdown in *daf-2* mutants. Initial results show that when insulin signaling is low, *mog-4* knockdown on a high-glucose diet prevents healthspan decline of *C. elegans* worms later on in life. However, we found no lifespan extension on a high-glucose diet when *mog-4* is knocked down in a *daf-2* mutant with low insulin signaling. These results suggest that *mog-4* knockdown has different effects on different insulin-signaling phenotypes. Future directions include repeating these experiments, as well as tracking the stages of mobility decline alongside lifespan.

This work was supported by Kathleen and Stephen R. Winslow P16,14 and the William F. McCall, Jr. '55 Summer Research Fund.

**Poster 23**

## Adaptive Tests for Mixed Paired and Two-Sample Designs

*T. Yacovone, E. Sun, and S. Richter*
*Department of Mathematics and Statistics,*
*University of North Carolina at Greensboro*

A common situation in statistics is the desire to measure the impact on a population before and after some treatment. Traditionally, this is solved using a paired test-a measure is taken of a sample, the treatment is applied, then a second measurement is taken of the same exact sample. Inference can then be performed on the difference of locations. Consider a teacher who wants to determine whether a particular lesson improves student knowledge on a topic; an exam can be administered to the students prior to the lesson, then the same exam can be administered to the students after the lesson. But what if, at the time of the second test, some students are homesick? Or have moved districts? We may frequently be left with a combination of data that is paired and unpaired. While we could simply throw out either the paired or unpaired data, and perform the correspondingly appropriate analysis, this risks losing important information that we may not have to discard. Alternatively, experiments may be designed wherein investigators intentionally have both paired and unpaired observations. We propose adaptive tests for mixed paired and two-sample designs using a $t$-based test and a Wilcoxon-based test. Previous simulation studies have found that $t$-based tests perform well for normal data, while Wilcoxon-based tests perform well for nonnormal data. The proposed adaptive tests use two different proposed tail index combination schemes to distinguish between normal and nonnormal mixed pairs data to select the situationally most powerful test. A simulation study is conducted to measure the power and Type I error rate of the proposed adaptive tests, compared to using their constituent tests uniformly.

We thank the National Science Foundation (Grant DMS-1950549) for financial support through their summer REU program

**Poster 24**

## Investigating Myth in *Iliad* Scholia: New Computational Approaches

*R. R. Kaczmarek and N. Smith*
*Department of Classics, College of the Holy Cross*

Can we find latent patterns in commentaries on the *Iliad*? We examined tens of thousands of comments on the *Iliad* in sources from the 10th to the 12th centuries CE using an unsupervised computational analysis method called topic modeling. This method finds recurring patterns of co-occurring terms, which human readers can then interpret as topics or subjects. We developed a vocabulary of "stop words" (terms like "the" or "and" that are so frequent they should be omitted from the analysis) and applied a new system of morphological analysis to unite inflected forms of the same terms into their base lexeme. Thus, we successfully isolated topics such as grammar, Homeric weaponry, and mythical history and geography. While topic modeling uncovers similar content in different documents, it can also highlight unexpected differences. We found, for example, that the phrase "the poet" (ὁ ποιητής) is so pervasive in the commentary of the twelfth-century scholar Eustathius that we had to treat it as a stop word in modeling his text.

We gratefully acknowledge the Weiss Summer Research Program for their financial support of this project.

**Poster 25**

## Peer Effects in StarCraft II

*C. Tobin and J. Svec*
*Department of Economics and Accounting, College of the Holy Cross*

The goal of our summer research project was to examine the potency of peer effects: the degree to which the quality of an individual's peer group influences that individual's success. To accomplish this, we used data from the real time strategy video game StarCraft II (SC2). This setting, novel for the peer effects literature, was chosen because professional players compete in tournaments individually but often train by joining a team consisting of other professional SC2 players. Within these teams, players practice build-orders with each other, discuss strategy, and hone their skills. We wondered whether measures of team ability influence the future performance of each individual on the team. Using a fixed effects panel specification, we found that average team ability has a small but positive influence on individual performance, holding constant player age, matches played, player race, and starcraft game version. Thus, there is evidence of peer effects in the SC2 universe! Upon learning this, we sought to decompose the effect to determine whether the general skill level of a player's teammates was more or less important than the race-specific or tactic-specific skills of a player's teammates. We found that the latter were more influential than the former. Our next step will involve attempting to account more explicitly for the endogeneity associated with better players joining better teams.

We would like to acknowledge the Weiss Summer Research Program for financial support.

**Poster 26**

## Out of Sight and Out of Mind: The Case for Prisons as Environmental Injustices

*C. Shortell and D. Harvey*
*Department of Sociology and Anthropology, College of the Holy Cross*

In this paper I explore prisons through an environmental justice lens, asking questions about how patterns of racial capitalism, mass incarceration, and environmental racism inform today's incarceration regime in which prisons are constructed on environmentally toxic land. I assess dynamics in how we treat the environment and how we treat marginalized communities that are entrenched in ideologies about who and what constitutes waste, what value is assigned to them, and how these factors shape recurring patterns of disposing of people and disposing of our environment at the same time. I ask, how did these ideologies historically emerge to criminalize marginalized communities on toxic land? Moreover, if environmental justice movements center around ensuring mutual rights to a livable ecosystem, how do perceptions about disposability interfere with what people and what environments are protected? I answer these questions through a consideration of the ways in which racism, identity, and oppression combine with economic forces to create complex environmental suffering directly impacting the lived experiences of inmates at a state prison in Pennsylvania.

Thank you to Professor Harvey and Dr. Cashman for their guidance, as well as the Weiss Summer Research Program for its financial support.

**Poster 27**

## Molecular Attachments to Planar Gold

*E. Robinson and E. Landis*
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Gold's conductivity and its inability to oxidize in air makes it a promising material for nanoelectronics. If it is to be used in this way, a thorough understanding of molecular attachments to gold is required. Though there have been studies regarding the attachment of thiols in single-component layers, the mixing of multiple thiols on gold surfaces is not yet well understood. There has also been little research thus far into the attachment of carbenes, molecules with a neutral carbon atom containing two unshared valence electrons, which may have stronger bonds with gold than thiols. Accordingly, both carbene layers and thiol mixtures were studied. We sequentially attached thiols of varying chain lengths and structures to planar gold in different orders, and attached carbenes to planar gold using an electrical current. In both cases, results were analyzed with cyclic voltammetry. By comparing the desorption potential of the most stable thiol with that of the carbenes, we verified that the carbene-gold bond is significantly stronger than the thiol-gold. This finding is promising for the use of carbenes in nanoelectronics in the future. The study of thiol mixtures showed that thiols can mix on the surface of gold, but will instead attach only as single-components if attachment time and order are not fine-tuned to the given molecules. More research in this field may provide greater insight into the principles of mixing.

Many thanks to Wendy R. and Kenneth J. Edwards, M.D. '80 P12 and to Deirdre O'Brien Soltesz '94 and Edward G. Soltesz, M.D. '94 for financial support.

**Poster 28**

## Quantification and Comparison of Sea Urchin Internal Organ Structures

*G. DiRaimo and S. B. Crofts*
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*Friday Harbor Laboratories, University of Washington*

In this study, we examined the Aristotle's lantern and other internal organs to determine if morphology varies with ecology between three species of urchin: the purple urchin (*Strongylocentrotus purpuratus*), the green urchin (*S. droebachiensis*), and the pale urchin (*S. pallidus*). In particular we are focusing on the Aristotle's lantern, a complex tool used for feeding and, in the purple urchin, for excavation. To measure internal anatomy, we used contrast-stained CT scans of urchins collected at Friday Harbor Labs, WA. We utilized the image computing program 3D slicer to isolate structures of interest in these scans, as well as to measure length and volume of both the entire test and the isolated organs. We measured the test, gonads, gut, and structures associated with the Aristotle's Lantern (total size, protractor muscles, and retractor muscles). To account for size differences between the urchins, we normalized our measurements by test size. Our preliminary findings indicate that the Aristotle's Lantern is overall the same size (relative to the test) in our different species of urchin, but has different proportions in different species. We also observed differences in the muscles associated with the feeding apparatus, between protractors and retractors, as well as between species. We will use the methods developed this summer to continue to explore how ecological factors might relate to Aristotle's Lantern morphology between species, and between populations of a phenotypically plastic species.

We thank Allison O. and Steven D. Harr, M.D. '93 and the Friday Harbor Laboratories for financial support.

## Poster 29

### Ferrocene Attachment to Nanoporous Gold via Click Chemistry

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Nanoporous gold (NPG) has been studied primarily due to the high surface area and conductivity of its porous surface. NPG samples are synthesized from the de-alloying of a thin gold/silver leaflet in nitric acid for at least 30 minutes. Higher time frames resulted in the formation of larger planar terraces on the NPG surface. We have attached ethynylferrocene using a copper catalyzed azide-alkyne cycloaddition (CuAAC). This click reaction takes advantage of the reactivity between an azide and an alkyne and is generally insensitive to most conditions. Different ratios of surface diluent, thiophenol, and dithiobis phenyl-azide, were bound to the NPG surface after three days of functionalization and verified by infrared spectroscopy. Subsequent click reaction of the ethynylferrocene to the surface-bound azide was successfully verified by cyclic voltammetry. Our results suggest that ferrocene attachment to NPG via click chemistry proves to be electrochemically stable. Longer de-alloying times decreased the uneven ferrocene intermolecular interactions.

We thank Janna L. Murgia-Hoppin ’98 and John W. Hoppin, Ph.D. ’98, and Deirdre O'Brien Soltesz ‘94 and Edward G. Soltesz, M.D. ’94 for their generous financial support of this research.

## Poster 30

### Age-Related Differences in Reactive Oxygen Species and Senescence in Canine Lung Mesenchymal Stem Cells

*P. Molluso, A. Tanveer and J. Paxson*
*Department of Biology, College of the Holy Cross*

Our lab is interested in understanding how cells age. Lung mesenchymal stem cells (LMSCS) are a group of highly proliferative, multipotent cells which have the ability to self-renew or differentiate into various connective tissues found in the lungs (Svieven et al., 2020). Previous research has identified decreased proliferative and regenerative capacities, as well as a senescent phenotype, in high-passage MSCs, (Fafian-Labora et al, 2019). Given the potential that MSCs have shown for regenerative and immunomodulatory therapies (Chen et al., 2022), it is crucial to understand exactly how these cells age. To better understand how these cell populations age, we examined two hallmarks of aging-cellular senescence and reactive oxygen species (ROS)- in canine LMSCs isolated from companion dogs of varying breeds and aging. This canine model of aging is a novel model system which may be more robust and generalizable than the high-passage clonal cell line models of aging used in most cellular aging studies. We hypothesized that cells from older dogs would display higher levels of both ROS and senescence, and then developed assays using flow cytometry to assess these hallmarks. Interestingly, our data found no significant difference in both ROS and senescence between cells from old and young dogs, which is contrary to past research (Liguori et al., 2018). In future research, we hope to test more cell lines as well as different, related variables, such as the time it takes cells to recover from oxidative stress.

We thank the George I. Alden Trust Excellence in Career Related Undergraduate Education and the Weiss Summer Research Program for financial support.

## Poster 31

### Dimethyl Fumarate as a Potential Therapy for Neurological Complications of Long COVID

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*Albert Einstein College of Medicine*

Long COVID, also known as PASC, post-acute sequelae of SARS CoV-2, is a condition in which patients with COVID-19 experience persistent symptoms. There is currently no clear definition for PASC but the WHO definition is that the symptoms must be persistent 3 months post the onset of COVID-19 while the CDC defines it as persistence 1 month following the onset of COVID-19. One important aspect of PASC are the widespread neurological symptoms in previously healthy people who experienced mild COVID. The most common neurological symptoms include brain fog, headache, cognitive impairment, mood and sleep disorders, depression, anxiety, myalgia, sensorimotor deficits and dysautonomia. The cause of these neurological symptoms is unknown. Studies have shown that patients with neurological PASC have a decrease in overall brain mass, neuroinflammation, elevated tau levels, reductions in localized grey matter regions, brain lesions and abnormal cerebral spinal fluid (CSF). Many of these structural and functional effects of PASC overlap with multiple sclerosis (MS). MS patients are treated with dimethyl fumarate (DMF) to reduce relapse rate and brain lesions. DMF is an anti-oxidative and anti-inflammatory drug that is approved by the FDA to treat patients with MS and psoriasis. Interestingly DMF-treated MS patients with COVID-19 were less likely to be hospitalized compared to MS patients not on DMF ($p<0.05$). Here we propose a new clinical trial to test the efficacy of DMF on the neurological complications of long COVID.

We thank the Crusader Internship Fund of the College of the Holy Cross for financial support.

## Poster 32

### The effects of knocking down sei and ncc69 in neurons and glia

*S. Iannone and A. Hill*
*Department of Biology, College of the Holy Cross*

Nervous system activity must be regulated in order for animals to respond properly to changes in environmental conditions. The ability of the nervous system to adapt in a homeostatic manner and continue managing bodily functions and behaviors is vital for survival; however, we lack an understanding of how glia interact with environmental stressors. We have previously identified two genes in *Drosophila melanogaster* whose function in glia affect nervous system susceptibility to environmental stress: *sei* and *ncc69*. s*ei* is a voltage-gated potassium channel whose knockdown in all glia or neuropile ensheathing glia (EGN), a subtype of glia, increases susceptibility to heat-induced seizure and paralysis. Similarly, *ncc69* is a sodium/potassium/chloride symporter, whose knockdown in all glia or EGN increases susceptibility to bang-induced seizure and paralysis. In *Drosophila*, EGN may support adaptability of the nervous system through their function as phagocytes, which mediate axonal and dendritic pruning. We hypothesize that phagocytic functions of EGN glia may be critical for homeostasis during environmental stress. We developed a novel, mild bang-induced seizure protocol in which about half of the *ncc69* knockdown flies exhibited paralysis-like behavior, so that in future experiments we can test if additional manipulations in EGN lead to increased seizure susceptibility. The knockdown of *sei* in neurons, all glia, and EGN has been previously conducted using an adult assay, but we wish to focus on larvae because there are many techniques that allow us to explore larval neuronal activity. Knocking down *sei* in all glia or neurons causes larvae to spend less time exhibiting normal locomotion behavior and more time exhibiting seizure-like whipping behavior, as compared to controls. Based on these findings, we plan to test the hypothesis that phagocytic functions of EGN glia may be critical for homeostasis during environmental stress by using the mild protocol. In addition, we plan on studying the impact of EGN glia on larval neurophysiology to better understand how glial cells regulate neuronal homeostasis.

Thank you to Janna L. Murgia-Hoppin ‘98 and John W. Hoppin, Ph.D. ‘98 for supporting this work.

**Poster 33**

## Using Comparison to Promote Causal Learning in a Science Museum

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*and [1]Department of Psychology, Worcester State University*

Science museums facilitate the learning of STEM concepts (science, technology, engineering, and math) through informal experiences in which children may not have an adult to guide their learning. Therefore, exhibits must be structured accordingly to optimize learning and prevent misconceptions. Our approach draws on the power of comparison, which facilitates learning through the structural alignment of multiple representations. In the present study, we tested the effects of comparison in an exhibit about the day-night cycle. Children have the common misconception that the Sun moves across our sky to transition from daytime to nighttime rather than Earth rotating on a 24-hour cycle to face a stationary Sun. We hypothesize that the comparison between the Earth-based perspective (the sky seen from Earth) and the space-based perspective (Earth's rotation seen from space) will enhance children's learning about the day-night cycle (Jee & Anggoro, 2021). This project was carried out at the EcoTarium, the museum of science and nature in Worcester, in summer 2022. Across two conditions, we manipulated whether participants saw both the Earth- and space-based perspectives (Comparison Condition) or the space-based perspective alone (No Comparison). We observed 78 children across both conditions, some of whom interacted at our exhibit with a caregiver and/or siblings. We will report preliminary findings on children's engagement with the exhibit and whether the exhibit conditions affected their causal explanations of the day/night cycle.

We thank the generous contribution of Trent and Michele Kamke P23 and a grant from the Scholarship in Action for funding this project.

**Poster 34**

## Geodesic Growth of Numbered Graph Products

*L. Marjanski, E. Solon, F. Zheng, and K. Zopff*
*Department of Mathematics, University of Virginia*

In our paper, we study geodesic growth of numbered graph products; these are a generalization of right-angled Coxeter groups, defined as graph products of finite cyclic groups. We first define a graph-theoretic condition called link-regularity, as well as a natural equivalence amongst link-regular numbered graphs, and show that numbered graph products associated to link-regular numbered graphs must have the same geodesic growth series. Next, we derive a formula for the geodesic growth of right-angled Coxeter groups associated with link-regular graphs. Finally, we find a system of equations that can be used to solve for the geodesic growth of numbered graph products corresponding to link-regular numbered graphs that contain no triangles and have constant vertex numbering.

We would like to extend our gratitude to the University of Virginia who provided financial support for our research and for organizing the 2022 Topology REU at UVA.

## Poster 35

### Analyzing Frequency Tuning and Multimode Behavior of an Extended Cavity Diode Laser (ECDL)

*L. Cass and T. Roach*
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Extended Cavity Diode Lasers (ECDL) are used in many atomic physics experiments because of their ability to finely tune laser light to specific frequencies made possible because the light is controlled by two optical resonators (or cavities) over which light is reflected; an internal cavity in the ~1 mm semiconductor chip of the laser diode and an extended, external cavity created by placing a diffraction grating 1-2 cm outside of the laser diode. Using a laser spectrometer developed by past research students, we wrote LabVIEW and Python programs that automatically record and analyze laser behavior by taking multiple images of laser light as the cavity lengths are adjusted. One program incrementally adjusts injection current to the laser diode, heating the semiconductor chip and elongating the internal cavity. A second program incrementally adjusts voltage applied to a piezo transducer, reducing the external cavity length on the scale of microns. Our Python programs analyze spectrometer frequency and intensity data quantitatively and present it visually, allowing us to study complicated laser spectra with ~0.1 GHz precision. We observe that as injection current increases, frequency decreases and as voltage to the piezo increases, frequency increases, as expected from the theory of resonator cavity modes. Unexpectedly, we observe multiple output laser frequencies, separated by ~2.5 GHz, ~3 GHz, ~7 GHz, and ~122 GHz. We discuss possible explanations for these in terms of the resonator modes and other laser phenomena.

We thank Marion and Samuel E. Krug, Ph.D. ’65 for financial support.

## Poster 36

### The Electrochemical and Material Characterization of Titanium Alloy, Ti-5553, by Selective Laser Melt Fabrication

*R. Weston, G. Swain, C. Boehlert, I. Dammulla, and S. Saha*
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The process of additive manufacturing allows for the creation of metal alloys layer by layer, increasing design and manufacturing freedom. This enables complex material shapes to be fabricated from the bottom-up rather than traditional top-down approaches, making these metal alloys of particular interest for aerospace applications. However, with many of the prospective uses of these alloys being situations where the materials will be under mechanical stress, there is a need to characterize the mechanical strength and hardness of this 3D printed alloy and to understand how the electrochemical properties are affected by tensile stress loads. Our research focused on studying the mechanical and electrochemical properties of the additively manufactured Ti-5553 alloy containing 5 wt.% aluminum, vanadium, and molybdenum, and 3 wt.% chromium. The microstructure of Ti-5553 was investigated using scanning electron microscopy. The electrochemical behavior or corrosion resistance was investigated using potentiodynamic polarization curves and electrochemical impedance spectroscopy measurements at the. Open circuit potential in 3.5 wt.% NaCl at room temperature. Overall, our studies have indicated that the additively manufactured Ti-5553 alloy displays greater corrosion resistance in comparison to other aluminum and titanium-based alloys.

This work was supported primarily by the Division of Chemistry: Research Experience for Undergraduates (REU) Program of the National Science Foundation. The authors also thank Luke Rice and Zachariah Rueger (Honeywell FM&T/DoE) for their collaborative efforts and for specimen preparation by SLM.

## Poster 37

### Disruption of Wnt/PCP Signaling in Astrocytes Limits Functional Recovery After SCI

*S. Vleck, A. Vivinetto, and E. Hollis II*
*Burke Neurological Institute, Brain and Mind Institute, Weill Cornell Medicine*

Astrocytes play an essential role in modulating wound healing after spinal cord injury (SCI) and better understanding of their response to injury could aid in development of drug therapies that promote recovery in SCI patients. However, the molecules involved in driving astrocyte response to injury are unknown. In this context, the Wnt planar cell polarity (PCP) signaling pathway, which allows cells to polarize towards a Wnt source, was studied because preliminary data found that inhibition of this signaling after SCI reduces astrocyte response and functional recovery. We specifically looked at two coreceptors in the Wnt/PCP pathway, Celsr1 and Celsr3, as they are known to be expressed in astrocytes. Mice with either a Celsr1 or Celsr3 conditional knockout in astrocytes with a moderate thoracic SCI were used as models to analyze locomotor recovery for two weeks post-injury. Wound healing was also analyzed by 3D reconstructing the lesion to analyze volume. We found that Celsr1 knockout mice had impaired locomotor recovery while Celsr3 knockout mice locomotor recovery was unaffected. This suggests that Celsr1, not Celsr3, expression in astrocytes is important for functional recovery. For both Celsr1 and Celsr3 knockout mice, the lesion volumes were insignificantly different from control mice. This suggests that Celsr1 and Celsr3 are not involved in driving wound healing processes. The underlying mechanisms of astrocyte wound healing will be further investigated by knocking out other coreceptors in the Wnt/PCP pathway.

We thank the NYS Department of Health Spinal Cord Injury Research Board for financial support.

## Poster 38

### People's Incorrect Assumptions About Why Men and Women Play Video Games Reinforce Traditional Gender Roles in the Gaming Community

*J. Ding and A. Browman*
*Department of Psychology, College of the Holy Cross*

Over 40% of all video game players are women, and research has shown that women can acquire gaming skills at the same rate as men. Despite this, very few female gamers advance to the professional level. While the overt sexism prevalent in the gaming community likely contributes to this gender imbalance, in the present work, we examined whether more subtle preferences for the maintenance of traditional gender roles in the gaming community might also contribute. We conducted a correlational study, in which 188 gamers (90 male, 88 female, 10 non-binary) indicated the extent to which (1) they personally played video games for traditionally masculine *agentic* motives (e.g., recognition, achievement) versus traditionally feminine *communal* motives (e.g., helping and connecting with others), (2) they personally experienced video games as cognitively, emotionally, physically, and socially demanding, and (3) they believed that these motives and demands applied to male versus female gamers. We found no significant difference between the extent to which men and women have agentic motives (high for both) or communal motives (low for both) for playing. However, participants *incorrectly believed* that women have more communal (vs. agentic) gaming motives, while men and professional gamers have more agentic (vs. communal) motives. Thus, the gaming community *incorrectly perceives* women's gaming motives to be misaligned (and men's to be aligned) with the professional player role, which could present a barrier for women's entry to the top level of the video game world. Participants also misperceived gender differences in demands: they believed that video games were experienced as more cognitively and socially demanding for women than for men, when in fact the opposite was true.

We thank the Weiss Summer Research Program for financial support.

## Poster 39

### Autophagy in canine lung mesenchymal stem cells

*D. Newcomb, F. Perez-Alvarez, and J. Paxson*
*Department of Biology, College of the Holy Cross*

We are interested in understanding how the function of stem cells changes with age. In our lab, we study aging in canine lung mesenchymal stem cells (LMSCs). These are highly proliferative multipotent cells that are able to differentiate into various specialized cells and self-replicate (Sinclair et al. 2013). We isolate LMSCs from companion dogs of different ages to better understand what happens during this natural aging process. Autophagy is the body's process of cleaning out damaged cells and regenerating young, healthier cells, which connects to anti-aging effects (Glick et al. 2010). There have been some studies done on how the process of autophagy may change during aging in several different MSCs such as bone marrow MSCs. However, most of these studies are conducted in artificially aged cells. We conducted an assay on LMSCs isolated from both young and old dogs that we designed to detect the level of autophagy in our cells. Our team has hypothesized that the younger LMSCs will demonstrate a higher frequency of autophagy detected using this assay. By examining autophagy through the lens of aging in this assay, we further our understanding of how aging affects not only lung function asthma and lung cancer, but also how induced or increased autophagy can enhance a life span.

We thank the Weiss Summer Research Program for funding this project. Thank you to Dr. and Mrs. Anthony M. Marlon '63 Summer Research Fellowship for supporting Fernanda Perez-Alvarez. We would also like to thank Brian Saville, Paxson lab manager, for assisting us.

## Poster 40

### Investigating the Sex-Specific Effects of High-Glucose Diets on Fertility in *C. elegans*

*D. Chen, Z. Nicholson, and M. A. Mondoux*
*Department of Biology, College of the Holy Cross*

A high-glucose diet has been shown to correlate with declined human fertility. This effect can be modeled in the organism *C. elegans.* Both sexes of *C. elegans*, males and hermaphrodites, demonstrate a decline in fertility when fed a high-glucose diet. We investigated the potential mechanisms that lead to the decline in fertility on a high-glucose diet for both sexes. In males we examined sperm transfer, which is the number of sperm transferred from a male to a hermaphrodite during mating. If a high-glucose diet reduces fertility by reducing sperm transfer, then we would see fewer sperm transferred to the hermaphrodite. We quantified sperm transfer by staining male *C. elegans* sperm with a fluorescent dye (MitoTracker Red). Preliminary data suggest that there is no significant difference in sperm transfer when males are fed a high-glucose diet. Increased dietary glucose leads to storage of glucose as glycogen in both humans and hermaphrodite *C. elegans.* To investigate decreased fertility in hermaphrodites we interfered with the expression of the *gsy-1* gene, which encodes the enzyme primarily responsible for the synthesis of glycogen. The gene was either knocked down only in adulthood or knocked out for the entire lifecycle of the organism. When glycogen storage was disrupted on a high-glucose diet in adulthood, we saw an 18% decrease in fertility, while a lifelong disruption of storage showed a 10% decline in fertility. Both of these declines are smaller than the 33% decline we observe with a high-glucose diet in the presence of full *gsy-1* function. The results suggest that glycogen storage in hermaphrodite *C. elegans* is partially responsible for the decline in fertility on a high glucose diet. By determining what factors are involved in declining *C. elegans* fertility, we can hone in on the specific mechanism that reduces fertility on a high-glucose diet. Many of the mechanisms that respond to glucose, like glycogen storage, are conserved in humans allowing us to consider parallels between *C. elegans* and humans in regards to decline in fertility.

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**Poster 41**

## COVID-19 Infection and Death in Massachusetts Correctional Facilities: An Indicator of Systematic Healthcare Failures

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*Health Studies Program, Department of History,*
*College of the Holy Cross*

The study aimed to understand the COVID-19 pandemic management practices in Massachusetts state and county correctional facilities, as rates of infection were three times that of the state's general population. Nationwide, incarcerated people were observed to die from COVID-19 at a rate three times that of the U.S. general population. A literature review of previous studies on the risk factors of developing severe COVID-19, management of COVID-19 in prisons at the national and statewide levels, the state of prison healthcare from worldwide expectations to county jail realities, and the incarcerated COVID-19 experience in Massachusetts state prisons and local county jails was carried out. Interviews were conducted with professionals in Massachusetts who work in relevant fields such as public health, state policy, and prisoner reentry. Correspondence with incarcerated authors of essays, anecdotal reports, and COVID-19 data reports informed the study's review of the human experience of COVID-19 behind bars in Massachusetts. In conclusion, the pandemic was severely mismanaged in Massachusetts prisons and jails, but that this was not an isolated phenomenon. The prevalence of COVID-19 in Massachusetts state and county jails exacerbated and exposed deeper systemic failings such as sustained inadequate funding for healthcare, unreliable prison administration oversight or collaboration with public health officials, and the consolidation of essential social services into prisons. These compounded the likeliness of COVID-19 infection and death for a population already at high risk due to the overrepresentation of the sick, elderly, disabled, and addicted in prisons.

We thank the Weiss Summer Research fellowship program for financial support.

**Poster 42**

## Controlling Secondary Electrons in a Charged Particle Monitor

*J. Phan and P. Oxley*
*Department of Physics, College of the Holy Cross*

In order to experiment with charged particle beams effectively, it is important to know their sizes, shapes and intensity. These characteristics can be measured by a device called a beam profile monitor (BPM). The BPM used in the Oxley lab was constructed by past research students and consists of 16 tungsten wires in a grid structure, with 8 wires placed vertically and another 8 placed horizontally. When the charged particle beam strikes these wires, electrical currents are generated. These currents are then converted to voltages and brought to a data acquisition system for analysis. The analysis provides location details of where the particle beam struck the monitor and with this information the beam size, shape and intensity can be determined. A significant problem with the current BPM design is its inability to control "secondary electrons". As the name suggests, they are electrons that are liberated from the BPM wires after the wires are struck by the charged particle beam. They are an issue because electrons leaving a wire changes the electrical current generated in that wire, and if the secondary electrons strike other BPM wires that will change the current in those wires as well. The presence of secondary electrons therefore "scrambles" the wire currents, meaning we are unable to correctly determine the size, shape and intensity of our original charge particle beam. The goal for this summer was to find a solution to this problem. A digital model of the current BPM was created using a program called Simion to create simulations of secondary electron trajectories. We found that with the addition of two wire meshes with appropriate voltages applied, secondary electrons can be prevented from leaving any of the BPM wires. AutoCAD software was then used to create machine shop drawings of the parts which must be added to the BPM to incorporate the wire meshes.

We thank the Weiss Summer Research Program for the financial support and Dick Miller for his machining expertise.

**Poster 43**

## Americans Misperceive Progress Towards Racial and Gender Educational Equality in STEM

*C. Robshaw and A. Browman*
*Department of Psychology, College of the Holy Cross*

Women and people of color have and continue to be severely underrepresented in Science, Technology, Engineering, and Mathematics (STEM) disciplines. Despite this, public support for affirmative action policies in college admissions decisions, which could narrow such gaps, has remained chronically low. The present work explored whether one contributor to this lack of public support might be a lack of awareness among the public about the amount of *progress* (or lack thereof) that has been made towards achieving racial and gender equality in STEM education. We conducted a correlational study, in which 394 American adults indicated what percentage of American STEM degrees they believed were held by White, Black, and Hispanic men and women, both in the past (1993) and the present (2019), and indicated the extent to which they supported or opposed the use of affirmative action policies designed specifically to help Black and Hispanic women in STEM disciplines. Compared to actual STEM degree attainment statistics, American adults significantly overestimated the gains that Black men and women have made. By contrast, they significantly underestimated the gains made by Hispanic men and women. However, participants' misperceptions of the lack of progress that has been made towards achieving racial and gender equality in STEM education did *not* predict their level of opposition to affirmative action policies.

We thank the Weiss Summer Research Program for financial support.

**Poster 44**

## 'It Restored a Bit of their Humanity': Bridging the Gap through Hands-On Intergenerational Learning

*R. Beard and K. Meszaros*
*Department of Sociology and Anthropology, College of the Holy Cross*

The Covid-19 pandemic laid bare many of the social inequities and vulnerabilities within the American nursing home industry. Intergenerational learning is thought to be an effective approach to debunking ageism and addressing social isolation, especially in institutional care settings. This study used a mixed method approach to explore the benefits of intergenerational learning for college-aged students and nursing home residents. We analyzed qualitative observational data, including 56 hours of participant observation during TimeSlips™ sessions with 32 students and 30 residents at a nursing home in Worcester, Massachusetts. A content analysis of 68 student reflections on the classroom community-based learning (CBL) experience was also performed. This poster reports on the findings from the students who participated in the intergenerational learning project in 2020-2022. A series of common themes emerged. Many students began their experience as skeptics, but retrospectively reported that it was transformative. Personal interactions with elders revealed to students the shared humanity that had with older generations, which then forced them to confront their own ageism and ableism. Intergenerational learning also encourages students to reflect on their lives, ask what type of person they want to be, what world they would like to live in, and gain new life lessons and perspectives on how to age meaningfully. The value of intergenerational learning far exceeds providing nursing home residents with social stimulation. It can be just as formative to the personal philosophies and outlooks of college-aged students. Intergenerational learning provides tangible and intangible "in-the-moment" benefits to those who participate.

We thank the Greisch Family Summer Research Fellowship for Sociology Students for financial support.

**Poster 45**

## Effects of Familiarity on Object Recognition Efficiency I: Visual Search is More Efficient with Familiar Distractors

*M. Archambeault, J. Allen, D. Diestel, and R. E. B. Mruczek*
*Department of Psychology and Neuroscience Program*
*College of the Holy Cross*

We are interested in understanding the neural mechanisms that support efficient object recognition. Previous research shows that familiarity, seeing the same image many times, leads to faster neural responses that return to baseline more quickly (Meyer et al., 2014; Manahova et al., 2019). This summer, we explored whether novel images, which are processed more slowly, cause a brief deficit in object recognition. In the first phase of our experiment, participants completed 4 days of training to build familiarity with a set of images. Participants were first trained to respond to 8 different targets, first in isolation, then in a visual search task with up to 20 other distractors on the screen. They performed this search task over a 3-day period during which the distractors remained the same. On the fourth day, participants performed the same search task with unfamiliar and familiar distractors. Our results show that the individuals were faster at finding objects when the surrounding stimuli were familiar. This indicates that the participants became familiar with the distractors themselves, which contributed to their increased speed in completing the search task.

We thank the Dr. and Mrs. Anthony M. Marlon ‘63 Summer Research Fellowship and the Weiss Summer Research Program for financial support.

**Poster 46**

## Effects of Familiarity on Object Recognition Efficiency II: Novel Objects cause an Attentional Blink

*D. Diestel, M. Archambeault, J. Allen, and R. E. B. Mruczek*
*Department of Psychology and Neuroscience Program*
*College of the Holy Cross*

The attentional blink is a processing limitation in which identifying a target presented in a rapid stream of distractors impairs one’s ability to detect a second target presented immediately afterwards. Given that novel images are processed more slowly by the visual system (Meyer et al., 2014; Manahova et al., 2019), we asked whether novel objects disrupt serial visual processing in a manner akin to the attentional blink, even when they are task irrelevant. After a 4-day training period (see our other poster), participants completed 324 trials of a rapid serial visual presentation (RSVP) task in which stimuli appeared every 100ms. Participants were asked to detect a single familiar target image embedded in each trial. Importantly, the target image appeared just before or just after (-700 to 700 ms) a single novel distractor. Our preliminary results ($n = 8$) show a subtle decrease in target detection when the target appeared immediately after (100 ms) the novel image. Reaction times increased in the same time range (100-200 ms). Consistent with previous results, deficits in target detection were brief, lasting up to 200 ms after the onset of the novel image. To enhance the size of this effect in the future, we plan to make the stimuli grayscale in order to take away color cues and increase task difficulty. We also hope to compare these behavioral effects to neural measures of familiarity in the same participants.

We thank the Dr. and Mrs. Anthony M. Marlon ‘63 Summer Research Fellowship and the Weiss Summer Research Program for financial support.

## Poster 47

### Network Analysis of the Massachusetts Bay Transportation Authority Train and Bus Transportation Systems

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*College of the Holy Cross*

The efficiency of transportation networks can be understood through mathematical network analysis. By representing transportation data in the form of a mathematical network, we can apply centrality measures to gain insight into transportation efficiency. The Massachusetts Bay Transportation Authority (MBTA) is responsible for Greater Boston's transportation systems and provides extensive on-line data for system analysis. Our project focuses on train and bus transportation. We constructed three network models: a train network model, a bus network model, and a combined train-bus network model. The train network represents stations as nodes, or points, and the train routes between stations by edges. To visualize the efficiency of the train system, we created an interactive and geographically accurate model that includes an accurate representation of our centrality measures and data retrieved from MBTA Open Data Portal. Similar procedures are applied to the bus network. By combining the train and bus networks, we are able to better understand the interactions and connections between two networks.

We thank Dr. Dan Kennedy '68 for his generous contribution and continued financial support.

## Poster 48

### Analysis of Stability and Light Dependence of Cold Atom Patterns

*A. Chin and T. Roach*
*Department of Physics, College of the Holy Cross*

In our research, a cloud of rubidium atoms is cooled to nearly absolute zero via a standing wave of light produced by laser beams from six different directions known as an "optical molasses". The 3-D standing wave has an electric field with a net polarization dependent on the relative optical time phases of the individual laser beams. Time phases vary with position across the cloud and are affected by the angle and displacement of the mirrors directing the beams. An intentional angle misalignment of 2 laser beams induces a relative phase difference creating a periodic polarization interference pattern on the scale of millimeters. Exposed to this standing wave, the atoms are rearranged into regions where the net polarization is 0, or linear, producing a cloud of cold atoms with a 1-D striped density pattern. We had shown that the contrast in the 1-D patterns increases with time, but with a high degree of variability. We now studied this instability and increased our ability to capture stable and repeatable patterns. We directly observed the relative phase between 2 laser beams using the optical interference pattern and found significant phase shifts with time, on scales of milliseconds and seconds, related to mechanical vibrations and drift. The mechanical stabilization of mirrors, removal of adverse components, and dampening of vibrations from the surrounding environment decreased the phase shift with time. Additionally, our original software conducted experiments and captured a singular image of the atom cloud in about 1 second. Within LabVIEW, however, we optimized our software to conduct multiple iterations of our experiment, with each trial taking only 140ms. This allowed us to maximize the number of trials we can conduct within the time that the phase remains somewhat constant, improving our ability to capture consistent 1-D patterns of a more stable atom cloud. We now observe a steady increase in atomic density contrast over tens of milliseconds. This should allow us to study the optical forces on the atoms, by observing the dependence of the pattern formation time on the laser frequency and intensity and the fringe width of the polarization interference pattern.

We thank Janna L. Murgia-Hoppin '98 and John W. Hoppin, Ph.D. '98 for their financial support.

## Poster 49

### Progress Towards Low Energy Lithium-Proton Collision Experiments

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Quantifying charge transfer collisions between lithium atoms and protons is relevant to ongoing nuclear fusion research. Previously, Professor Oxley's lab has collided a continuous beam of protons with a beam of lithium atoms. Using an electric field to sweep Li+ ions produced in the collisions to a detector, the charge transfer collision cross section was measured at energies as low as 130 eV. To better mimic the collisions occurring in nuclear fusion reactors, we would like to reach energies around 10 eV, which requires a modified experimental method. Progress towards achieving this new method is described in this poster. The new method entails pulsing the proton beam and the electric field rapidly on and off. In order to achieve this, precisely coordinated voltage pulses must be applied to specific parts of the experiment. Two pulse generators are used to create the seven required pulses which are controlled using a computer program called LabView. To improve the accuracy of the timings, internal equipment delays were considered and the final output pulses from each piece of equipment were examined together. Aside from generating the correct pulses, the new method requires new experimental parts to be designed and machined. For the purpose of turning the proton beam on and off a pair of deflection plates were proposed to control when protons would be allowed to enter the collision site. Moreover, the inclusion of a metal ring with a constant positive voltage, coined the Lithium Slow Ring, to slow down the Li+ ions was shown to help optimize the detection efficiency of Li+ while allowing for a longer proton-lithium interaction time. Using the computer program Simion we were able to simulate particle trajectories, verifying that these new parts will work. Lastly, using AutoCAD we created machine shop designs for the deflection plates and Lithium Slow Ring, along with their associated parts.

We thank the Robert J. Stransky Foundation Research Fellowships in the Sciences for their generous financial support and Dick Miller for machining expertise that made this research possible.

## Poster 50

### Steps Towards Understanding the Mechanism of Beta Sheet Inhibition by GGA

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Parkinson's disease has plagued the human race for centuries; it is a neurological disease, caused by the misfolding of the alpha-Synuclein protein, that causes tremors, rigid muscles and speech changes. Our research is directed toward breaking apart the beta sheets that form as the protein misfolds. It has been found, through our lab, that the short tripeptide GGA has a significant effect in breaking apart AVA beta sheets. My research is focused on understanding the mechanism behind the degradation of the amyloidogenic beta sheets utilizing GGA, specifically, whether or not kinetics affects the mechanism and how rearranging the order of amino acids affects the disordering of beta sheets. In order to measure the loss in beta sheet and the formation of disordered peptides, Fourier transform infrared spectroscopy was utilized. FTIR involves passing infrared light through each sample, allowing the secondary structure to be analyzed with further data manipulation. The Amide I peak, associated with carbonyl vibration, is particularly useful for the determination of peptide secondary structure. Specifically, a broad peak 1645 $cm^{-1}$ is indicative of disordered peptides and narrower peaks at 1620 $cm^{-1}$ and 1630 $cm^{-1}$ indicate the presence of antiparallel and parallel beta sheets respectively. The data is then processed using Origin software to subtract solvent and water vapor, to correct the baseline and to normalize the data to a standard area. Following this processing, we can fit the curve to a number of peaks and determine the percentage of beta sheet and disordered peptide in the sample. It was found that beta sheets reform over time even in the presence of GGA. It was also found that, like GGA, AGG and GAG are disordered in isolation but unlike GGA, they cannot decrease the amount of beta sheets present in AVA. In fact, there was even more beta sheet with the addition of GAG, suggesting that it actually stabilizes beta sheets. Our early conclusions, therefore, are that there is a specific interaction between GGA and AVA that prompts the unfolding of beta-sheets and that this interaction is not possible when the amino acids are positioned differently.

We thank the Weiss Summer Research program for financial support.

**Poster 51**

## From *Lochner* to *Dobbs*: The Rise and Fall of Unenumerated Rights

*C. Yackira and A. Hindman*
*Department of Political Science, College of the Holy Cross*

Over the past half-century, the Supreme Court has used the Fifth and Fourteenth Amendments to protect certain unenumerated "fundamental rights" from being abridged through its doctrine of substantive due process (SDP). Over time, the Court's understanding of some rights has evolved, and this project explores how these unenumerated rights fair under this doctrine. In pursuit of this goal, my work compared two different eras of SDP jurisprudence. By comparing the Lochner Era with the Court's right to privacy cases, my work shows that a right being found under the SDP analysis does not guarantee that the right will be protected over time. Any right found under SDP needs a strong political infrastructure built around it by other public policy actors to provide for the lasting durability of unenumerated rights.

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**Poster 52**

## The Impact of Food Insecurity on Disordered Eating Behaviors in College Students

*J. DeBonis, M. D'Angelo, and D. Harvey*
*Department of Sociology and Anthropology, College of the Holy Cross*

Food insecurity on college campuses has been a topic that has been discussed for a few years, yet it remains one of the most under-addressed issues in many areas. Food insecurity is correlated with many negative mental and physical health outcomes. To address these topics, we created an in-depth survey to assess whether there is a correlation between food insecurity and disordered eating in college students, the population most susceptible to eating disorders in the United States. We created an anonymous self-report survey that consists of 6 demographic questions, 37 Likert scale questions assessing the level of food insecurity and disordered eating behaviors, and 9 short answer questions. Our respondents included 155 participants from college students all over New England, including students from Holy Cross, Framingham State, Massbay Community College, Westfield State, Stonehill, Boston College, and UMASS. Our findings indicate that of our participants, 73% of are not financially independent, 64% of college students indicate that there is not access to food late night, 55% of college students have friends that do not have access to food to eat enough, and over 75% of college students agree that the pandemic has made food insecurity worse. In addition, 69% of college students agree that they focus more on prices than nutrition, and 60% of college students admit to food restriction for reasons other than lack of access. While our findings suggest that food insecurity is present in a small number of our participants, they also suggest that disordered eating issues are nonetheless a prevalent concern among college students. We will continue to work with Professor Daina Harvey this fall in order to strengthen our findings and expand this research to other colleges and universities in New England.

We thank the Weiss Summer Research Program for financial support.

**Poster 53**

## The Effect of the Block Island Wind Farm on House Prices

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6.1 kilometers (3.8 miles) off the coast of Block Island, Rhode Island stands the Block Island Wind Farm, America's first ever offshore wind farm. Consisting of five turbines, this wind farm is expected to produce 125,000 megawatts and lower carbon emissions by 40,000 tons annually to help replace the island's dependency on diesel generators. Although this wind farm has positive environmental effects, the view of the turbine could also be considered a negative social externality. As a summer island destination dependent on tourism, if people consider the view of the turbines as an eye sore, then it could negatively impact the local economy. In this study, we used house price hedonics to analyze whether the Block Island Wind Farm caused a change in house prices on Block Island. Our data consisted of assessment and transaction data from Zillow for houses from January 2000 to December 2020. We used a difference-in-difference regression analysis method and controlled for housing characteristics, including lot size, age, total bedrooms, total bathrooms, building area in square feet, and others. We compared our treatment group of Block Island, RI to Cape Cod, MA, Martha's Vineyard MA, Nantucket, MA, Newport, RI, and Washington County RI. We hypothesized that there would be a change in housing value due to the Block Island Wind Farm. After running our preliminary regression, we conclude that the Block Island Wind Farm did decrease housing values. We acknowledge that these are preliminary results, and would like to continue this research by controlling for different variables, testing different timelines, and more.

We thank the Dr. Charles Weiss Summer Research Program in Economics for financial support.

**Poster 54**

## Functional heterodont vs homodonty in extant crocodilians.

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For most vertebrates, teeth are the primary tools used to process food, and a wide variety of shapes and specializations have evolved to handle different types of food. This variation exists between species, but can also occur within a single mouth, with regional specialization within a single tooth row. Teeth of the same size and shape are considered homodont, while teeth that are of different sizes or shapes are heterodont. These descriptions, however, are mainly morphological and do not take into account how tooth position in the jaw interacts with tooth shape during food processing. Despite looking the same, morphologically homodont teeth may not function in the same way. This difference in use, functional homodonty, is distinct from morphological heterodonty, and these distinctions have previously only been described in fish. Our goal for this study was to measure and compare functional heterodonty in extant crocodilians, using 3D analysis of crocodile skulls. Measuring tooth surface area and position allows us to estimate the stress experienced by each tooth, and comparing stress between teeth allows us to identify functional outliers based on either 95% quartile and k-means cutoffs. We found a difference in normalized stress between teeth near the jaw joint and those further away in both *Osteolaemus tetraspis* and *Alligator mississippiensis*. This indicates that both species have a functionally heterodont dentition. Teeth closer to the jaw joint will generate more power and are commonly used for crushing, while teeth further from the jaw joint move more quickly with less force, serving another evolutionary purpose.

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**Poster 55**

## Determining the Role of *ppk29* in Adult *Drosophila melanogaster* Walking and Grooming Behaviors

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Degenerin/epithelial sodium channels (DEG/ENaCs) are trimeric ion channels found throughout the animal kingdom. DEG/ENaCs play diverse roles in neurons, glia and non-neuronal cells, yet many of their functions are not yet understood. In this experiment we used the model organism, *Drosophila melanogaster,* more commonly known as the fruit fly, to better understand their function. In *Drosophila melanogaster,* DEG/ENaCs are coded for via pickpocket genes (*ppks*). Previously in the lab when we studied the specific *ppk* gene *ppk29*, we found that there was a significant difference in adult fly behavior between control flies compared to *ppk29* mutant flies. The fly behaviors observed in both past and current studies are walking and grooming. Here we tested the contribution of *ppk29* in two specific cell types: neurons and muscle cells. To do this, we overexpressed *ppk29* in each cell type, in a *ppk29* mutant background. We found no significant effect of overexpressing *ppk29* in neurons. We did however find a significant effect of overexpressing *ppk29* in muscle cells. Overexpressing the gene in muscle cells does not rescue the control phenotype. Instead, it has larger behavior differences compared to controls, beyond that of the mutant alone. These results support a role for *ppk29* in adult muscles, possibly due to a postsynaptic function at neuromuscular junctions. In future experiments we hope to determine in which cell type, whether it be one already tested or a different cell type such as glia, *ppk29* normally functions to mediate walking and grooming behaviors.

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**Poster 56**

## Embryonic Expression of the *Drosophila* DEG/ENaC *ppk29*

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Degenerin/Epithelial Sodium Channels (DEG/ENaCs) are non-voltage gated ion channels that regulate cationic gradients across epithelial barriers. The *Drosophila* DEG/ENaC subunit gene *pickpocket 29* (*ppk29*) is expressed in the central and peripheral nervous systems and we have previously also found it expressed in the glia of larvae and adults. Embryos have been a prime model system for neuronal development, and it is known that DEG/ENaCs are expressed during development, yet we do not know how they contribute to specific developmental processes, which we can study in *Drosophila*. Here, we troubleshoot the process of obtaining images of *ppk29* expression patterns in the *Drosophila* embryonic nervous system. We used fly lines containing the transgenes *ppk29-gal4* and *UAS-Redstinger*, which expresses nuclear localized red fluorescence in cells that normally express *ppk29*. We worked through protocols of embryo collection, dechorionation, fixation, and immunostaining in which we altered the timing and reagents used. After optimizing our protocols, we found that *ppk29-gal4* drives expression in the *Drosophila* embryo. We also imaged wild-type embryos, labeling their neurons and glia. We found that glia were present on and in between the rungs of their ladder-patterned axon bundles. Comparison of our images suggest that *ppk29* may be expressed in glial cells in *Drosophila* embryos, but future experiments are needed for verification. During development, glia regulate cell proliferation, migration, survival, synapse formation and pruning. Future experiments will help us understand the role of *ppk29* in these developmental processes, helping solidify our knowledge of DEG/ENaCs more broadly.

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**Poster 57**

## Evaluation of a Training Program for Effects on Accuracy and Precision in 3D Neuronal Reconstructions

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*Department of Psychology, College of the Holy Cross*

We are interested in relating cellular and neuronal circuitry in the brain to behavior and cognition. To study neuronal structure, we generate 3D neuronal reconstructions using a microscope coupled to a computer. A motorized stage allows us to "trace" a neuron in 3D, converting the position of the stage when the neuron is in focus to x, y, and z coordinates. We designed a training program for novice tracers to increase accuracy and precision in measurements of neuronal dendritic length and complexity in the hippocampus of the mammalian brain using these reconstructions. A training protocol used a set of neurons for 8 novices in a series of 4 tracings per neuron. Dendritic lengths from the reconstructions were analyzed and the coefficient of variation (CV) determined the reliability between inter-rater reliability versus expert, intra-rater reliability among novices, and inter-rater reliability among novices. Accuracy was measured through inter-rater CV of each novice compared to an expert benchmark and inter-rater CVs between the novices. As accuracy increases with training, then the CV between novice tracers should decrease. Our results revealed no significant effects of the training program on accuracy in the preliminary analyses. Furthermore, the inter-rater CVs did not show accuracy based on a low CV of 0.15 being considered an acceptable amount of variation in measurement. If precision increases with training, then intra-rater CVs should decrease. Our results revealed no significant effects of the training program on precision in the preliminary analysis. In this case, the intra-rater CVs at all stages of training, indicating internal consistency within tracers regardless of the training program. To further improve novice accuracy during the reconstruction process, we will identify common types of choices made during tracing and design a modified protocol.

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**Poster 58**

## Limitation and Creativity: A Rock Album Inspired by Mathematical Constraints

*Mark Czerwinski and M. Jaskot*
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A constraint on a system by definition bounds its set of possible outcomes. Paradoxically, limitations appear to propel creativity, complexity, and beauty. I am writing a rock album inspired by these themes as a thesis through the College Honors Program advised by Professor Jaskot of the music department and under the guidance of Professor Roberts of the math department as a thesis reader. I began work on this project over the summer, by researching mathematical concepts such as recursion, infinite regress, and the Fibonacci Sequence, devising a large-scale arc for the album, writing rough drafts of lyrics and music for 3 songs tentatively titled *Opaque to Ourselves*, *Turtles all the Way Down*, and *Addiction Contradiction,* and creating mockup recordings.The album will include vocal and instrumental music thematically inspired by these ideas while also being subjected to constraints in rhythm, lyrics, and other musical parameters. I am collaborating with Holy Cross vocalists and instrumentalists and will record the album in the new studio in the Prior Performing Arts Center. The end goal is to record and release the album by the end of spring and produce a corresponding written document detailing my writing process, research, and influences.

We thank the Weiss Summer Research program for financial support.

**Poster 59**

## Learning Process: The Deterioration of the Unconscious Process by Pigeons

*A. J. Chhim and M. A. Qadri*
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Humans utilize two different categorization learning processes: one unconscious/implicit and the other conscious/explicit. Delaying reinforcement by one trial degrades the implicit process while it does not for the explicit process. This manipulation may impact implicit learning by multiple mechanisms, such as time delay, reinforcement of incorrect responses, or non-reinforcement of correct responses. We examined these three features of delayed reinforcement individually using pigeons, who have only demonstrated an implicit process. The pigeons experienced a series of conditions: an initial condition with traditional reinforcement contingencies, then modification of the reinforcement contingencies to reflect each of the three mechanisms. Through analyses with linear models, we compared the rate of declining accuracy between one-trial delay and the three mechanisms individually. This revealed that each component can deteriorate implicit learning. For two out of the seven pigeons, a single component seems to account for the detoritation caused by one-trial reinforcement delay, but for the others, no single component was sufficient. These effects suggest the human's explicit system is robust to the three sources of interference rather than just time delay.

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**Poster 60**

## Colorful Narration: Transposing Free Indirect Discourse in Autumn de Wilde's *Emma*

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Jane Austen's 1816 novel, *Emma*, tells the story of a "handsome, clever, and rich" heroine who seems to know, and have, it all. Throughout the novel, Austen uses free indirect discourse, a narrative technique that renders a first-person point-of-view in the grammar of third-person narration, to focalize the narrative through Emma Woodhouse's point of view. In *Emma*, FID offsets Emma's undesirable qualities by compelling the reader to sympathetically identify with her while at the same time ironizing her missteps, thereby bolstering the novel's didactic message. In the past, filmmakers have struggled to reproduce FID when adapting for the screen, resorting to such techniques as voiceover or closeups to render a character's interiority. By contrast, Autumn de Wilde's *Emma*, which premiered in 2020, departs from the visual tradition of Austen adaptations by using a profuse pastel palette. By drawing upon FID scholarship and interviews with *Emma*'s production team, I argue that in the utilization of the film's color palette to form various color relationships between Emma's costumes and settings, *Emma* transposes the effects of FID to emotionally invest the audience in Emma's well-being.

This work was supported by the Summer Research Fellowships Fund for Students in the Humanities.

**Poster 61**

## Covid-19 & Cognitive Control

*M. Garrison, K. Bradshaw, and G. J. DiGirolamo*
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Since the breakout of Covid-19, individuals are constantly exposed to pandemic stimuli. The stress and danger of Covid-19 has led some people to develop a specific Covid Anxiety Disorder (independent of general anxiety or depression). We wanted to know if people who did not self-report any Covid Anxiety still showed a breakdown in how their brain processes Covid-related stimuli. To test this, participants performed an anti-saccade task (look away from a suddenly appearing stimulus; e.g., facial mask or baseball). Delays in responding or errors on the task are an indicator of breakdowns in controlling your behavior toward those stimuli. 13 Undergraduates that self-reported no Covid Anxiety at all (scored a zero on Covid Anxiety Questionnaire) made significantly more errors to Covid stimuli than Neutral stimuli; and had slower correct eye-movement in looking away from the Covid stimuli than neutral; demonstrating a breakdown in cognitive control. Moreover, they showed increased physiological arousal (as indexed by increases in pupil size) for Covid stimuli than neutral stimuli. These data demonstrate that the brains of participants' who self-report no Covid anxiety are still treating Covid stimuli as more important stimuli than neutral. Future research will expand on the effects these unconscious responses could have on decision making around the virus such as vaccination status. Further, research will focus on analyzing individuals that are otherwise not clinically anxious or depressed but exhibit high levels of Covid anxiety.

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**Poster 62**

## Perceptual Training to Detect Abnormalities in Histopathology

*K. Bradshaw, M. Garrison, M. A. J. Qadri, and G. J. DiGirolamo*
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Abnormality gist is the ability of a medical expert to get a brief half-second (500 ms) presentation of a scan and know that an abnormality is present without knowing what kind or where. As a poorly understood, yet important part of abnormality diagnosis, it is unclear when abnormality gist develops during learning. We wanted to determine whether novices given brief perceptual training would develop this abnormality gist ability. 18 Novice undergraduates were briefly perceptually trained (under 1 hour of training) on 4 skin histopathology and normal skin histology. Next, novices were shown a brief presentation (500 ms or 50 ms) of a histology image asked to detect if an abnormality was present and if abnormal to classify it based on the 4 skin histopathologies they were perceptually trained on. Novice participants showed both significant abnormality gist as well as the ability to classify the histopathology. Remarkably, with only a 50-millisecond presentation (without conscious processing) participants even were able to detect the abnormality as well as the category. This gist ability was dependent on the level of learning of the normal images; suggesting that a normal template is compared to the presented image to detect abnormality. These results suggest that learning what a normal scan looks like first would be highly beneficial for abnormality detection instead of concentrated learning of the abnormalities (current teaching practice in medical schools).

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**Poster 63**

## Beauty Standards Among Black College Students at Predominantly White Institutions

*B. Barnes and A. Francis*
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Pretty privilege can be defined as an individual receiving advantages or opportunities based on their physical attractiveness. The American beauty standards we have in place today are Eurocentric, meaning what is deemed "beautiful" mainly resembles people of European descent. How does that change when Black people talk about the beauty standards and what they deem is "beautiful" or physically attractive? How is physical attractiveness defined by Black college students attending predominantly white institutions and to what extent do they perceive themselves as receiving pretty privilege? This exploratory study draws from interviews with five Black students to begin addressing these questions. Previous research on this topic focuses on the psychological aspects of Black womanhood and conceptualizes race as a demographic variable. This research focuses on Black students' (men's and women's) own narratives and personal experiences with beauty standards in relation to the specific social contexts they are embedded in. It also uses a sociological perspective, which allows for a more critical analysis of race as a social and historical phenomenon. These pilot data suggest that, in this particular setting, Black men do not consider the mainstream beauty standards as applying to them and instead see themselves in terms of personality and other non-physical characteristics. Black women, on the other hand, may scrutinize American beauty standards in relation to their own skin color, physique, and hair type.

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**Poster 64**

## Do Pigeons Have Confidence?

*D. Steadman and M.A. Qadri*
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Humans clearly have metacognitive abilities like assessing their performance on a previous task. For example, students often reflect upon a previous answer during test-taking. Confident judgements may also be available to non-human animals. We aimed to develop a method of evaluating confidence judgments in pigeons. A pigeon was trained to categorize line stimuli based on thickness and orientation. Accurate responses on this task were rewarded with food while inaccurate responses resulted in a timeout. After categorizing, but prior to feedback, we introduced a "hurry-up signal" that, if pecked a fixed number of times, allowed the pigeon to experience the outcome faster. We analyzed the relationship between the pigeon's accuracy on the categorization task and three metrics of the "hurry up" behavior; speed to first peck, peck rate, and completion of the peck requirement. The presence of any relationship between accuracy and these three metrics may reflect a cognitive representation of accuracy pre-feedback which would therefore be a demonstration of confidence. Our tentative conclusion is that peck rate is the only metric with a consistent relationship with accuracy and therefore is a good candidate for a confidence judgment metric.

We thank the Weiss Summer Research Program for financial support.

**Poster 65**

## The Impact of Health Inequities on Healthcare Utilization in Latinx Communities Throughout COVID-19

*K. Ramesh and T. Masvawure*
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History shows us that the social determinants of health are disproportionately impacting minority populations, such as the Latinx community. These health disparities have become exacerbated by the COVID- 19 pandemic. We conducted in-depth interviews both in Spanish and English with thirteen individuals from the surrounding areas of Worcester who identify as Latinx (4 cis-males, 9 cis-females, 10/13 immigrants). We examined the experiences that they had with healthcare utilization and how those experiences changed from before and after the peak of the pandemic. We found that during the peak of the pandemic, 9 individuals did not have the privilege to work virtually from home and those who lived with multiple family members were unable to social distance effectively in their homes (9/13). When asked about how COVID-19 changed the way in which they use or access healthcare, the most common responses were the following: more expensive (8/13), difficulties in getting an appointment (9/13), and longer waiting times before getting treated (9/13). The majority of participants listed language as being a barrier for themselves or someone they know (10/13). Only 1 person stated the use of translators in the healthcare community as being 100% effective. 12 participants believe they face unique challenges when accessing or using healthcare compared to other groups. It is clear that the health infrastructure in place is flawed in helping the Latinx community reach their highest quality of health and must be reformed so we are better prepared for the next pandemic.

We thank the Weiss Summer Research Program for financial support.

**Poster 66**

## Strategic Grain Reserves and Deforestation

*M. Ourand and C. Carney*
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Government and parastatal crop purchase programs, popular among sub-Saharan African countries, play a key role in influencing grain market outcomes. This paper looks specifically at the Food Reserve Agency (FRA) in Zambia, the dominant buyer of Zambian smallholder farmers' maize. Since there is little empirical evidence of the impact these organizations have on small-scale farmer agricultural decisions and environmental outcomes, this paper looks at the effect of the FRA on household agricultural decisions and deforestation. Using spatial deforestation data combined with administrative data on purchases of maize by the FRA, we estimate a two-way fixed effects regression exploiting the expansion of the FRA's presence over the past few decades. In addition, we also use three waves of survey data on Zambian farmers from the Rural Agricultural Livelihood Survey (RALS) to explore the mechanisms causing the increase in deforestation. The main result is that the introduction of the FRA to a district significantly increases deforestation observed through satellite imagery. Additionally, the preliminary findings from the RALS data suggest that the increase in deforestation is correlated with increases in the amount of land Zambian farmers are dedicating to maize cultivation and it also reveals that farmers are leaving significantly less land fallow when the FRA becomes active within their district.

We thank the Weiss Summer Research Program for financial support.

**Poster 67**

## Muon Flux at Various Elevations

*L. Yatsuhashi, F. Willette, O. Berzansky, T. Narita, and A. Caffery*[1]
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Cosmic rays are high energy particles that come the sun and other galaxies. They reach Earth's atmosphere and decay into muons, which are subatomic particles. Muons are created with an energy of approximately 6 GeV and they lose around 2 GeV of energy while traveling through Earth's atmosphere. Some muons start with less than 2 GeV of energy, and therefore lose most of their energy before reaching the surface of Earth. This means the muon flux will decrease as we move closer to sea level. We are able to detect muons on Earth using special telescopes. This summer, we were able to use our telescopes at different elevations to measure the muon flux at each location. We measured the muon flux at Holy Cross here in Worcester, in the town of Idaho Falls, Idaho, and at the summit of Grand Targhee Mountain in Alta, Wyoming. We were able to see a clear increase in muon flux as we increased our elevation.

We thank the Weiss Summer Research Program for financial support.

**Poster 68**

## Cosmic Ray Trajectories and Veto Shields

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Cosmic rays are made of high energy protons which collide with air molecules in the atmosphere and cause showers of small particles that eventually decay into muons. The quantity rigidity takes into account the energy of an incoming cosmic ray and the effect that the earth's magnetic field has on a cosmic ray. By modeling the rigidity, we can further understand the trajectories of cosmic rays. Cosmic ray muons can limit the sensitivity of High Purity Germanium (HPGe) detectors which are used for precise gamma ray spectroscopy. We built two types of coincidence veto shields, one with scintillating plastic coupled to a standard photomultiplier tube and the other using silicon photomultipliers (SiPMs). The veto shield surrounds the HPGe detector and detects the incoming muons to ensure that the counts recorded by the HPGe detector are only from the radioactive sources.

We thank the Weiss Summer Research Program for financial support.

## Poster 69

### Stuff, the Chinatown Kid vs The Green Turtle: The Constructions of Chinese American Identity in Golden Age Comic Books

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Perceptions and experiences of Chinese American identity were often affected by the relationship between China and the United States. During World War II, both countries were Allies, which encouraged better treatment of Chinese Americans. Despite the collapsing relations between the two countries during the 1950s, acceptance of Chinese Americans was encouraged to unite the country, and counter propaganda from the Soviet Union and China. There is a lack of scholarship that focuses on how Chinese Americans perceived their own identity and even how others viewed them during World War II, and the early Cold War period. Comic books in these two decades were often produced by creators who were in the working class, and immigrants. This is one of the few mediums at the time that Chinese Americans had an opportunity to express themselves in the mainstream, and in a broader sense it reflects the thoughts of average Americans. The main focus of this research will be on the characters "Stuff, the Chinatown Kid" from DC's *Action Comics* by Mort Weisinger (1941-1954), "The Green Turtle" from Rural Home's *Blazing Comics* by Chu F. Hing (1944-1945), and both "Jimmy Woo" and "Yellow Claw" from Atlas Comic's *Yellow Claw* series by Al Feldstein (1956-1957). I investigated comic books authored by white Americans and by a Chinese American during the 1940s-50s, in order to elucidate the discrepancies between how the Chinese American identity was constructed by different groups of people at the time.

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## Poster 70

### The State of Social and Development Impact Bonds

*T. McNulty and D. Tortorice*
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In 2010, a new financing strategy that allowed the private sector to partner with the public sector to fund social projects was used in the Peterborough prison in the U.K. to reduce recidivism among prisoners. This new tool, social impact bonds, allowed investors to invest upfront capital for public projects and receive a return based on the results of the project from the government. After the huge success of the Peterborough bond in 2010, this financing strategy has been replicated in governments, towns, and nonprofits all over the world. We have researched and built a database on all 236 of these bonds issued since 2010. The data show that although these bonds appear to be diminishing in popularity, 2022 saw a huge spike in capital raised for development impact bonds. Additionally, nonprofits seem to be expanding on rate cards, a pay per positive outcome strategy, which stemmed from social impact bonds to structure other forms of impact-based financing. Some bonds such as the Wildlife Conservation Bond and the Fair Chance Fund show the diversity of these bonds and how they can be adjusted to put emphasis on outcomes and ensure project success.

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**Poster 71**

## Investigating P-Wave Asymmetrical Dark Matter

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Dark matter makes up roughly 27% of the universe and interacts with other types of matter through gravitational interactions. The leading theory on the production of dark matter in the universe is called "freeze-out," where, as the universe expands, the density of dark matter particles and antiparticles decreases until they can no longer annihilate each other. At that point in time, the number of dark matter particles and antiparticles remains the same forever. In this research project, we consider an asymmetrical model of freeze-out, in which an initial imbalance of dark matter particle abundance and dark matter anti-particle abundance is present. We investigate the relic abundance, taking into account current observational constraints for the asymmetrical dark matter particles that were in thermal equilibrium in the early universe. We also analyze a set of differential equations which describe the evolution of dark matter particle and antiparticle yields over time. By solving these equations using both analytical and numerical methods, we model a number of characteristics of asymmetrical dark matter. Additionally, we consider p-wave collisions, which gives a more accurate depiction of angular momentum in our model.

We would like to thank William F. McCall, Jr. '55 Summer Research Fund for financial support.

**Poster 72**

## Muon Rate as a function of the Azimuth Angle, Pressure and Temperature

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A cosmic ray is a charged particle that collides with Earth's atmosphere and creates smaller particles that then can decay into muons. Muons can come from any angle but those that arrive at large azimuth angles, i.e. traveling near the horizon, are more likely to lose their energy since they take a longer path through the atmosphere. To be able to detect the different angles that muons can come from we altered one of our telescopes so that it would only look at a smaller section of the atmosphere so we could then create a model on how the azimuth angle affects the muon rate at our location. Our data agreed with the results of others who had done similar experiments. We also began measuring the barometric pressure and the local temperature at our detector site. A higher atmospheric pressure means that there are more particles that a cosmic ray can collide with and create more muons. The temperature would affect the count rate of muons because when it is hotter the atmosphere expands making more cosmic rays collide at a higher altitude and then more muons will decay before reaching the detector. To record the pressure and the local temperature we had an Arduino, a programmable microcontroller, programmed to record the pressure and temperature above the Science Complex and post them to a website. We also had other telescopes recording detections. We did not find that the pressure or the local temperature changed the muon rate.

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**Poster 73**

## The Age-Specific Impact of RSV Infection on Airway Contractility

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Respiratory Syncytial Virus (RSV) is the leading cause of bronchiolitis and pneumonia in children under the age of one. Severe infection in children may require hospitalization. Clinically, common bronchodilators (β2-adrenergic receptor agonists) and general or inhaled steroids fail to provide therapeutic relief to newborns. The primary cellular target of RSV are epithelial cells, however since cases of wheezing and airway constriction are clinically observed in infants, airway smooth muscle cells (ASMC) are investigated in this study. The primary research question asks whether these ASMC are implicated in the RSV induced bronchiolitis. Furthermore, if these ASMC are implicated, why are common bronchodilators ineffective? Using the Precision Cut Lung Slice method, the relaxation and constriction of the small conducting airways of human and mice lungs can be investigated directly. First, a RSV supernatant is used to incubate lung slices for 72 hours. The slices are then put through a contraction/relaxation assay using a phase-contrast microscope to visualize and measure airway area. Human lung slices are treated with increasing concentrations of a bronchoconstrictor, histamine. After the maximum concentration of bronchoconstrictor has been applied, a bronchodilator, formoterol, is used to treat the slices. RSV treated human lung slices were found to have a hypercontractility phenotype compared to the control. In addition to the hypercontractility, when the bronchodilator was applied the RSV treated slices did not relax to the extent that the control slices did. A mouse model was also constructed to access airway contractility and relaxation. Using the same assay, instead this time with methacholine as a bronchoconstrictor, RSV treated mouse lung slices were investigated. A similar hypercontractility phenotype was observed to a lesser extent, but still significantly different than the control. However, when formoterol was applied the RSV treated lung slices did not differ from the control in terms of airway relaxation. Optimization of the mouse model is now the future direction of the study in order to portray human infection more accurately in mice.

We thank the National Institute of Health for financial support.

**Poster 74**

## Computational Modeling of Asymmetric S-Wave Dark Matter

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Dark matter makes up roughly 27% of the universe and unlike normal matter, does not interact with the electromagnetic force. The leading theory on the production of dark matter in the universe is called “freeze-out,” in which, as the universe expands, the density of dark matter particles and antiparticles decreases until they can no longer annihilate each other. At that point in time, the number of dark matter particles and antiparticles remains the same forever. The freeze out scenario essentially says that there is some large amount of dark matter in the early universe that decreases to the amount we observe today. This particular research project analyzed a model for “asymmetric dark matter”, in which an initial imbalance between dark matter particle and dark matter anti-particle abundance is present. A set of differential equations were analyzed which described the evolution of S-wave dark matter particle and antiparticle yield over time. By solving these equations using both analytical and numerical methods, a number of characteristics of asymmetric dark matter were modeled including the freeze out of dark matter particles in the early universe and the effect of particle cross section on relic density of both normal matter and antimatter DM. Additionally, the relationship between particle cross section and the difference in particle and antiparticle yields C was plotted wrt the current observational constraints with a maximum value of C determined.

Special thanks to Janna L. Murgia-Hoppin ‘98 and John W. Hoppin, Ph.D. ’98 for financial support for our research.

**Poster 75**

## The Economic Feasibility of a Parking Lot Solar Canopy at the College of the Holy Cross

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Solar power has skyrocketed in popularity, due to increases in efficiency and decreases in costs of the necessary infrastructure. We performed a cost-benefit analysis of whether the implementation of a solar canopy, a newer solar concept, would be profitable. The canopy would also provide intangible benefits like EV charging, shade, and snow protection. We collected models and data from papers by WPI and the Vermont Department of Public Service, and email correspondence with Solect Energy's Andrea Schmid. To maximize solar exposure and electricity output, we found tilt and azimuth angles of 10 and 248 degrees respectively. Our research found we'd produce an output of about 430,000 kWh of electricity in our first year, the equivalent to $44,000 of electricity. The canopy would cost about 1.3 million dollars up front, and the canopy would pay itself off after twenty-two years. Massachusetts' SMART incentive program would provide a 10.21¢/kWh subsidy, a major influence on the projects' profitability. Factoring in Holy Cross' discount rate to correct for time, we found the project would profit about $260,000 over a thirty-year period.

We thank the Weiss Summer Research program for financial support.

**Poster 76**

## Drones and the 4th Amendment, Juveniles and the 8th Amendment: Moot Court 2022 Issues

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Our project looks at these two constitutional questions presented in a fictional fact pattern provided by the American Moot Court Association, in preparation for the College's Moot Court program. The two questions are: First, how much privacy do you have? Second, what is a just penalty for juvenile offender? To address these two questions and prepare our team, we have analyzed relevant U.S. Supreme Court Jurisprudence on the Fourth and Eighth Amendments respectively. Because we have to be able to argue for both sides in the competition, we reach conflicting conclusions for both amendments. On the privacy issue, the court asks: Can police fly a high-tech drone at 350 feet to observe your RV on private property? The state contends that there is no reasonable expectation of privacy, whereas the appellate claims that there is, thus prompting a 4th amendment violation. Similarly, on the juvenile offender question: Can a 15-year-old guilty of 2nd degree attempted murder be sentenced to life with the possibility of parole after 50 years? Does low prison life expectancy make this equivalent to a life term? The state answers no to both questions, while the appellate answers yes, prompting a categorical ban of this sentence. Finding sophisticated legal arguments for these complex questions provides a foundation for our team to develop even better arguments, all with the hope of creating a very successful Moot Court season this year at Holy Cross.

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**Poster 77**

## Assessing Protein Expression Dynamics of APOBEC3G, an Anti-HIV Protein

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APOBEC3G (A3G) is a human cellular restriction factor that inhibits HIV-1 replication. The protein catalyzes cytidine to uridine mutations during viral reverse transcription and these extensive introduced mutations short-circuit viral infection. This antiviral function is actively countered by the HIV-1 protein Vif. Prior work in the Sheehy Lab has identified an A3G variant that demonstrates increased catalytic activity when compared to wild type. Interestingly, this variant also exhibits elevated cellular expression which could explain the observed hypercatalysis. It is currently unclear whether this elevation of protein expression is due to increased translation or greater protein stability. To characterize the stability of A3G protein, the persistence of A3G expression after transient transfection was assessed. HEK (human embryonic kidney) cells were transfected with A3G and cellular lysates were collected at 24-hour intervals. The lysates were then analyzed by western blot. While expression of A3G appeared to peak at 72 hours, protein expression was detectable until 108 hours post transfection. These results provide insight for experimental design to determine specific time points of interest for half-life measurements, enabling the Sheehy Lab to accurately measure the expression dynamics of A3G and its variants.

I thank Dr. and Mrs. Anthony M. Marlon ‘63 Summer Research Fellowship for its generous financial support of my outstanding research experience.

**Poster 78**

## Measuring Political Polarization on Twitter Over Time

*D. Pritchard and M. G. Rodrigues*
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Twitter has become an increasingly prevalent part of political discourse in the United States, particularly since the Presidency of Donald Trump. Another current feature of American politics is hyper-partisanship, which has produced increased levels of affective political polarization. Affective polarization can be defined as a particularly corrosive type of political polarization, one in which the main unifying factor of a political group or party is a disdain for the opponent group. In order to determine whether or not affective polarization has increased on social media in the past 10 years, this research analyzed a series of significant political events: starting with a-lobbying effort from President Obama and Sandy Hook families in 2013, followed by the online reaction to Hillary Clinton’s “basket of deplorables” comment during the 2016 Presidential campaign, followed by the online reaction to President Trump’s “very fine people on both sides” comment in reference to the 2017 Charlottesville riots, and up to the January 6th insurrection in 2021. In order to assess the degree of polarization at each point in time, and to assess the overall trend across all four selected events, we collected four sample sets of tweets surrounding the four events. The sample of tweets was collected using Twitter’s advanced search feature. This research was meant to lay a foundation for a further examination of polarization during a year-long thesis project. During this upcoming project, the collected tweets will be categorized using parameters established by scholars in the fields of polarization, political rhetoric, and social media communication, which were identified during the summer research period. It was hypothesized that the percentage of tweets surrounding a particular event that contained conflictual or polarizing rhetoric has increased since 2013. In order to confirm this hypothesis, an in-depth analysis of the data and a large-scale coding of the collected tweets based on their strict informativeness vs. presence of conflictual/polarizing rhetoric must be conducted.

We thank the Weiss Summer Research Program for its financial support.

**Poster 79**

## The Catalytic Profile of the Anti-HIV Protein, APOBEC3G, Can Be Altered with Single Amino Acid Substitutions

*Tianci Guan, Kim Nguyen, and Ann Sheehy*
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APOBEC3G (A3G) is an antiviral restriction factor that interferes with the propagation of HIV in human cells. A3G restricts HIV primarily through its cytidine deamination activity. This process converts cytosine (C) to uracil (U) in viral DNA. Furthermore, this A3G-mediated cytosine deamination occurs in a specific nucleotide context, denoted as 5'-CC-3', where deamination of the second C (underlined) results in the generation of uracil mutations. Ultimately, extensive C to U mutations render the virus incapable of producing infectious particles, effectively terminating viral infection. Here, we describe an assay designed to reveal whether specific variants of A3G have acquired a more promiscuous ability to recognize and mutate beyond the canonical nucleotide context. A3G variants were generated in which a critical amino acid in the well-defined catalytic site was singly substituted with each of the twenty amino acids. This mix of variants was then assessed, in bulk, for catalytic activity; variants that retained enzymatic function were then further characterized for target sequence preference. One interesting variant, *GT1*, was found to have an altered recognition context exhibiting a novel preference for 5'-TC-3' In the future, we hope to determine how this new recognition context impacts *in vivo* antiviral function.

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**Poster 80**

## Investigation of Mixed Self-Assembled Monolayers of Terphenylthiol and Dodecanethiol on Au(111)

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The molecule dodecanethiol (DDT) was deposited onto a flame annealed chip of Au (111) on mica through soaking in a solution with ethanol and a low concentration of DDT. A self-assembled monolayer (SAM) is a single layer of molecules on the surface of a substrate that occurs when thiol head groups react with the atoms of the substrate, forming energetically favorable bonds. The samples were scanned at the molecular level with a scanning tunneling microscope (STM) in order to produce images of the sample. By varying the deposition lengths between 1-24 hours both with and without heat and analyzing the data obtained, an optimal deposition length for DDT was found to be a period of one hour in an 80°C hot water bath, followed by rinsing with ethanol and drying with a stream of nitrogen gas. Furthermore, quantitative analysis of the images reveals an average distance between DDT molecules to be 5 angstroms, which will help identify the presence of DDT in future experiments.

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## Poster 81

### Surmounting the System: An Analysis into the Psyche of Providers in Respect to Intersectional Understanding of Race and Mental Health Within the Criminal Justice System

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The modern interceptions of both race and mental health, individually, have been extensively studied within the criminal justice system. Yet, there still remains very little research of the intersectional aspects of mental health attitudes and race, combined. Within the summer of 2022, we have performed an analysis into the psyche of providers in respect to premeditated categorization of race and mental health attitudes. The singular and multidimensional aspects of socio-economic class, race, mental health, and stigma were examined, with particular attention directed towards the current job title and level of education each interviewee held. Inquiring to seek if individuals recognize the impact of mental health in crime, and whether or not it is equally understood across different races. While still in the beginning works of this study, it revealed that individuals with lower title jobs held a deeper understanding for the intersectionalities of both race and mental health. Interference between race and mental health were observed through detailed questioning, statistical data, and body language. We have also proposed several possible implementations of the variety of answers to the interview questions; which includes differing socioeconomic status, preservations of one's individual reputation, career training, and prior experiences involved with race and mental health attitudes combined. While the research topic is relatively new, in retrospect to both the multidimensional aspects of race and mental health attitudes, we have estimated significant statistical data to display through each participant's interview and willingness to participate.

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## Poster S1

### Efficacy of platelet-rich plasma and intra-articular hyaluronic acid as separate and combined treatment options for knee osteoarthrosis: a systematic and biochemical review

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*Johnson & Johnson MEDTECH, DePuy Synthes Spine, Inc*

Osteoarthrosis (OA) is a disease characterized by inflammation and the body's inability to properly regenerate articular cartilage resulting a progressive breakdown and loss over time in the joint space. Affecting millions of people worldwide, OA results in debilitating pain and loss of function over time. Its cause is attributed to a multitude of genetic and environmental factors. Novel pharmacological and nonpharmacological treatment methods have been investigated for joint damage to the knee, where OA is most prevalent. A class of drugs called corticosteroids are the prevailing first level treatment for OA and while they can briefly minimize pain and increase joint mobility, recent studies have reconsidered the effectiveness of such injections. Moreover, there is evidence to suggest that certain drugs like corticosteroids can ultimately lead to cartilage deterioration with repeated use. Additionally, other classes pharmacological drugs may cause nephrotoxic and gastrointestinal issues. By contrast, this review investigates two alternative treatments that are not only safer due to the body's natural ability to produce them but may also have the potential to provide cartilage maintenance and induce chondrocyte proliferation in localized joint regions. Both hyaluronic acid (HA) and leukocyte-rich platelet-rich plasma (PRP) intra-articular injections have been used independently over the past few years to manage the symptoms of OA. While the two have been adopted separately with some success, here we suggest that combining the two treatments is more effective in reducing pain (and possibly managing the progressive destruction of cartilage tissue) than either of the two treatments on their own. Our review investigates the compositional variability among the different HA and PRP systems on the market. In doing so, we aim to examine the effectiveness of using different biochemical concentrations of these injectables. Insight into the molecular mechanisms driven by the presence of these two combined treatments may help us provide better early disease management and possibly prevent the chronic degeneration of articular cartilage in patients with OA.

**Poster S2**

# Web-based Mathematics Teaching Tool

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Mathematics is about logical relationships. Concepts from algebra and calculus may have geometric interpretations that assist with understanding and learning. In this project we created interactive web pages to illustrate concepts from linear algebra and multivariable calculus. We used HTML, CSS and JavaScript along with several CSS and JavaScript libraries including jQuery, D3 and Bootstrap to build our websites. We decided to use this approach mainly because it is free and the most convenient way for students to get additional information about a related subject. Our project focuses on providing a series of interactive web pages for students to experience basic concepts in multivariable calculus and linear algebra. Topics include vector field, flow line, basis and eigenspace which are basic concepts in the two subjects mentioned above. Each web page contains an interactive HTML canvas responsive to mouse and keyboard actions. Along with the interactive canvas, we wrote a clear mathematical explanation, and tips for using the program for each program. By using CSS and HTML, we are able to allow users to switch between websites and information they want to see.

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NOTES