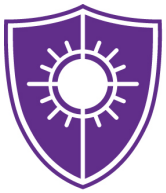

COLLEGE OF THE
Holy Cross

Twenty-Seventh Annual Symposium

Dr. Charles S. Weiss Summer Research Program

October 4, 2021
Hogan Ballroom

Dear Members of the Holy Cross Community,

Welcome to the 2021 Dr. Charles S. Weiss Summer Research Symposium. Now in its 27th 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 2021. 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
Victor Matheson, 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 to Pr. Gaby Avila-Bront, Chemistry Department

National Science Foundation grant to Pr. Geoffrey Findlay, Biology Department

National Science Foundation grant to Pr. Justin McAlister, Biology Department

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Presenting Authors / Abstract Number

Presenting Authors / Abstract Number

Faculty Mentors / Abstract Number

Florencia Anggoro	Psychology	40
Gaby Avila-Bront	Chemistry	10
Alo Basu	Psychology	48, 49
Robert Baumann	Economics and Accounting	59
Rachelle Beaudoin	Visual Arts	S2
Robert Bellin	Biology	22
Shreyashi Chakdar	Physics	69
Christine Cox	English	81
Joshua Congdon-Hohman	Economics and Accounting	64
Mary Conley	History	53
Stephanie Crofts	Biology	58
Dave Damiano	Math and Computer Science	47, 84
Steve DeSimone	Economics and Accounting	67
Gregory DiGirolamo	Psychology	39
Geoffrey Findlay	Biology	27, 32
Meredith Fluke	Cantor Art Gallery	50
Bridget Franco	Spanish	S1
Peter Fritz	Religious Studies	62
Christine Hagan	Chemistry	9, 20
Mark Hallahan	Psychology	80
Alexis Hill	Biology	60, 61
Alex Hindman	Political Science	25
Amber Hupp	Chemistry	82
Sarah Ihmoud	Sociology and Anthropology	46
Andre Isaacs	Chemistry	11, 12, 13
Alvaro Jarrin	Sociology and Anthropology	76
Ben Kain	Physics	3, 4, 6
Elizabeth Landis	Chemistry	7, 23
Brian Linton	Chemistry	33, 74
Amanda Luyster	Visual Arts	18, 73
Tsitsi Masvawure	Health Studies	57, 70, 75
Victor Matheson	Economics & Accounting	59
Justin McAlister	Biology	44, 54, 78
Gwen Miller	History	51
Kenneth Mills	Chemistry	2, 16, 19
Michelle Mondoux	Biology	83
Tomohiko Narita	Physics	37, 38
Paul Oxley	Physics	34
Victor Pacheco	Visual Arts	79
Adele Parker	French	17
Julia Paxson	Biology	24
Muhammad Qadri	Psychology	39, 42, 43, 77
Kevin Quinn	Chemistry	15
Timothy Roach	Physics	21, 36
Mathew Schmalz	Religious Studies	28
Bianca Sculimbrene	Chemistry	5, 8
Ann Sheehy	Biology	45, 55, 68
Jameliah Shorter-Bourhanou	Philosophy	14
May Sim	Philosophy	56
Neel Smith	Classics	1
Samuel Stoddard	Political Science	72
Justin Svec	Economics and Accounting	66
Daniel Tortorice	Economics and Accounting	65
Stephanie Yuhl	History	71

Table of Contents

(Note: Presenter names are underlined. Even-numbered posters will present from noon to 2 pm, odd-numbered posters from 2 to 4 pm)

20. **Developing a Biochemical Assay to Monitor Bacterial Contact-Dependent Inhibition.** *C. Billetter and C. Hagan. Department of Chemistry, College of the Holy Cross*

21. **Spectrometer Design for Studies of Laser Physics.** *P. Jonak and T. Roach. Department of Physics, College of the Holy Cross*

22. **Investigating the Effectiveness of a Synthetic Hydrogel Polymer to Support Cell Viability of 3T3 Fibroblasts in a Tissue-on-a-Chip Device.** *J. Kelly, B. Lawton, and R. Bellin. Department of Biology, College of the Holy Cross*

23. **Alkyne Based Molecular Layers on Nanoporous Gold.** *R. Weston and E. Landis. Department of Chemistry, College of the Holy Cross*

24. **Investigating the Oxidative Stress Responses of Canine Mesenchymal Stem Cells Across Different Age Groups.** *N. Agyapong, E. Trim, and J. Paxson. Department of Biology, College of the Holy Cross*

25. **The Constitutionality of Preventing Pandemics.** *C. Yackira and A. Hindman. Hon. Joseph F. Greene Moot Court Program, College of the Holy Cross*

26. **How to Better the Life of an English Learner.** *V. Maza. Office of the Governor John Carney, Wilmington, Delaware*

27. **Investigation of *katherine johnson,* a *de novo* evolved gene essential for *Drosophila* male fertility.** *S. Y. Guay, J. M. O'Toole, P. H. Patel, and G. D. Findlay. Department of Biology, College of the Holy Cross*

28. **QAnon and American Christian Nationalism.** *P. Pardo Cota and M. Schmalz. Department of Religious Studies, College of the Holy Cross*

29. **Characterization of *Pseudomonas aeruginosa* Genes Involved in Bile Salt-Induced Polymyxin Resistance.** *D. Wall, E. Drenkard, and B. Hurley. Mucosal Immunology and Biology Research Center, Massachusetts General Hospital*

30. **Tau phosphorylation sites differ in chronic traumatic encephalopathy and Alzheimer disease.** *S. A. Stathas, V. E. Alvarez, W. Xia, R. Nicks, M. L. Alosco, J. Mez, A. C. McKee, and T. D. Stein. Boston University CTE and Alzheimer's Disease Research Centers, Boston University School of Medicine, VA Healthcare System, Bedford and Boston, MA*

31. **An Internship Pathway to Dentistry: A Dual Evidence-Based Approach.** *K. Wright; P. Levi; and I. Dragan. Department of Periodontology and Office of Academic Affairs, Tufts University School of Dental Medicine*

32. **Characterization of Saturn in Drosophila.** *S. J. Metri, R. E. Barrett, P. H. Patel, and G. D. Findlay. Department of Biology, College of the Holy Cross*

33. **Investigating Intramolecular Hydrogen Bonding.** *M. Beausoleil, H. Cavanaugh, and B. Linton. Department of Chemistry, College of the Holy Cross*

34. **Low Energy Charge Transfer Collision Experiments using Pulse Sequencing.** *A. DiResta and P. Oxley. Department of Physics, College of the Holy Cross*

35. **Glucose confers resistance to Aβ aggregation pathology in Alzheimer's disease.** *M. Nakhla, S. F. Kingsley, and H. A. Tissenbaum. Department of Molecular, Cell, and Cancer Biology, University of Massachusetts Medical School*

36. **Cold Atom Pattern Analysis of Light-Atom Interactions.** *A. Chin and T. Roach. Department of Physics, College of the Holy Cross*

37. **Diurnal Variation in Cosmic Rays.** *L. Yatsuhashi, F. Willette, and T. Narita. Department of Physics, College of the Holy Cross*

38. **Muons and The East-West Effect.** *F. Willette, L. Yatsuhashi, and T. Narita. Department of Physics, College of the Holy Cross*

39. **Assessing Gist Development in Novices Following Perceptual Training.** *M. DiDominica, M. Qadri and G. DiGirolamo. Department of Psychology, College of the Holy Cross*

40. **Designing and Testing a Museum Exhibit to Support Children's Science Learning.** *M.G. Harris, C. McLeod, F. Anggoro, and B. Jee*. Department of Psychology, College of the Holy Cross; *Department of Psychology, Worcester State University*

41. **Prediction of Temperature and Pressure Broadening Effects in IR Spectroscopy of Chemicals.** *D. Kreka, J. Chesslo, D. Burns, and R. Molt. National Security Solutions, ENSCO Inc.*

42. **Explicit and Implicit Categorization in Pigeons.** *O. C. Ezemma and M. A. Qadri. Department of Psychology, College of the Holy Cross*

43. **Evaluating the Correspondence Between Physical Motion and Motorized Motion in Pigeons.** *Y. D. Pierre and M. Qadri. Department of Psychology, College of the Holy Cross*

44. **Hybrid performance in *Asterias* sea stars.** *K. Bresnahan and J. McAlister. Department of Biology, College of the Holy Cross*

45. **Mutating the Mutator: Delineating the Critical Residues of an ABOPEC3G Variant.** *J. Guiry and A. Sheehy. Department of Biology, College of the Holy Cross*

46. **Vulnerable vs. *Vulnerables* vs. *Vulneradas:* Examining the Role of Language Rights for Indigenous Women in the "Crisis at the Border."** *C. Florita and S. Ihmoud. Department of Sociology and Anthropology, College of the Holy Cross*

47. **Discourse Sheaves to Model Opinion Dynamics on Watts-Strogatz Networks.** *S. Vermette and D. Damiano. Department of Mathematics and Computer Science. College of the Holy Cross*

48. **Standardized Quantitation of Neuronal Morphology in the Hippocampus.** *K. Barahona, M. Rubert, and A. Basu. Department of Psychology, College of the Holy Cross*

49. **Morphological Response of Hippocampal Neurons to Environmental Factors.** *M. Rubert, K. Barahona, and A. Basu. Department of Psychology, College of the Holy Cross*

50. **Art at Holy Cross: 150 Years of Collection.** *J. Mi and M. Fluke. Iris & B. Gerald Cantor Art Gallery, College of the Holy Cross*

51. **Indians in the Archives.** *J. Hynick and G. Miller. Department of History, College of the Holy Cros*

52. **Psychological Resilience Research During the COVID-19 Pandemic: A Scoping Review.** *O. Baldi, K. Nishimi, and K.W. Choi. Lee Kum Sheung Center for Health and Happiness, Harvard T.H. Chan School of Public Health, Department of Psychiatry, Massachusetts General Hospital*

53. **John Wilkes and British Radical Roots of American Revolutionary Politics.** *A. Vrountas and M. Conley. Department of History, College of the Holy Cross*

54. **Examining the benefits versus costs of brooding in the Dwarf Brittle Star, *Amphipholis squamata.*** *A. McGrath and J. McAlister. Department of Biology, College of the Holy Cross*

55. **Investigation of elevated expression of an APOBEC3G Variant.** *A. Howley and A. Sheehy. Department of Biology, College of the Holy Cross*

56. **Mencius and Aristotle: Human Nature and Resources for Dignity**. *M. Baker and M. Sim. Department of Philosophy, College of the Holy Cross*

57. **Racism in the Health Sector: A Qualitative Study of Healthcare Providers' Views.** *R. Dolan and T. Masvawure. Health Studies Program, Center for Interdisciplinary Studies. College of the Holy Cross*

58. **Bending Mechanics of Sea Urchin Spines.** *B. Saville and S. Crofts. Department of Biology, College of the Holy Cross; Friday Harbor Laboratories, University of Washington*

59. **Estimating the Economic Impact of Major League Baseball's All-Star Game Using High Frequency Tourism Data.** *R. Murray, V. Matheson, and R. Baumann. Department of Economics & Accounting, College of the Holy Cross*

60. **The *Drosophila* ERG Voltage-gated Potassium Channel *seizure* Affects Development.** *E. M. Hensley, D. L. Ruiz, A. Dermady, and A. S. Hill. Department of Biology, College of the Holy Cross*

61. **Investigating the Expression and Function of the DEG/ENaC, *ppk29*, in Glia of the *Drosophila* Nervous System.** *M. Girgis and A. Hill. Department of Biology, College of the Holy Cross*

62. **The World's Migration Crisis Through a Theological Lens.** *B. Acome and P. Fritz. Department of Religious Studies, College of the Holy Cross*

63. **Categorization of Artists.** *C. Babikian, K. Corcoran, and K. Umezaki. Verifi Media*

64. **Are Olympic Gymnasts Out for Individual or Team Glory?** *M. Luca and J. Congdon-Hohman. Department of Economics and Accounting, College of the Holy Cross*

65. **The Impact of the Gavi Program in India.** *M. Sexton and D. Tortorice, Department of Economics and Accounting, College of the Holy Cross.*

66. **Peer Effects in StarCraft II.** *E. Leary and J. Svec. Department of Economics and Accounting, College of the Holy Cross*

67. **Internal Auditing and Financial Reporting Quality in the Public Sector.** *B. Connelly and S. DeSimone. Department of Economics and Accounting, College of the Holy Cross*

68. **Designing a Quantitative Assay to Identify Critical Amino Acids for APOBEC3G Function.** *T. Guan, H. Matsuo*, W. Myint*, and A. Sheehy. Department of Biology, College of the Holy Cross; *Center for Cancer Research, National Cancer Institute*

69. **Investigating Phantom Dark Energy as a Quantum Field in FLRW Space.** *T. Sullivan and S. Chakdar. Department of Physics, College of the Holy Cross*

70. **Water Practices in the City of Worcester.** *J. M. Gonzalez and T. B. Masvawure. Health Studies Program, Center for Interdisciplinary Studies, College of the Holy Cross*

71. **Queering the Archive: Worcester's Sexual Asylum Task Force.** *S. Suwal and S. Yuhl. Department of History, College of the Holy Cross*

72. **Optimizing Environmental Law: A Study of Federal Best Practices.** *W. Sampson and S. Stoddard. Department of Political Science, College of the Holy Cross*

73. **"The Crusades and the Chertsey Tiles: A Medieval Masterpiece Reconstructed" Exhibition Brochure.** *G. P. Morrissey and A. R. Luyster. Department of Visual Arts, College of the Holy Cross*

74. **Synthesis and Study of Cystine β-sheet Mimics.** *H. Cavanaugh and B. Linton. Department of Chemistry, College of the Holy Cross*

75. **Researching COVID-19 in America: A Summer Course Experience.** *M. Lorenz, M. Behnan, S. Carew, M. Conant, J. DeBonis, K. Esteban, S. Hoang, G. Karimu, F. Leveque, R. McCarthy, and T. B. Masvawure. Health Studies Program, Center for Interdisciplinary Studies, College of the Holy Cross*

76. **Investigating the Formation and Impact of Transnational Latinx Migrant Communities in Worcester, MA.** *Jaime Perez and Alvaro Jarrin. Department of Anthropology, College of the Holy Cross*

77. **Motion Same/Different Processing in Pigeons.** *L. Bernier and M. Qadri. Department of Psychology, College of the Holy Cross*

78. **Interactive Effects of Food Availability and Salinity on Phenotypic Plasticity of Sand Dollar Larvae.** *I. Uong and J. McAlister. Department of Biology, College of the Holy Cross.*

79. **Who is Worcester? Rekindling the Relationship between Holy Cross and the City of Worcester.** *C. Bachez, A. Toth, and V. Pacheco. Department of Visual Arts, College of the Holy Cross*

80. **The Importance of Having Diverse Representation in Fictional Books.** *J. Tronsky and M. Hallahan. Department of Psychology, College of the Holy Cross*

81. **Public Idioms and Private Love Lyrics: From Catullus to Shakespeare.** *X. Zhu and C. Coch. Department of English, College of the Holy Cross*

82. **Artificial Terracotta Staining and Removal.** *C. Cassidy, A. M. Hupp, and S. D. Costello* Department of Chemistry, College of the Holy Cross *Harvard Art Museums*

83. **Investigating the Mechanisms that Decrease Fertility of *C. elegans* on a High-Glucose Diet.** *S. Santiago, M. Powell, S. Samuels, and M. A. Mondoux. Department of Biology, College of the Holy Cross*

84. **Topological Diagrams Distinguish Subtypes of Cancer.** *D. Rodden and D. Damiano. Department of Mathematics, College of the Holy Cross*

……

S1. **Afro-Latin American Representation in Contemporary Colombian and Venezuelan Cinema.** *E. Florez-Villamarin and B. Franco. Department of Spanish, College of the Holy Cross*

S2. **Women Shaping Women: Beauty Standards and Rituals in the Age of the Selfie.** *N. Ventura and R. Beaudoin. Department of Visual Arts, College of the Holy Cross*

Poster 1

A Composite Model of Iliad Scholia

N. DiMattia, A. Holyfield, R. R. Kaczmarek, A.-C. Schaaf, and N. Smith
Department of Classics, College of the Holy Cross

We identified a network of relations among medieval manuscripts of the Iliad and reconstructed the transmission of their scholia dating as early as the 2nd century BCE. Previous scholarship assumed a stemmatic model of transmission. However, because we recognized that scribes creatively mixed material from multiple sources, we applied computational methods to identify common "units" of scholia content. These "units" have been compressed, expanded, and combined in the different manuscripts; therefore, an unrooted network is a more accurate model for scholia than a stemmatic tree. No single method accounts for all the diagnostic features of the scholia —thematic content, technical language, non-linguistic markings on the manuscript, and chronological indications. Therefore, we drew on a variety of methods such as TF-IDF, a measure of the proportional importance of words to the document; topic modelling, which identifies recurring clusters of co-occurring terms; and word embeddings, which model sequences of terms. Using this new methodological framework, we created a composite model of the relationships between the scholia. The resulting network has no stemmatic family tree, or even one source. Rather, it illustrates an interweaving, two-thousand-year scholarly debate about the Iliad.

We gratefully acknowledge Nancy Savage Skinner '79 and Stephen P. Skinner '77 and the Weiss Summer Research Program for financial support.

Poster 2

Salty Enzymes: Protein Splicing Dependence on Salt Concentrations

T. Nguyen and K. Mills
Department of Chemistry, College of the Holy Cross

Halophiles are organisms that thrive in very high salt concentrations. Enzymes from halophiles tend to have a negative surface charge and a low isoelectric point. We are interested in converting an enzyme that requires high salt for activity and proper folding into one that is functional at more moderate salt concentrations. Our model enzyme is the intein that interrupts the DNA polymerase II from *Halobacterium salinarum*. Inteins are intervening sequences in proteins that are spliced out from their flanking polypeptides, which then generates a functional protein. *Halobacterium salinarum* is an extreme halophilic archaeon, a salt-loving microorganism that is a member of the Archaea domain. We discovered a mutant intein that facilitates a splicing reaction at lower salt concentrations that has nine residue changes. We have determined that only at most two of these residue changes are required for activity at lower salt.

We acknowledge the National Institutes of Health (NIGMS - grant 1R15GM132817-01) for financial support of this work.

Poster 3

Investigation of neutron stars containing bosonic dark matter

J. Nyhan and B. Kain
Department of Physics, College of the Holy Cross

It is an open question today what dark matter is and how it behaves in physical systems. We created a model to examine possible interaction by looking at the case study of a neutron star, where we coupled a bosonic description of dark matter, a complex scalar field, with the visible, fermionic matter within the star. These two sectors were coupled together by gravity. We further extended the model by adding charge to the boson, giving us additional parameters for analysis. To practically analyze the behavior of such a system, we created a computational simulation. This simulation evolves a system of highly coupled partial differential equations through time and space using numerical techniques, including finite differencing, the method of lines, and Runge-Kutta. These allow our simulation to run efficiently and produce meaningful results in a reasonable temporal span. In order to analyze a starlike system, however, we must have physically realistic data to evolve. This initial data is found by solving a second set of differential equations (time independent and ordinary) to create a "static solution". This data is then loaded into our temporal simulation, where the evolution of a realistic starlike system can be observed.

This work was funded by an anonymous donation to the Weiss Summer Research program, for which we are very grateful.

Poster 4

Simulation of Neutron Stars with Fermionic Dark Matter

T. Gleason and B. Kain
Department of Physics, College of the Holy Cross

Dark Matter is a theoretical substance of which we know nothing about. It is unknown how to model it, but if it were a particle, it would be either a fermion or boson. We explored the possibility it is of fermionic characteristics. We simulated the physical system of a neutron star in space composed of two different fluids: one representing the detectable matter and the other representing the fermionic dark matter. The system is described by a set of differential equations for which we used a variety of numerical techniques to solve, as they cannot be solved analytically. Each fluid had its own independent parameters, but the two fluids were interrelated in the star. The simulation of the star was done through the computer programming language Python. Our code used the equations describing the neutron star's particles to evolve the parameters in both space and time. As we evolved the neutron star we looked to see if it maintained its stability or was unstable and collapsed into a black hole.

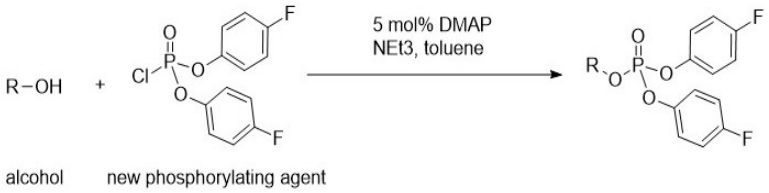
This work was funded by an anonymous donation to the Weiss Summer Research Program.

Poster 5

Phosphorylation of Alcohols with Fluorinated Phosphorylating Agent

G. Gavis and B. Sculimbrene
Department of Chemistry, College of the Holy Cross

Phosphorylation is essential to virtually all physiological processes. Enzymes in the body such as kinases and phosphorylases often control the activity of proteins through phosphorylation of alcohols. Pharmaceuticals take advantage of this process by creating "pro-drugs" that are initially biologically inactive until activated by phosphorylation (or dephosphorylation) once inside the cell. Research in the Sculimbrene group has historically focused on phosphorylating a wide variety of alcohol substrates with different phosphorylating agents and catalysts. My focus has been on the development of a new phosphorylation agent that contains fluorine (pictured below). About 30% of all pharmaceuticals contain a fluorine, due to the metabolic stability and lipophilicity it imparts to compounds. We hope to incorporate the phosphate and fluorine in a single step in the hopes of affording compounds with novel properties. My work this summer involved phosphorylating a series of standard and biologically relevant alcohols with the fluorinated phosphorylating agent. We adjusted various steps of the procedure throughout the summer to optimize the yield and purity of the products. Since these products are the first of their kind, much of my time this summer was spent characterizing these novel compounds.



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

Poster 6

Exploration of Neutron Stars in Numerical Relativity

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

In general relativity the Tolmon-Oppenheimer-Volkoff, or TOV differential equations provide a description of neutron stars. Given an equation of state relating pressure and energy density, static models of neutron stars can be analyzed. Using Runge-Kutta 4^{th} Order methods, solutions for the TOV equations were found. Solutions are distinguished by the central pressure of the star as an initial condition. From each solution information such as the mass and radius of the star can be obtained. Data from static solutions was recorded as the initial state of a neutron star to be simulated in time. Models were adjusted to include fermionic dark matter within the star. This required a two-fluid integration where one fluid represented dark matter and the other represented ordinary matter of the star. For stable neutron stars static solutions are expected to oscillate about equilibrium values. Through incorporation of additional parameters into the TOV equations the frequency of these oscillations can be determined. The shooting method was implemented as a numerical technique to solve for this frequency.

We thank the Research Associate Program of the J. D. Power Center for financial support

Poster 7

Electrochemical Analysis of Mixed Molecular Layers on Gold

A. Molski and E. Landis
Department of Chemistry, College of the Holy Cross

There is ample research to show that surface scientists can confidently attach and control a single layer of molecules to a surface. The question of how bi-layers and molecular mixtures attach to a surface is much more complicated and less understood. The energetics of several alkanethiols on Au(111) were explored by preparing monolayers and bilayers on the surface of gold electrodes through solution immersion. Molecules with various structures and levels of conjugation were selected to probe the differences between linear and conjugated alkanethiol desorption energies. The three molecules of interest were 1-octanethiol (1OT), 2-naphthalenethiol (2NT), and biphenyl-4-thiol (BPT). We found that the energy of desorption for the linear alkanethiol was greater than the energies necessary to desorb the conjugated molecules. We found that desorption energies of molecules in mixtures differ from the single component layers, indicating a more stable attachment to the surface. This research will help us understand fundamental molecular interactions and attachment energies of single component layers and molecular mixtures on gold surfaces.

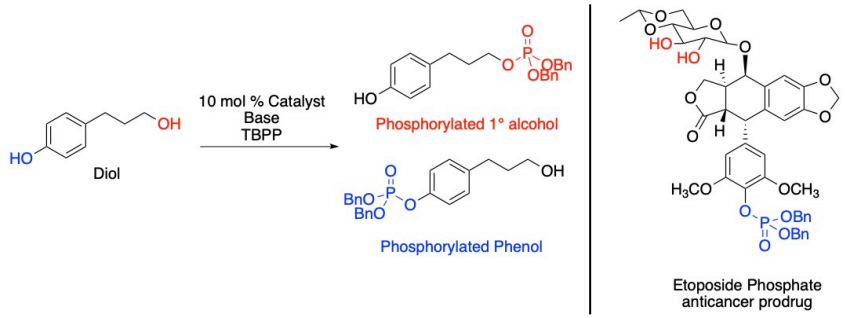
We thank Deirdre O'Brien Soltesz '94 and Edward G. Soltesz, M.D. '94 for their generous financial support of this research.

Poster 8

Optimization of the Site Selective Phosphorylation of Polyols

E. Eason and B. Sculimbrene
Department of Chemistry, College of the Holy Cross

Selective phosphorylation of alcohol groups in peptides, proteins, and steroids play essential roles in many biological processes for example: cell progression, transcription, translation, and bioenergetic metabolism. Diseases such as cancer and immune system disorders are often characterized by a disruption of these natural phosphorylation processes. Cells contain large enzymes which help differentiate hydroxyl groups (-OH) for selective phosphorylation. The question our lab aims to answer is how we can mimic this process with small molecules. To answer this question, we have taken the simple diol (molecule with two -OH groups) shown below and screened different phosphorylation conditions (i.e., various catalysts, bases, solvents, equivalence of starting materials, etc.) to gauge the effect on selectivity. Methods to selectively phosphorylate a molecule with multiple -OH groups will aid the pharmaceutical industry in the development of novel drugs, such as Etoposide phosphate.



We thankfully acknowledge the George I. Alden Trust Excellence in Career Related Undergraduate Education for financial support.

Poster 9

Characterizing Interbacterial Protein-Protein Interactions Can Lead to More Effective Antibiotics

E. Bouzan and C. L. Hagan
Department of Chemistry, College of the Holy Cross

Certain types of Gram-negative bacteria suppress the growth of competing bacteria in their environments through contact-dependent inhibition (CDI). These bacteria produce a CdiA protein on the surface of their cells that interacts with a receptor protein in the outer membranes of adjacent bacteria. The CdiA protein then delivers a toxin domain into those target bacteria, killing them. We aim to characterize how the CdiA protein from *E. coli* strain EC93 binds to its receptor protein, BamA, to understand how the interaction between these two proteins leads to the toxin delivery process. We have identified specific amino acid residues in the CdiA receptor binding domain (RBD) that interact with BamA via site-specific photo-crosslinking. An unnatural, photoreactive amino acid was introduced at specific positions in the CdiA RBD sequence and then crosslinked to BamA by irradiation with UV light. Using this method, we have identified residues in the N-terminal region of the RBD that interact with BamA. Further visualization of the structure of the CdiA RBD and the details of its interaction with BamA may reveal how subsequent steps in the CDI mechanism proceed. By understanding that mechanism, we hope to identify new methods of killing Gram-negative pathogens that pose an urgent threat to public health and are resistant to many of the currently available antibiotics.

We thank Kim and Wendell P. Weeks P15 for their generous financial contribution that made this project realizable.

Poster 10

Investigation of 1-NT and Mixed Monolayer Systems on Au(111)

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The monolayers of 1-naphthalenethiol (1-NT) and the mixed monolayers of 1-NT and octanethiol (OT) are studied at the molecular level using scanning tunneling microscopy (STM) in ambient conditions on Au(111). The effect of the manner and sequence of depositions is investigated. We do not observe the presence of well-ordered domains with 1-NT regardless of the deposition method. When 1-NT is solution deposited followed by vapor deposited OT, we observe the presence of distinct stripes and domains, which we believe to be OT. However, vapor depositing OT with subsequent 1-NT solution deposition does not yield the same prominent ordering.

This material is based upon work supported by the National Science Foundation under Grant No. 2045012.

Poster 11

Efforts Towards the Synthesis of Indolizines

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Indolizines are 10 pi electron conjugated heterocycles that are commonly found in many medical drugs. While there are a variety of methods to synthesize indolizines, we have developed a one pot synthesis in which a terminal alkyne is converted to a 1,4 disubstituted-1,2,3-triazole, followed by a rhodium-catalyzed transannulation to arrive at the indolizine in excellent yield with readily available starting materials. 2-methylpyridine derivatives readily undergo propargylation, yielding the starting terminal alkyne. "Click Chemistry" is used to access the intermediary 1,4 disubstituted-1,2,3-triazole using a copper catalyst. With the addition of rhodium (II) dimer and heat, the triazole decomposes to the ketenimine intermediate, which then undergoes a 5-exo-trig nucleophilic addition of the pyridine to provide the indolizine upon aromatization. This method allows for the synthesis of highly substituted indolizines. So far, we have synthesized a number of substrates in high yields, and our future work will be focused on substrate scope expansion.

We thank Kathleen and Stephen R. Winslow P16,14 for financial support.

Poster 12

Synthesis of β-Lactam Precursors via Copper Catalysis

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Ketenimines are synthetic intermediates that are highly reactive with various nucleophiles. Our research group forms ketenimines through "click chemistry." In this process, an alkyne reacts with tosyl azide in a copper catalyzed reaction to form a 1,4-disubstituted 1,2,3-triazole that will decompose into the reactive ketenimine intermediate which upon engagement with a nucleophile can form various nitrogen heterocycles. We utilize this ketenimine intermediate in a spontaneous intramolecular reaction with a tethered ethynyl ether nucleophile in order to synthesize β-Lactam precursors. β-Lactams are a vital structural component of many antibiotics, making their synthesis very important in light of the public health crisis of increasing bacterial resistance to treatment. We hope to gain access to a variety of substrates that can successfully participate in the copper catalyzed reaction in order to showcase the utility of the method. Our future work will involve conversion of these β-Lactam precursors into fully functionalized β-Lactams.

This research was supported by a grant from the National Science Foundation to Notre Dame University's Center for Computer Assisted Synthesis.

Poster 13

A Ketenimine Approach to the Synthesis of 1,2-dihydroisoquinolines

M. D. Floyd and A. K. Isaacs
Department of Chemistry, College of the Holy Cross

Ketenimines are reactive synthetic intermediates that can engage with nucleophiles, electrophiles, and radicals. In our lab we employ 'click chemistry' methods which utilize copper catalysts to generate desired ketenimines from the reaction of a terminal alkyne with tosyl azide. In a one-pot copper-catalyzed process, the substrate is transformed into a 1,4-disubstituted 1,2,3-triazole that spontaneously decomposes to the ketenimine intermediate, which can then be engaged by a nucleophile at the electrophilic carbon to form a range of cyclic products. Our current project sought to optimize these ketenimine reactions for the synthesis of heterocycles known as 1,2-dihydroisoquinolines. These heterocycles are found in a wide range of organic molecules which exhibit varying degrees of biological activities, making them a profound candidate for pharmaceutical development. We optimized reaction conditions using a model substrate, and then applied these conditions to a variety of substrates with different electron withdrawing groups and substituents on the ring system. We observed visible trends in reactivity and have been able to isolate and develop an effective method for synthesizing a large number of novel 1,2-dihydroisoquinolines with reproducible yields.

We thank Dr. and Mrs. Anthony M. Marlon '63 Summer Research Fellowship for financial support.

Poster 14

Racial Trauma and Resilience in Black College-Aged Women: A Case Study of Holy Cross' Black Women Alumnae

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Black women have a complex relationship with the Ivory Tower due to their experiences of erasure, oppression, and discrimination as a result of the institution's foundation of white and male superiority. Despite these challenges, Black women have proven themselves to be academic trailblazers. This is demonstrated in the history of the College of the Holy Cross, established in 1843: Black men first attended the College in 1968, whereas Black women first attended in 1972. For this project, ten Black women alumnae of the College who graduated between 1976 and 1995 were interviewed. This research relies on these women as a case study in order to explore racial and gendered trauma which constitute the unique experiences of Black women in higher education. My research further considers scholarship on racial trauma, intersectionality, and resilience to better understand the systemic experiences of Black women. I argue that we are able to understand how racial trauma may manifest itself in Black women in higher education through the variety of themes central to the experience of Black women at Holy Cross— such as voicelessness, feelings of invisibility, and lack of inclusivity and support. The study found that the field of racial trauma must focus on intersectional identities (such as those belonging to Black women) by uplifting their voices in the effort to convey the complexity and regularity of societal influences that perpetuate racial trauma. This study recognizes racial trauma as both a field and a phenomenon that interacts largely with societal influences, thus exceeds clinical distinctions. Black women further demonstrate resilience— such as leaning on Black community for support, remaining focused and internally mission-driven, and recognizing the racial realities they navigate. Their demonstration of resilience suggests that resiliency in Black women goes beyond current literature's conclusions. The aim of this project is to move the scholarship on racial trauma in a direction that takes account of the impact of institutional and interpersonal oppression with a specific focus on Black women's unique intersectional identities.

We thank the Weiss Summer Research Program in Humanities, Social Sciences, and Arts, and the J. D. Power Center Ignite Fund.

Poster 15

Efforts Toward the Synthesis of Diospongin B

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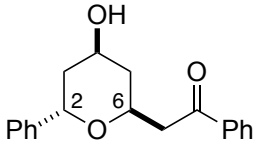

Diospongin B

Diospongin B is a natural product isolated from the rhizomes of *Dioscorea spongiosa*, a flowering plant in China notable for its utility in traditional medicine. This compound exhibits potent inhibitory activity on bone resorption, accounting for the plant's historical application in treating rheumatism. Diospongin B serves as an attractive target not only for its reported biological activities but for the distinctive challenge posed by the stereochemical arrangement of substituents on the six-membered tetrahydropyran ring. Specifically, the substituents in the 2- and 6-positions on the ring are in the thermodynamically unfavorable *trans*-orientation, which makes this target inaccessible by most common approaches used for the synthesis of tetrahydropyrans. We have developed a strategy to the synthesis of diospongin B that employs a ring-closing metathesis/deprotection/Michael addition sequence which controls the relative 2,6-*trans* stereochemical relationship via a bicyclic intermediate. We anticipate this strategy will facilitate the total synthesis of diospongin B as well as other natural products with similar structures.

We gratefully acknowledge funding of this work from Diane Brink P12, Catherine and Domenic J DiNardo '75 P21, 17, 06 and the Robert J. Stransky Foundation Summer Research Fellowships in the Sciences.

Poster 16

The Effect of Salt Concentrations on Homing Endonuclease and Protein Splicing Activity from an Extreme Halophile

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Halophiles are extremophiles, usually archaebacteria, that reside in very salty conditions with low water activity. These highly saline environments can have salt concentrations up to five times greater than the ocean. Protein enzymes from halophiles need to adapt to the high-salt environment in order to be fully functional in their proper folded configuration. Our enzymes of interest are inteins. Inteins are intervening polypeptides that direct their own excision from host polypeptides to form functional proteins. This process is referred to as protein splicing, an intramolecular reaction in which an internal protein segment is removed from a precursor protein. We are interested in two inteins from the extreme halophile *Halobacterium mediterranei.* The inteins both interrupt the *H. volcanii* minichromosome maintenance protein or cdc21, and each is interrupted by a homing endonuclease domain. We will study both the protein splicing and homing endonuclease activity of the inteins in vitro after expression in *E. coli* BL21. For the splicing assay, we are observing the salt dependence of splicing activity. For the homing endonuclease assay, we will investigate whether the nuclease can digest the target sites when the inteins are missing. Downstream, we will observe how the mutation of the wildtype affects both nuclease and splicing activity.

We thank the National Institutes of Health (NIGMS - grant 1R15GM132817-01), Jim Doyle, and Richard A. Marfuggi, MD '72 for financial support of this work

Poster 17

Lost in Translation: Exploring the Feminine Voice in French Translation

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Hélène Cixous famously said, "We translate what the American women write, they never translate our texts." In a world where English dominates as the lingua franca, there inherently lacks the keen understanding of linguistic differences in matters relating to the translation of neologisms, metaphors, and definitions of key terms. Without a foundation in the nuances of a work's source language or culture, many details can be misportrayed or potentially not portrayed at all. Cixous's fictional texts have been left mostly untranslated in favor of her more theoretical pieces, leaving many non-French readers with a limited grasp on her range. Through studying key elements of Cixous's work and researching the art of translation, feminism, and literary influences, we have produced an accurate and thematically rich translation of Cixous's play *Les Naufragés du Fol Espoir* or *The Shipwrecked of the Fol Espoir*. This research will help other English-speaking individuals understand more fully and more accurately the ideas and development of Cixous's central arguments as well as explore methods in which translators can work to dispel the inherent discrepancy in meaning and comprehension of foreign texts. This play has never been translated into English. The play's historically rich plot educates readers and spectators on the history of World War I, French socialism, and European colonization. This translation also offers English speakers the opportunity to experience Cixous's creative work, creating a more holistic perspective on her body of work and beliefs.

We thank the Weiss Summer Research Program in the Humanities, Social Science, and Arts for funding this project.

Poster 18

Reconstructing a Lost Masterpiece: The Chertsey Tiles and the Crusades in the Visual Culture of Western Europe

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Despite the Crusades being a tumultuous time of cultural, religious, and military collisions, the interactions that came from this conflict also induced cultural interactions that reimagined artistic traditions in western Europe. Reconstructing a Lost Masterpiece: The Chertsey Tiles and the Crusades in the Visual Culture of Western Europe will be an exhibition centered around a digital reconstruction of the Chertsey combat tiles with other objects, such as ceramics, textiles, and metalwork from Byzantium, the Mediterranean, and the Near East in order to explore the impact of those distant artistic traditions on that of medieval England and Western Europe. This research has focused on individual objects that act as touchstones of the themes of the history of the Crusades and the ongoing conflict and relationship between Christians and Muslims, and the royal and religious context around the objects that travelled back to England. This process includes writing short essays that summarize important historical, cultural, or artistic contexts around medieval art from the regions impacted by the Crusades. Further, the research has involved drawing connections between the object and its context to the Crusades, illuminating cross-cultural relationships between western Europe and the Near East and Byzantium. This element also includes how the object connects more specifically to the Chertsey Tiles and their visual depiction of the Crusades. The final part of these object essays is a hook for each object, something that is unique or noteworthy about it, from anything that sets it apart from other similar objects to an interesting aspect about the piece as a part of a group of objects. The broader goal of this project has been to contribute to this narrative of the influence of Byzantine and Islamic objects on the visual characteristics of medieval art in England, as evidenced by the Chertsey tiles.

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

Poster 19

A Directed Evolution Experiment to Improve Protein Splicing of Two Inteins from *Haloquadratum walsbyi*

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Halophiles are archaebacteria that are adapted to living in high salt environments that are otherwise hostile and deadly to other organisms. *Haloquadratum walsbyi* is one such halophile with four inteins interrupting the cdc 21 protein. Inteins are intervening polypeptides located between two flanking polypeptides, called exteins. The intein catalyzes its excision from the extein concomitant with the ligation of the exteins. This process is known as protein splicing and occurs post-translationally. Inteins were taken from *Haloquadratum walsbyi* and expressed within *E. coli* to disrupt the protein responsible resistance to the antibiotic kanamycin. Directed evolution was used to select for mutant inteins that can promote splicing in *E. coli* at low salt concentration. This was accomplished by transforming the plasmids into an *E. coli* strain with low fidelity DNA replication to create sequence diversity, and then plating on different concentrations of kanamycin to select for cells that have inteins that can promote splicing. Initial results suggest that the cells containing the mutated DNA did not have improved splicing and only grew on carbenicillin, whereas the cells containing the non-mutated DNA also had breakthrough growth on kanamycin plates. Replicating these results and further testing the growth of the mutated DNA is needed to further determine if splicing is improved in the mutated DNA. Future work will include testing growth on lower concentrations of kanamycin as well as using error-prone PCR to generate a different library of mutated inteins.

This work was supported by the National Institutes of Health (NIGMS - grant 1R15GM132817-01).

Poster 20

Developing a Biochemical Assay to Monitor Bacterial Contact-Dependent Inhibition

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Contact-dependent inhibition (CDI) is a mechanism of interbacterial competition between Gram-negative bacteria. CDI depends on a large protein named CdiA, which forms a filament on the surface of the bacterial cell that produces it. CdiA binds to a receptor on the surface of a neighboring, target bacterium and delivers a toxin across that cell's outer membrane, killing the target cell. The details of how this toxin delivery system functions remain mostly unknown. A better understanding of this mechanism might allow us to exploit CDI systems for medicinal purposes against Gram-negative bacterial infections. Bacteria that are resistant to currently available antibiotics pose a serious threat to human health, making novel therapeutic strategies increasingly important. We are developing an assay that will allow us to monitor the process of toxin delivery by the CdiA protein across a target membrane. We are studying a CDI system from *E. coli* strain EC93, which uses the essential protein, BamA, as its target cell receptor. We have developed an expression system for the CdiA protein in which the toxin domain is replaced with a SNAP-tag and have demonstrated that this protein is properly assembled on the *E. coli* surface. Preliminary experiments suggest that the SNAP-tag may be delivered by CdiA like the native toxin in a BamA-dependent manner. Future experiments will be directed towards improving the efficiency and specificity of the assay. We will then investigate the details of how this CDI system delivers the SNAP-tag across the target membrane in hopes of identifying new ways of delivering antibiotics across the outer membranes of Gram-negative bacteria.

We would like to thank Kim and Wendell P. Weeks P15 for generously supporting this research.

Poster 21

Spectrometer Design for Studies of Laser Physics

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Research in our lab makes use of specialized lasers for manipulating the quantum states of atoms. These lasers emit light at precise frequencies (or wavelengths), corresponding to modes of oscillation. The light frequency is adjustable but shows complicated behavior, which has led us to study the physics of these laser frequency modes. The aim of this project was to improve the design and functionality of a laser spectrometer. We focused on two aspects: the spectrometer housing, and the software which collects and analyzes the spectrometer data. Our goal for the housing was to protect the sensitive optical equipment inside and ensure stable conditions, while still allowing easy access to the internal components. We achieved this through a modular design of aluminum panels. The aluminum provides high thermal mass and conductivity for even temperature distribution. The panels can be removed individually without disassembling the entire housing. This makes the components accessible, which is necessary during calibration or testing of the spectrometer. The panels can be replaced or modified as new needs arise, like adding connectors for external wiring. This allows for the design to evolve while maintaining its structure. Our goal for the software was to streamline design and improve functionality. We achieved this by automating the data collection and analysis components of the software. For example, we programmed the spectrometer camera to automatically adjust its exposure time to stop light saturation, which prevents accurate measurement of the laser frequencies. Additionally, we created an algorithm which identifies the laser beam positions on the camera image. This information is passed to other programs which use it to calculate the laser frequencies. Furthermore, we wrote software that automatically takes data at different laser injection currents, saves and formats them into a spreadsheet. In sum, these software improvements allow for rapid data analysis, meaning more time can be spent studying the underlying laser physics.

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

Poster 22

Investigating the Effectiveness of a Synthetic Hydrogel Polymer to Support Cell Viability of 3T3 Fibroblasts in a Tissue-on-a-Chip Device

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Vitrogel is a synthetic polymer that has properties similar to the extracellular matrix surrounding human mammary ductal epithelial cells. Our lab has hypothesized that Vitrogel could replace animal-derived collagen in a tissue-on-a-chip device that we use to study the role that fibroblasts may play in promoting the tumorigenesis of epithelial cells in the formation of breast cancer. Past research in our lab has shown that 3T3 fibroblasts express and shed syndecan-1, a signaling protein known to lead to poor breast cancer prognosis when present in fibroblasts near epithelial tumor sites. It is our hope that co-culturing 3T3 fibroblasts with NMuMG epithelial cells in our chip system will allow us to determine the mechanism by which syndecan-1 expression in fibroblasts can help drive the uncontrolled division of these ductal epithelial cells. This chip device we use, which we refer to as the *EpiChip*, was originally designed by the Chen Biomedical Engineering Lab at Boston University to study ductal cell growth. In our overall experiments, we are aiming to fully mimic the stromal microenvironment surrounding the epithelial duct of a mammary gland using the *EpiChip*. The goal of our work this summer was to determine the best method for hardening the Vitrogel polymer into a gel containing living fibroblasts while also leaving an open channel to enable the growth of an epithelial cell-based duct inside the *EpiChip*. Our initial studies have successfully produced Vitrogel gels, but at the expense of fibroblast viability. Our ultimate goal is to culture a stable, CRISPR-Cas9-edited fibroblast line that does not express syndecan-1, and compare the proliferation and tumorigenesis of NMuMG cells in the presence of the edited and wildtype fibroblasts inside separate *EpiChips*. This comparison may provide valuable insights into the impact of syndecan-1 presence on the formation of breast cancer, paving the path for the potential development of cancer-preventing therapies.

We thank Jacqueline H. and George A. Paletta, Jr., M.D. ’84 P15 for their generous financial support of our summer research project.

Poster 23

Alkyne Based Molecular Layers on Nanoporous Gold

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The highly desirable nonreactive, conductive, and mesoporous surface of nanoporous gold can be formed through a dealloying process in concentrated nitric acid. Past research has indicated that terminal alkynes can be attached to the surface of gold with the formation of stable bonds, and maintain electrical conductivity. Our research focused on functionalizing nanoporous gold with varying molecules that each contained benzene rings with a terminal alkyne attached. The molecules varied in the functional groups or elements also attached to the benzene ring, including fluorine and carboxylic acid groups. The impact of these different groups' molecular structure on overall electrical conductivity and stability was tested through analytical methods including cyclic voltammetry and x-ray photoelectron spectroscopy. The results show that these molecules also form stable bonds with the nanoporous gold's surface, and the functionalized nanoporous gold maintains its electrical conductivity.

We thank Patricia McGovern Hill '82 P12 and Peter J. Hill '82 P12 Family Summer Research Scholarship for financial support.

Poster 24

Investigating the Oxidative Stress Responses of Canine Mesenchymal Stem Cells Across Different Age Groups

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Mesenchymal stem cells (MSCs) are multipotent and highly proliferative cells important in tissue repair. By evaluating the capacity of these cells to proliferate and regenerate as they age, we have been able to document age-related declines in these functions. We are now investigating molecular mechanisms that may underlay these declines. MSCs from the lungs of companion dogs of diverse ages and breed categories were used for the similarities in environmental stressors that pets share with humans. A series of assays designed to examine how age affects the ability of these cells to recover from stressors commonly associated with senescence were employed. One such assay targeted the capacity of cells to respond to oxidative stress provided by hydrogen peroxide through the production of reactive oxidation species (ROS), which can be very damaging to the cells. The Annexin V early apoptosis and 7-AAD dead cell markers were added to samples damaged by hydrogen peroxide exposure. Flow cytometry was utilized to detect the prevalence of ROS, AnnexinV and 7-AAD in older and younger stem cell populations. Preliminary data suggested that MSC populations damaged with hydrogen peroxide contain more dead and early apoptotic cells than undamaged MSCs, as would be expected. Further research across different dog breeds and ages using this assay will provide insight into stem cell senescence in relationship to aging on an organismal level.

This research was funded by a generous gift made by John Bray to the Alumni / Parents Summer 2021 Research Scholarship Fund and by the Weiss Summer Research Program in the Natural Sciences and Mathematics.

Poster 25

The Constitutionality of Preventing Pandemics

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Hon. Joseph F. Greene Moot Court Program, College of the Holy Cross

For over a year, the COVID-19 Pandemic has had a devastating impact on the economy across the world. Thankfully, the rapid development and distribution of vaccines has slowed the death toll and brought people back to work safely in person, allowing the economy and the nation to heal. Though the COVID-19 pandemic is ending, a serious constitutional question remains; what can the federal government do to prevent future pandemics? In preparation for our Fall 2021 Moot Court season, this project has considered two issues. First, could Congress, under the Commerce Clause, authorize the President to order compulsory vaccinations. Second, would this vaccination program violate an individual's right to liberty and privacy under the Fifth Amendment. To answer the first question, we analyzed Supreme Court cases that delineate the extent of Congress's power under the Commerce Clause. The case law in this area explores the difference between regulations of "economic" and "non-economic" activity, as well as the degree of deference the Court gives to congressional judgment. For the second issue, this project researched landmark substantive due process cases that establish liberty interests in bodily integrity and refusing medical treatment. Despite these recognized interests, the Court has ruled that the government's interest in preserving life often outweighs them. Through our analysis of Supreme Court precedent, the strongest case could be made that compulsory vaccinations do not violate the petitioner's rights, but Congress did exceed its power under the Commerce Clause making this action unconstitutional.

Thank you to the Dr. Charles Weiss Summer Research Program for the financial support.

Poster 26

How to Better the Life of an English Learner

V. Maza
Office of the Governor John Carney, Wilmington, Delaware

Policy changes are necessary yet sensitive. Opportunity Funding (OF) is a clear example in Delaware; the legislation was signed to increase support for English Learners (ELs) and low-income students in the state. It impacts 13,261 students and their families. Therefore, the opinions of thousands of individuals must be considered during both the decision-making and implementation processes. As part of my internship, I interviewed stakeholders such as teachers and advocates to understand the challenges faced by ELs and how to address them. I also conducted research and used my experience as an EL to provide suggestions and recommendations to best support these students. I found that the barriers experienced by ELs are very individualized, two predominant ones are supporting ELs in their first language while acquiring English proficiency and finding certified teachers. To tackle these issues, our education system needs to value ELs from an asset-based mindset, not as a deficit, and students must be given ownership of their empowerment process. To achieve that mindset, school staff and teachers need the training to understand the needs and life circumstances of ELs. Furthermore, the individual empowerment of ELs can be achieved by giving them a voice and opportunities. Specifically, they need to be aware and supported through the college admission and employment-seeking processes. Other opportunities might look like participating in professional development sessions or curriculum writing. Overall, we need to continue drawing attention to ELs and bring their stories to life.

I would like to thank Jon Sheehan for his supervision during the completion of this project.

Poster 27

Investigation of *katherine johnson,* a *de novo* evolved gene essential for *Drosophila* male fertility

S. Y. Guay, J. M. O'Toole, P. H. Patel, and G. D. Findlay
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De novo evolved genes arise from previously non-coding DNA regions and are unique to a few species. We used RNAi and CRISPR/Cas9-mediated knockout (KO) to identify putatively *de novo* evolved, testis-expressed genes that are essential for *Drosophila melanogaster* male fertility. These experiments identified *katherine johnson* (*kj*), whose disruption resulted in significantly reduced male fertility. Dissection of mutant testes revealed high numbers of mature sperm. Functional analysis of mutant sperm transfer showed that *kj* KO sperm are successfully transferred to and retained within the female. This summer, I performed a hatchability assay and determined that females mated to *kj* mutant males laid eggs at the same rate as control mated flies, but these eggs failed to develop into larvae. Mutant sperm are getting to the female and egg laying is normal, suggesting that the loss of *kj* either affects sperm ability to fertilize or alters the use of the paternal genome during early embryonic development. To distinguish these possibilities, we have worked on optimizing an embryo staining procedure meant to assess the ability of mutant sperm to penetrate the egg. To investigate the normal function of the KJ protein, we also constructed a transgenic fly line that expressed a 6x-histidine-tagged *kj* transgene under its own regulatory sequences. Antibody staining of KJ-HA in *Drosophila* testes revealed localization to the pre-meiotic spermatocytes, and the absence of KJ from mature sperm. These data suggest that while KJ may function early in the process of sperm production, the effects of its loss are not observed until embryonic development initiates. *Katherine johnson* stands as an example of a putatively *de novo* evolved gene, which has developed essentiality to *Drosophila* maturation via functions in sperm operation.

This research was funded by a grant from the National Science Foundation to G. Findlay.

Poster 28

QAnon and American Christian Nationalism

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Since the storming of the United States Capitol on January 6th 2021, a fringe movement known as "QAnon" has garnered much attention for propagating conspiracy theories alleging that members of the Democratic Party and the Hollywood elite are involved in a Satanic plot to undermine former president Donald Trump. While the movement seems to rely upon an evangelical Christian structure, more fundamental to it is Christian nationalism. It is therefore important to distinguish between Christian religiosity and Christian nationalism in understanding QAnon's appeal to American Christians. In analyzing QAnon's claims, this study has found that they may have been more specifically informed by three Christian nationalist themes: Scapegoating, apocalypticism, and messianism.

We thank the WEISS Summer Research Program for financial support.

Poster 29

Characterization of *Pseudomonas aeruginosa* Genes Involved in Bile Salt-Induced Polymyxin Resistance

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Pseudomonas aeruginosa is a gram negative, multidrug-resistant bacterium. As an opportunistic pathogen, *P. aeruginosa* commonly infects the lungs of Cystic Fibrosis (CF) patients. Gastroesophageal reflux (GER) is a complication associated with CF in which bile is aspirated into the lungs. Recent research has suggested that aspirated bile contributes to the chronicity of *Pseudomonas* infections in the lung by promoting biofilm formation and antibiotic resistance. Polymyxins are a class of antibiotics used as a last resort treatment for *Pseudomonas* lung infections because of their high toxicity and the risk of bacteria developing resistance. Previous research has shown that bile salts induce lipopolysaccharide (LPS) modifications in Enterohemorrhagic *Escherichia coli* leading to increased resistance to polymyxins. We previously established that bile salts also induce increased resistance to polymyxins in *P. aeruginosa* strain PA14 and identified several PA14 transposon mutants with insertions in genes involved in LPS modification pathways that lost the ability to enhance polymyxin resistance when exposed to bile salts. Here we report further characterization of two PA14 genes, *ssg* and *wapR*, which are involved in bile salt-induced polymyxin resistance. Analysis of the effect of bile salts on biofilm-related phenotypes that contribute to polymyxin resistance show that *ssg* and *wapR* play an important role in surface attachment in the presence of bile salts. Results also indicate that bile salts significantly decrease swimming motility and increase twitching motility in wild-type PA14, but it has a minor effect on the *ssg*::*Mr2xT7* and *wapR*::*Mr2xT7* mutants. Lastly, bile salts impact biofilm colony morphology in wild-type PA14 and the *wapR*::Mr2xT7 mutant. Characterization of genes and pathways involved in bile salt-induced polymyxin resistance will contribute to our overall understanding of resistance mechanisms and promote the development of new treatments for *Pseudomonas* infections.

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Poster 30

Tau phosphorylation sites differ in chronic traumatic encephalopathy and Alzheimer disease

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Chronic traumatic encephalopathy (CTE) is a neurodegenerative disease which has been associated with exposure to repetitive head impacts (RHI), typically sustained by contact sport athletes. CTE is characterized by accumulation of tau pathology; however, the phosphorylation sites of tau involved in CTE, and the similarities and distinctions from Alzheimer disease (AD), are not well understood. We measured quantitative levels of phosphorylated tau (p-tau) species within the dorsolateral prefrontal cortex from post-mortem brains (n=473) with neither CTE nor AD (controls), CTE, AD, and both CTE and AD. Specifically, we focused on quantifying levels of Thr181 (p-tau$_{181}$), Ser202 (p-tau$_{202}$), Thr231 (p-tau$_{231}$), and Ser396 (p-tau$_{396}$), as well as amyloid-beta (Aβ) species Aβ$_{1-38}$, Aβ$_{1-40}$, and Aβ$_{1-42}$. Of the four p-tau epitopes, p-tau$_{202}$ was the most upregulated phosphorylation site in CTE, and the only epitope that was significantly predicted by total years of contact sport participation ($p=0.001$), a proxy for RHI. Conversely, p-tau$_{396}$ was the most increased epitope in AD and also was most closely associated with Aβ$_{1-42}$ levels ($p<0.001$). The ratio of p-tau$_{202}$:p-tau$_{396}$ was significantly increased in CTE and CTE-AD compared to AD, even between early CTE and AD disease stages ($p=0.018$). Overall, within the frontal cortex, p-tau$_{202}$ is associated with RHI and CTE, while p-tau$_{396}$ is more associated with Aβ and AD. These results may aid in the neuropathological discrimination of CTE and AD as well as the development of clinical biomarkers for CTE.

We thank the U.S. Department of Veterans Affairs, Alzheimer's Association, National Institute of Aging, National Institute of Neurological Disorders and Stroke, Department of Defense Peer Reviewed Alzheimer's Research Program, and the Concussion Legacy Foundation for their financial support.

Poster 31

An Internship Pathway to Dentistry: A Dual Evidence-Based Approach

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Tufts University School of Dental Medicine

The aim of the internship program was dual: professional and personal development. For professional development, an educational project was designed to shed light on a recent change in the dental school curriculum: the use of psychometric reports. With the transition from the two-part National Board Dental Exam to the Integrated National Board Dental Exam (INBDE), Tufts University School of Dental Medicine (TUSDM) faculty and administrators aligned the exam formats to mirror that of the INBDE. Since TUSDM made this transition in January 2020, the aim of this initiative was to compare the psychometric reports. The goal on personal development focused on taking an evidence-based approach to career growth. Phase one consisted of appraising Harvard Business Review articles on various topics (leadership styles, difficult conversations, financial agility, etc.). Successful dental professionals across the United States were interviewed and shared perceptions on the identified topics. The shared experiences varied based on their current roles and responsibilities (dental students, clinicians, practice owners, researchers, faculty members, and administrators including deans, associate deans, program directors). All conversations were inspirational and motivational. There were multiple lessons learned through this experience, but one common theme was highlighted: the value in asking. Maintaining an open mindset and absorbing as much information in the four years of dental school is essential for success. The ability to question and learn from experienced colleagues in the field of dentistry further signifies the importance of inquisitiveness. An internship pathway for predental students can serve as a journey filled with inspiration and professional growth. This framework internship program can serve as an example for other academic institutions, as it can expose predental students to the challenges and opportunities this field may offer.

I sincerely thank Tufts University School of Dental Medicine, College of the Holy Cross, and the Crusader Internship Fund for making this happen.

Poster 32

Characterization of Saturn in Drosophila

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De novo evolved genes emerge from previously non-coding regions of DNA. In *Drosophila melanogaster*, many *de novo* genes are expressed in male reproductive tissues, suggesting that they may play critical roles in fertility. We previously showed that loss of the rapidly evolving *saturn* gene caused a 92 percent reduction in male fertility. Here, we have investigated the Saturn protein's localization within developing sperm cells and the functional consequences of its rapid evolution between species. Antibody staining for Saturn and confocal microscopy showed that the protein localizes to the nuclear membrane of the post-meiotic sperm cells, suggesting the gene may be important for the re-shaping of the nuclear membrane that occurs during this stage of sperm production. In the absence of *saturn*, the number of post-meiotic sperm cells appeared unaffected, but the shape of their nuclei consistently became aberrant at a particular point of development. We also investigated whether progressively more divergent forms of *saturn* from related *Drosophila* species could function in *D. melanogaster*. Using epitope-tagged *saturn* transgenes and confocal microscopy, I found that the Saturn proteins from closely related *D. simulans* and *D. yakuba* showed the same patterns of localization in *D. melanogaster* testes as the *D. melanogaster* version. In contrast, the more highly diverged copy from *D. ananassae* did not localize to post-meiotic sperm nuclear membranes. This result may suggest that Saturn's exact function has evolved over time, perhaps as a consequence of its rapid protein sequence evolution. Future experiments will assess the fertility consequences of these *saturn* transgenes and use evolutionary analysis to pinpoint the key amino acid differences that are responsible for their divergent localization patterns.

We thank the National Science Foundation for financial support

Poster 33

Investigating Intramolecular Hydrogen Bonding

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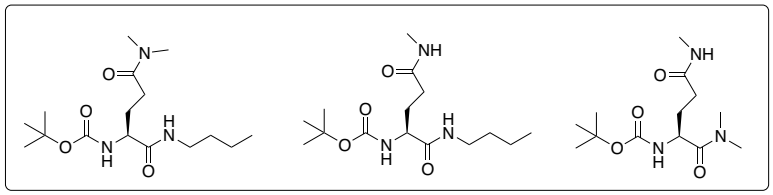
Hydrogen bonding within a molecule can be studied in attempt to better understand its properties. By synthesizing molecules containing an N-H, we can track the hydrogen on ^{1}H-NMR scans to predict which atoms are interacting. One variable we are interested in is the ability sulfur has to hydrogen bond, since previous data has suggested these interactions are not observed. We created various molecules and identical oxygen controls and compared them with concentration and solvent studies. We found sulfur behaving more like the oxygen molecules compared to the controls, suggesting some type of hydrogen-bonding interaction. We are also interested in the hydrogen-bonding interactions in proteins. Since proteins are known to primarily form alpha helices and beta sheets, studying the interactions on an individualized scale allows us to picture the forces that must be overcome. We began this investigation by synthesizing peptide mimics with glutamate derivatives for the side chain. By creating variations of the molecule, we can use concentration and solvent studies to see how the molecule is behaving.



We thank Karen and Gerald P. Migliaccio ’77 for their generous contribution to the Weiss Summer Research Alumni / Parent Scholarship Fund.

Poster 34

Low Energy Charge Transfer Collision Experiments using Pulse Sequencing

A. DiResta and P. Oxley
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The charge transfer collision cross section for collisions between lithium atoms and protons has previously been measured for proton energies between 130 and 3500 eV. We would like to extend these measurements to lower energies which will mimic the collisions which occur near the walls of some nuclear fusion devices. To do this we require a new experimental method, called the “pulse sequencing” method, and this poster details experimental and theoretical progress towards realizing this new method. Pulse sequencing requires that the protons involved in the collisions, and the charged lithium atoms which are created in the collisions, be controlled by a series of carefully timed voltage pulses. In addition, voltage pulses are required to control the electronics used to detect the protons and the charged lithium atoms. Two high-speed pulse generators are used to provide the 7 voltage pulses needed, and we have written a LabView program to allow computer control of these generators. We have also built an AND gate electrical circuit which is needed to correctly control the electronic counter used to measure the output of the charged lithium detector. Finally, we have used the SIMION computer simulation package to study the expected efficiency of detecting charged lithium ions as a function of the time that the proton beam is turned on in our experiment. The results of these simulations will be important for optimizing the pulse sequencing used in future experiments.

We would like to thank the Robert J. Stransky Foundation Research Fellowships in the Sciences for their financial support.

Poster 35

Glucose confers resistance to Aβ aggregation pathology in Alzheimer's disease

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Alzheimer's disease is a progressive neurodegenerative disorder that continues to plague millions worldwide. The model system *C. elegans* has been used successfully to study many neurodegenerative diseases including Alzheimer's (AD). Here, we modeled AD using two strains of *C. elegans*, CL2355 and CL2659. These transgenic strains express temperature sensitive human amyloid beta (Aβ) protein. Therefore, upon upshift to a higher temperature Aβ aggregates and forms plaques—a hallmark of Alzheimer's disease progression. Based on our prior studies in Kingsley et al., we hypothesized that a high glucose diet, perhaps akin to a diabetes model, would be associated with an increase in Aβ plaques, signifying advanced neurodegenerative pathology. To test this, we fed CL2355 and CL2659 transgenic animals different diets including varying glucose dosages. I conducted paralysis assays on hundreds of worms fed different diets recording how many hours/days it took for the worms to get paralyzed upon upshift. Since a certain level of Aβ plaques in *C. elegans* have repeatedly been shown to paralyze the worms, simply scoring paralysis provides information regarding the burden of plaques temporally. My preliminary results indicate that added dietary glucose leads to slower accumulation of Aβ plaques, and therefore a lower paralysis rate by Aβ plaque formation. It is possible this is due to the Unfolded Protein Response (UPR), as glucose has been previously shown to upregulate the UPR. The live *E. coli* condition yielded a faster rate of paralysis in the animals, which further elicits the effect of bacterial proliferation in the gut on Aβ accumulation. Further experiments include exploring the impact of glucose on genes in the Aβ aggregation pathway as well as the influence of carnosine on Aβ toxicity.

This research was funded by a grant from the National Institutes of Health.

Poster 36

Cold Atom Pattern Analysis of Light-Atom Interactions

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In our research, a vapor of rubidium atoms is cooled to nearly absolute zero through "optical molasses", a standing wave of light caused by laser beams from six directions. This technique is used in the best atomic clock standards used today. The atoms are slowed (cooled) both by forces from photon momentum kicks and from potential energy wells produced from the three-dimensional standing wave. A slight misalignment of the laser light causes atoms in the vapor to rearrange into either one-dimensional (1D) striped or two-dimensional (2D) elliptical patterns, seen in photographs of the vapor cloud. Past research has shown that the contrast of bright and dark regions in the 1D striped patterns increases with time, reaching a final level after some tens of milliseconds. This summer we aimed to research whether the cold atom distribution patterns are caused more by forces from the momentum kicks or from the potential energy wells. We used Fourier transforms of the images to calculate the contrast value of observed patterns. In a theoretical study, we found a relation between the Fourier transform and a model equation of the 1D pattern, in which the contrast value can be calculated from heights of the peaks in the Fourier transform spectrum. This method proved very efficient as this analysis can be done in less than 1 second, while a previous least squares method takes 1 minute or more. Utilizing a similar Fourier method, we also are able to calculate the contrast value of the 2D patterns and analyze how it increases with time of interaction with the laser light. Recent data analysis has shown that the 2D patterns begin to form within 2 milliseconds and continues to increase in contrast for about 20 milliseconds, leveling off afterwards. We hope to further explore which of the two forces are more responsible for pushing atoms into these patterns by varying the frequency and intensity of the laser light and observing how the contrast value changes with time.

We thank Janna L. Murgia-Hoppin '98 and John W. Hoppin, Ph.D. '98 for their contribution to the Alumni/Parents Summer Research Scholarship fund.

Poster 37

Diurnal Variation in Cosmic Rays

L. Yatsuhashi, F. Willette, and T. Narita
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Cosmic rays are high energy particles that move at the speed of light and create a shower of muons and electrons when colliding with atoms in Earth's atmosphere. A diurnal variation in cosmic rays is the change in the amount of cosmic rays that reach Earth throughout the day. Due to the Sun's rotation and magnetic field, we expect to see more muons during the daytime and less muons, and therefore less cosmic rays, during the nighttime. Observing muons over many days allows us to look for these diurnal variations in cosmic rays. The muons that reach Earth's surface can be detected with a telescope composed of a scintillator and a photomultiplier tube. These telescopes record the number of muons that pass through, as well as the time each muon came through, and we can observe cosmic rays by observing the muons. By observing the muons for many days, we can look for diurnal variations in cosmic rays. From our experiments, we did not find evidence of a diurnal variation in cosmic rays.

We gratefully acknowledge the Weiss Summer Research Program for funding this research project.

Poster 38

Muons and The East-West Effect

F. Willette , L. Yatsuhashi, and T. Narita
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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. Muons reach Earth's surface and we used muon telescopes (or muon detectors) to investigate the effect that Earth's magnetic field has on the positively charged cosmic rays and the muon showers that follow. This is known as the East-West Effect which has been found in previous studies and can be explained by the Lorentz force acting on the charged cosmic rays. The result is that more muons strike the ground traveling eastward than westward. To test this effect, we used two telescopes; for one part of the data collection period, they faced east with a zenith angle of 45 degrees and for the other part they faced west with a zenith angle of 45 degrees. Although some of our data did agree with the East-West Effect, it was inconsistent with previous findings and the data gathered from each of the telescopes could not support one another.

We thank the Weiss Summer Research program for financial support.

Poster 39

Assessing Gist Development in Novices Following Perceptual Training

M. DiDominica, M. Qadri and G. DiGirolamo
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Gist is the ability to extract meaning in the absence of detail following a brief glimpse of a scene or image. When radiologists view a half-second presentation of a breast mammography, they can detect cancer at above chance levels even when they report that they are just guessing, a sign of gist. This gist ability may be an important, though poorly understood, aspect of medical diagnosis. Gist is a measure of perceptual expertise as it is shown in experienced radiologists, but it is unclear when gist develops during learning. To test gist, novice participants completed a perceptual learning module of skin histology that used both accuracy and reaction time to increase perceptual learning as they identified abnormalities in histology images. Gist was measured through a key-press decision indicating normal or abnormal following a half-second presentation of a histology image. Novice participants showed gist following this brief training session. However, gist was developed without the establishment of significant explicit category learning as the amount of gist for abnormal images was unrelated to the degree of perceptual learning. However, the amount of gist for normal images was directly related to the amount of perceptual learning, suggesting that abnormality gist is a gestalt process that develops separately from detailed perceptual learning of categories. Future work will expand on the establishment of gist in novices and test the relationship between abnormality gist and explicit abnormality recognition.

We thank the Weiss Summer Research Program for financial support.

Poster 40

Designing and Testing a Museum Exhibit to Support Children's Science Learning

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**Department of Psychology, Worcester State University*

Informal settings, such as science museums, provide children with opportunities to learn through the exploration of different exhibits in a loosely structured, hands-on manner. Museum displays targeting complex science concepts can help children overcome misconceptions that they have about the physical and natural world. One commonly misunderstood concept in Earth and Space Science is the day/night cycle, because in order to explain it, learners must reconcile Earth- and space-based perspectives—i.e., that the Sun's apparent motion is caused by Earth's eastward rotation. In collaboration with the EcoTarium Museum of Science and Nature in Worcester, we developed an exhibit to support children's causal understanding of the day/night cycle and related events. We incorporated cognitive science principles by creating a display that invites the visitor to simultaneously align the different perspectives of the day/night cycle (Jee & Anggoro, 2019; Jee & Anggoro, 2020). Our exhibit prototype includes a 3D globe of Earth, a stationary light source (the "Sun"), a 2D image of the Worcester skyline that is illuminated at daytime and dark during the evening, and a clock face with an hour hand that moves as a crank is turned. Spinning the crank changes the hour of the day on the clock face and rotates the globe. Simultaneously, a circle representing the Sun moves in an arc across the 2D skyline. As summer research students, our work involved prototyping this exhibit on the museum floor in order to test its physical capacities and note what takeaways young children have after interacting with the display. We collected data from nine children in July 2021. We will discuss preliminary findings from the prototyping process and outline a plan to experimentally test the exhibit in the fall.

This research was funded by the Weiss Summer Research Program and by the Scholarship in Action Program, and by a donation made to the Alumni / Parent Summer Research Scholarship Fund by Richard B. Fisher '47 P79.

Poster 41

Prediction of Temperature and Pressure Broadening Effects in IR Spectroscopy of Chemicals

D. Kreka, J. Chesslo, D. Burns, and R. Molt
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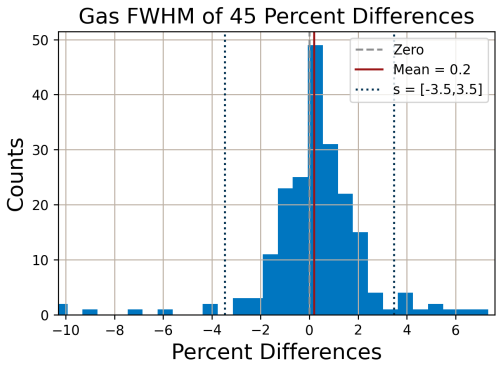
There are many materials whose **infra**red (IR) signatures are uncharacterized. We may compute absorption energies/intensities via solving the Schrödinger equation for a particular material, but the environment determines the broadening effects of the observed IR spectrum. We implemented algorithms to compute the total broadening for thermal, pressure, and instrumental effects. This allowed us to determine when the Voigt convolution was necessary for *ab initio* prediction of IR spectra of materials. Instrumental broadening effects are always larger than thermal or pressure effects for the operational conditions on the Earth's surface. As a result of this broadening code, we were able to benchmark our accuracy in estimating excitation frequencies and absorption cross sections for materials. Using quantum mechanical perturbation theory to estimate material-specific parameters in conjunction with our broadening code, we determined the accuracy of estimating IR frequency positions and IR absorption cross sections compared to NIST and HITRAN experimental databases. For gaseous molecules using a fixed FWHM of 45 cm^{-1}, our accuracy for frequencies is 0.2 ± 3.5 ($\bar{x}$ ± s) percent difference.



I would like to thank ENSCO for the opportunity to work on this project.

Poster 42

Explicit and Implicit Categorization in Pigeons

O. C. Ezemma and M. A. Qadri
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Research on mechanisms of categorization suggests that pigeons only use implicit categorization (features processed simultaneously) whereas primates use explicit categorization (features processed individually). During rule based and information integration tasks, animals are generally immediately rewarded with food for a "correct response," and not rewarded for an "incorrect response." This reward contingency allows implicit categorization mechanisms to learn the categories. Delaying reinforcement by one trial reduces the pigeons' accuracy on the explicit categorization task. By setting up these tasks and integrating a time delay before the feedback, we explored how the one-trial delay affects pigeons' implicit categorization. Results show that pigeons performed better within the time delay condition compared to the one trial delay condition. Therefore, their poor performance when reinforcement is delayed by one trial may not be fundamentally due to the delay itself but rather disruptions- such as a new stimulus or a new response- that occur during the delay trial. More broadly, the one trial delay method may impair learning not by disrupting the time-dependent process but instead by introducing irrelevant information that disrupts associations.

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

Poster 43

Evaluating the Correspondence Between Physical Motion and Motorized Motion in Pigeons

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Comparative studies suggest that pigeons recognize the correspondence between physical objects and their computerized images. However, the correspondence between apparent motion and motorized motion has yet to be considered. To address this gap, four pigeons were trained in two different types of specialized chambers. The motor chamber displayed multiple real rotating shapes, likewise the monitor chamber presented the same shapes digitally. During the training phase, the pigeons were trained to discern "slow" versus "fast" motion in a two-key choice paradigm. After learning the task, the pigeons' performance in the opposing chamber is evaluated to determine the transfer between apparent motion and motorized motion. Within most comparative studies, motion stimuli are displayed digitally. Our results will assist in allowing researchers to understand how pigeons perceive such computerized motion stimuli, and whether pigeons recognize its relationship with physical motion. Potential impacts on existing studies of motion and action in pigeons will be discussed.

We thank the Weiss Summer Research Program for financial support and John Carney for his assistance in constructing our motorized chambers.

Poster 44

Hybrid performance in *Asterias* sea stars

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Hybridization can occur when closely related marine species that live in proximity broadcast spawn their gametes. The biogeographical ranges of two species of sea stars *Asterias forbesi* and *Asterias rubens* overlap and form a hybrid zone in the Gulf of Maine. Compared to their parents, hybrid offspring can either have increased performance in the form of positive heterosis or hybrid vigor, or they can have decreased performance in the form of negative heterosis or hybrid inviability. To examine and establish baseline values of the physiological performance of *A. forbesi* and *A. rubens* hybrids, we measured their rates of oxygen consumption (metabolic activity) during early larval development. We performed two trials, measuring oxygen consumption of half-sibling hybrids up through six- or 10-days post-fertilization depending on the trial. In the absence of external food, we found that per-individual respiration rates varied based on whether offspring were purebred or hybrid. To assess size-specific respiration rates, we calculated the average body volume using images of larvae taken at each stage. This calculation indicated that size specific respiration rates started high and decreased before plateauing during development in all sibships we examined. We predict that respiration rate is correlated with the energy provisioned by the mother in the egg; additional analyses to be conducted this fall include measuring the average initial amounts of protein, lipid, and carbohydrate energy per egg per mother. This study provides a baseline foundation for future studies on the impacts of hybridization on larval performance.

We would like to thank the Division of Ocean Sciences of the National Science Foundation for their financial support.

Poster 45

Mutating the Mutator: Delineating the Critical Residues of an ABOPEC3G Variant

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Currently, the HIV pandemic remains a substantial threat to certain vulnerable populations. Consequently, understanding the molecular details of host:viral interactions is imperative. APOBEC3G (A3G) is an innate restriction factor capable of suppressing HIV-1 infection by mutating the HIV genome during viral replication. Previously, we identified an A3G variant, Variant 88 (Vt88), that displayed elevated mutagenic activity. Vt88 was generated via alanine-scanning mutagenesis and is mutated at three consecutive amino acid residues. To determine which amino acid(s) are critical for the enhanced function phenotype, individual point mutations were introduced to evaluate the impact of each individual amino acid on A3G function. Unexpectedly, each altered residue yielded a distinct functional phenotype. Subsequent experiments will examine additional effects of the individual mutations on protein stability and overall antiviral capacity. In characterizing the contribution of each amino acid, we can attempt to optimize the function of A3G, which can in turn be used to comprehend and potentially contest the extent of HIV-1 infection.

We thank Wendy R. and Kenneth J. Edwards, M.D. ’80 P12 for their generous financial support.

Poster 46

Vulnerable vs. *Vulnerables* vs. *Vulneradas:* Examining the Role of Language Rights for Indigenous Women in the "Crisis at the Border"

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This research examines the language rights of Indigenous women who speak Mam and K'iche' seeking political asylum in the United States. Drawing on decolonial feminist and Indigenous rights based analytical frameworks, it centers on the experiences of Indigenous Maya communities both during and after detention at the U.S./Mexico border. Based on a review of scholarly literature, media, human rights reports, and interviews with Maya scholars and activists, we argue that language rights of Indigenous communities are highly underserved and rarely addressed constituting a violation of Indigenous rights in regular proceedings at ports of entry, detention facilities, and beyond. The intersection of identities as Indigenous and as a woman often act as the impetus for persecution through widespread impunity leading to immigration to the U.S. Being monolingual in one of the several Indigenous languages of Latin America further secludes Indigenous women at detention centers where they are unable to receive medical care and understand medical procedures, reunite with their children, and make a credible case for political asylum. The lack of official data documenting languages spoken at the border and the paucity in research and scholarship on this issue compound to obscure the nature and breadth of the problem as it continues unfolding within a larger "crisis" at the border. Honoring language rights is intimately connected to the realization of rights for Indigenous peoples, including freedom of movement, reproduction, healthcare, cultural rights and more. Furthermore, the lack of language rights designated to "third world women" actively enables violence against Indigenous women.

We thank Mr. Richard J. Greisch & Mrs. Eileen Drew Greisch for their financial support.

Poster 47

Discourse Sheaves to Model Opinion Dynamics on Watts-Strogatz Networks

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College of the Holy Cross

Social networks can be modeled by mathematical networks which consist of nodes, representative of individuals, and edges, or the connections between these individuals. Our interest is in the development and changing of opinions across a network as individuals interact. A vector at a node represents an individual's set of opinions, while the interaction between two individuals takes place within a vector space associated with their discourse. We use the Laplacian, a matrix representation of the interactions, to develop a model for opinion dynamics. With this information we construct a discourse sheaf, an algebraic structure developed by Hansen and Ghrist, over the opinion space that reveals the details of the changing opinions. In particular, we apply this method to Watts-Strogatz ring networks and small world models to investigate how certain individuals can influence a collection of opinions.

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

Poster 48

Standardized Quantitation of Neuronal Morphology in the Hippocampus

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Cellular-level analysis of neuronal morphology is of high interest in the field of neuroscience to understand how factors such as the environment, genes, and drugs affect connectivity within a circuit or neural system, and thus behavior. Three dimensional reconstructions of neuronal morphology are used to obtain quantitative measurements of dendritic complexity such as dendritic length, branch number, and spine density. Since novice tracers differ from expert tracers in how they use reconstruction tools, we have developed a training process to standardize the quantitation of neuronal morphology in the mouse hippocampus. In our process, novice tracers trace each of four selected neurons four times. Key metrics from these tracings are compared to those obtained from expert tracings. Since the training protocol involves tracing the same neurons repeatedly, increased inter-rater and intra-rater reliability could be explained by practice effects rather than a learned skill. Therefore, we added a follow-up task of tracing three new neurons. If the training period results in skill acquisition, then measurements from the initial tracings of the new neurons should show high inter-rater and intra-rater reliability. Finally, we developed a standardized method to count dendritic spines using a hybrid of various methods from the published literature. We chose segments from distal and proximal regions of the dendritic arbor because a previously published developmental study on dendritic arborization in hippocampal neurons (Pokorný and Yamamoto, 1981) showed increased arborization in these regions between day 24 and 48, the post-weaning age range of interest for our studies of environmental enrichment in mice. We counted spines in a ten micron segment within one focal plane for each neuron. Ultimately, the purpose of the training process and development of these methods is to increase the standardization of quantitative analysis of neuronal morphology to a degree suitable for statistically reliable comparison of experimental groups.

We thank the George Alden Trust and the Weiss Summer Research Program for financial support.

Poster 49

Morphological Response of Hippocampal Neurons to Environmental Factors

M. Rubert, K. Barahona, and A. Basu
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The relationship between neuronal structure at the cellular level and organismal function at the level of behavior and cognition is of great interest. Since the early 20th century, in light of morphological illustrations by S. Ramón y Cajal and characterizations of structural connectivity within the hippocampal formation by R. Lorente de Nó, theories of activity-dependent structural plasticity have emerged. Later, D.O. Hebb introduced the notion of nervous system function both arising from and reinforcing active neuronal networks. Inspired by Hebbian theory, environmental complexity studies conducted by Rosenzweig et al. in the 1960s aimed to correlate neural measures to animal rearing conditions. Still, the published literature provides an incomplete understanding of the dynamic nature of neuronal structure at the cellular level as it relates to environmental factors. Based on a review of the literature on environmental enrichment and stress in rodents, we have conceptualized a large range of manipulations as part of a spectrum of experience that may affect neuronal morphology. Accordingly, we consider dendritic complexity to comprise a set of quantifiable dependent variables from which we can uncover relationships between cellular structure and organismal behavior and cognition. However, we found that results are difficult to compare across studies due to discrepancies between experimental approaches, subject variables, enrichment and stress protocols, and chosen measurements. While the dentate gyrus and CA1 remain under-studied, the literature suggests that stress induces dendritic atrophy, mainly in tertiary dendrites, in CA3 pyramidal cells. Conversely, there is evidence that enrichment increases total dendritic length, number of branch points, and spine counts in both CA3 neurons and dentate granule cells. Based on this analysis, toward an attempt to resolve discrepancies and address knowledge gaps related to lack of standardization, we have designed an approach to characterize the effects of environmental factors on hippocampal dendritic morphology.

We thank the George Alden Trust and the Weiss Summer Research Program for financial support.

Poster 50

Art at Holy Cross: 150 Years of Collection

J. Mi and M. Fluke
Iris & B. Gerald Cantor Art Gallery, College of the Holy Cross

Since its founding in 1983 as a rotating exhibit venue, the Cantor Art Gallery has amassed a collection of estimated 2,200 pieces, ranging from seventeenth-century Italian engravings and Robin sculpture to Japanese export art and Sumatran textiles. For years, the visual vocabulary, acquisition process, provenance history, and other biographic information attached to the objects have remained uncharted. To undertake our responsibility to the Cantor family, our research aimed to develop a public collection catalog—modeled after that of the Metropolitan Museum of Art—where faculty and students can access whenever necessary to conduct object-based teaching and hands-on learning. Our research, moreover, encompassed on-site physical work at the Cantor, where we collaborated with Paula Rosenblum on photographing, unframing, and packaging works of art in storage. Made possible by the Ignite Fund, we visited the Peabody Essex Museum, the RISD Museum, and the Isabella Stewart Gardner Museum to aid in our collection research of Asian art in particular and learn professional curatorial practices from the country's most prestigious institutions. Our research would culminate in the mounting of the Asian art exhibit in Spring 2022. Upon its installation, the exhibit would tailor itself to the needs of our audiences and engage them with a dozen of Japanese porcelains, sculptures, and prints.

We appreciate the Weiss Summer Research Program and Ignite Fund for financial support.

Poster 51

Indians in the Archives

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When most people think of Holy Cross, Native Americans rarely come to mind. Indigenous people have been intimately involved in the history of the college and the land the institution is settled on. My project analyzes the Nipmuc's story of removal from Pakachoag Hill and their resistance to settler encroachment. Through sources held in the Holy Cross Archives, I also uncovered passing glimpses of Nipmucs residing on the hill into the mid-nineteenth century. As a part of my research, I also scoured newspapers, yearbooks, and personal correspondences to recover the experiences of Indigenous students and guests on campus. In order to fully reckon with Holy Cross's impact on federal Indian policy, I recorded dozens of instances where students, alumni, faculty, and staff campaigned in the "Indian wars," allotted reservation lands, prosthelytize to Indigenous communities, funded Catholic Indian boarding schools, and desecrated Native bodies. Finally, I investigated the role of Native representations on campus—from the use of the "Warriors" as the college's mascot to cases of students "playing Indian." This study reveals that Indigenous people have been simultaneously reviled and pitied, sympathized and patronized by Holy Cross students. The college community has defined itself, historically, in opposition to and in close connection with a mythic form of indigeneity. Each of my findings indicate that the college has been involved in nearly every step of the settler colonial project. It is our hope that by shedding light on this overlooked part of the college's history that the institution can move forward on its path towards truth and reconciliation.

We thank the Office of Diversity, Equity and Inclusion for their financial support.

Poster 52

Psychological Resilience Research During the COVID-19 Pandemic: A Scoping Review

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The global outbreak of the SARS-CoV-2 virus not only poses an immense adverse physiological risk, but also has significant psychosocial implications that can result in adverse mental and physical health outcomes. This narrative review critically evaluates the emerging empirical literature on psychological resilience during the COVID-19 pandemic. Specifically, it investigates how psychological resilience has been defined and measured in studies, as well as summarizes empirical findings. We conducted a literature review of 690 empirical papers drawn from the PubMed database. In total, 233 relevant articles met the pre-identified inclusion criteria and were included in the current review. The two largest cohorts represented the general population (17.2%) and healthcare workers (32.2%). The literature mainly emerged from China (17.2%) and the United States (16.3%) and included 17 multinational studies (7.3%). The studies included both quantitative studies (93.6%) and qualitative studies (6.4%). Study designs included mostly cross-sectional studies (84.5%) but also longitudinal studies with pre/post-pandemic data (6.0%) and post-pandemic data (9.4%). Resilience was conceptually defined either as an individual adaptive trait (80.7%), external social protective factor (2.6%), absence of adverse effects despite a stress, outcome (6.0%), both an individual trait and protective factor (9.0%), or both a protective factor and outcome (1.7%). Statistical models tested resilience as either a predictor (48.1%), mediator (13.3%), moderator (7.3%), or outcome (31.3%). When resilience was considered as a predictor, the most common outcome was mental health symptoms and when considered as an outcome, the most commonly examined predictor was adaptive coping. These findings provide a framework for future research that will impact clinical interventions, practice, and policy for the long-term effects of the pandemic and future global stressors.

We thank the Center for Health and Happiness Summer Internship Program for support.

Poster 53

John Wilkes and British Radical Roots of American Revolutionary Politics

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As a radical British journalist and politician, John Wilkes was a hero to the leaders of the American revolution. He gained fame on both sides of the Atlantic for his critiques of King George III, and for the 1763 publication of the North Briton 45, a piece that resulted in his arrest under a general warrant for libel against the king. The arrest and his eventual imprisonment caused major uproar amongst the London mob, leading to the Massacre of St. George's Fields in 1768, and attracting the attention of American colonists across the Atlantic. In America, and in the streets of London, Wilkes served as a martyr in the fight to protect British ideals of liberty. His cause highlighted the injustices of the tyrannical monarchy of George III. Despite popular outcry over Wilkes's mistreatment, radical politics failed to pass any substantive parliamentary reform in Britain, only furthering American impatience with the possibilities of British reform and developing new conceptions of rights and citizenship in the American colonies. This research shows that the Wilkes affair both inspired American patriots like John Adams and Joseph Warren, who wrote directly to Wilkes, but also inspired colonists more widely through the dissemination of news about his case through both colonial newspapers and almanacs.

Thank you to the Weiss Summer Research Program for its financial support.

Poster 54

Examining the benefits versus costs of brooding in the Dwarf Brittle Star, *Amphipholis squamata*

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Brooding is a life history strategy found in some small marine invertebrates, although it is relatively uncommon. Evolution has likely maintained brooding because the benefits of developing offspring internally likely outweigh the costs for these animals: however, the benefits versus costs of brooding have not been directly tested. This study aimed to investigate the benefits of brooding versus the costs of not brooding with respect to growth in juveniles of the Dwarf Brittle Star, *Amphipholis squamata*. For this study, adult brittle stars were stained with calcein fluorescent dye to mark growth before the start of the experimental period; stained juveniles were then dissected from the bursal slits of mothers at different weekly time points during juvenile development. The dissected brittle stars were compared to juveniles that emerged from mothers independently of researcher intervention. Images were collected at each weekly sampling event of the adult mothers and all juveniles; juveniles that emerged during the experimental period were photographed the day they emerged. ImageJ analysis software was used to measure various parameters of growth, relative to the calcein mark, during the 28-day experimental period. Arm length, width, and quantity of skeletal vertebral ossicles per arm were measured and compared across experimental sampling timepoints. Data collection and statistical analyses are currently underway and results will be presented at the Symposium. The results of this study will provide insight into the evolutionary significance of brooded juvenile growth as a reproductive life history strategy that has been maintained in marine invertebrates.

We thank the Division of Ocean Sciences of the National Science Foundation for their financial support.

Poster 55

Investigation of elevated expression of an APOBEC3G Variant

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APOBEC3G (A3G) is an endogenous human protein that can restrict HIV infection. This restriction is accomplished in human cells primarily via the enzymatic function of A3G that efficiently mutates the viral genome. Accumulation of such mutations is catastrophic to the virus, ultimately short-circuiting infection. We recently identified an A3G variant (Vt88), that strikingly exhibits enhanced mutagenic activity. In addition to this elevated activity, the variant protein is overexpressed when compared to wildtype A3G. This investigation sought to determine whether this observed overexpression could be attributed to increased protein stability. The stability of each protein (wildtype and variant A3G) was examined in a cycloheximide chase assay. Preliminary data suggest that Vt88 exhibits a longer half-life and thus is more stable than the wildtype protein. We hypothesize that the overexpression of Vt88 as a result of increased stability promotes elevated mutagenesis, bolstering viral restriction. Understanding the molecular factors that contribute to Vt88's hyperactivity may suggest novel strategies to enhance the anti-HIV function of A3G.

We are grateful to Wendy R. and Kenneth J. Edwards, M.D. '80 P12 for generous financial support.

Poster 56

Mencius and Aristotle: Human Nature and Resources for Dignity

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Ever since the inclusion of human dignity in the preamble of the United Nations's Universal Declaration of Human Rights in 1948, the concept of human dignity has taken on prominence in moral, legal, and political discourses. However, the debate surrounding human dignity is contentious because of disputes over its conceptual ambiguity. Concerns over the vagueness of this concept have led some scholars to deprecate it as mere rhetoric. In contrast to such disputes, we draw from one of Bernhard Schlink's discussions of the current uses of human dignity. Namely, that dignity, as understood by several philosophical traditions, serves as the foundation of human rights. The primary purpose of this project, then, is to include Mencius and Aristotle as contributors of conceptual resources for understanding human dignity. This paper proceeds in two parts. First, we provide a comparative analysis of Aristotle's and Mencius's thoughts on human nature and the development of virtue. Second, we argue that both philosophers offer conceptual resources to support an understanding of human dignity as (a) foundational and (b) the goal of human existence.

We thank the J.D Power Center for the Liberal Arts in the World for financial support.

Poster 57

Racism in the Health Sector: A Qualitative Study of Healthcare Providers' Views

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College of the Holy Cross

Racism has always resulted in negative health consequences for people of color. Recently, though, these health effects have become far more apparent due to COVID-19. Consequently, the American Public Health Association has declared racism to be a public health crisis. We conducted in depth interviews with seventeen medical doctors (7 female, 10 male) and examined their views and awareness of racism in the healthcare sector. We found that none of the 17 MDs had received any formal training in racial equity, though eleven stated that their workplaces have now incorporated some type of diversity, equity, and inclusion (DEI) training. Most MDs (16/17) reported that they were aware of structural racism but only ten (100% of women, 30% of men) seemed aware of it in their own facility. When asked about common challenges faced by patients, most providers highlighted the following: racism (12/17), immigration related barriers such as language, legal, or insurance barriers (11/17), environmental and safety related barriers such as pollution, transportation, or violence (13/17), and access to resources/ preventative care (11/17). Although it is encouraging that most MDs were aware of structural racism, it is clear that more training is needed to help MDs better understand how racism and sociological factors directly impact the health of patients. Additionally, MDs need a greater awareness of the racism that is present and could be harmful within their respective healthcare facilities.

We thank the College of the Holy Cross Weiss Summer Fellowship and the Scholarship in Action

Poster 58

Bending Mechanics of Sea Urchin Spines

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Sea urchins employ their spines for a wide variety of tasks, and the forces exerted on urchin spines during the execution of these tasks will vary greatly. Forces generated during a puncturing defense, occurring along the long axis of the spine, will be very different from more lateral, bending-type forces experienced during burrowing or anchoring behaviors. In this study we look at how three species of urchin, all common in the Salish Sea, differ in regional spine morphology and structural resistance to bending. We collected and analyzed CT data to determine the second moment of area along the length of spines from three regions of the sea urchin body (oral, lateral, aboral). Purple urchin (*S. purpuratus*) spines had higher second moment of area values than those of the pale (*S. pallidus*) and green urchins (*S. droebachiensis*), which were similar to each other. Higher second moment of area values indicate a higher flexural stiffness, and a greater resistance to bending. To see if this is related to sheltering behavior, we ran a series of behavioral trials on the three urchin species, predicting that stiffer spines would correlate with a higher inclination for entering shelters. Finally, to test for a functional benefit to spine stiffness, we began construction of an underwater force plate to measure how much force spines exert during sheltering behavior. In all three facets of the study, variation among species points to differences in ecological niche.

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

Poster 59

Estimating the Economic Impact of Major League Baseball's All-Star Game Using High Frequency Tourism Data

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On April 2, 2021, Major League Baseball rescinded its offer to Atlanta (Cobb County, GA) to host the 2021 All-Star Game in response to the recent implementation of controversial voter I.D. laws in Georgia. The game was then awarded to Denver, prompting Georgia travel and tourism officials to claim that the estimated loss of economic impact for businesses in Cobb County was more than $100 million. Using daily hotel data from Smith's Travel Research, we estimate the economic impact of the 2014 (Minneapolis) and 2019 (Cleveland) MLB All-Star Games in order to determine the validity of Georgia's $100 million claim. We find it is unlikely that relocating the 2021 All-Star Game resulted in a $100 million loss for Cobb County's economy. Based on the activity surrounding the 2014 and 2019 events, a more accurate estimate for the 2021 ASG is a figure about one-tenth of the size, or $10 million of economic impact.

We acknowledge the Weiss Summer Research Program in for financial support.

Poster 60

The *Drosophila* ERG Voltage-gated Potassium Channel *seizure* Affects Development

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seizure (*sei*) is a well conserved voltage-gated potassium channel encoding gene in *Drosophila*. In the nervous system, *sei* has been shown to protect flies from heat-induced seizures and is expressed in both neurons and glia. *sei* is the fly ortholog of the human *ether-a-go-go* related gene (hERG), and mutations to this gene cause cardiac Long QT Syndrome (LQTS). Here, we show that *sei* mutants display a decrease in developmental time, as *sei* mutant larvae hatch from embryos and eclose as flies more quickly than controls. Our work also shows that neuronal overexpression of *sei* results in an increased time to eclosion, a delay in developmental time. We predicted that *sei* mutants would have more or faster movement during embryogenesis compared to controls, and that this could explain part of the mechanism that allows *sei* mutants to hatch quickly. Based on the data collected thus far, *sei* mutants show more movement for four out of five categories of embryo movement. Next, we used temperature to determine the relationship between genetic manipulation of *sei* and an environmental factor. Flies raised at a low temperature of 18˚C show a similar phenotype to flies raised at the preferred temperature of 25˚C, with *sei* mutants eclosing faster than controls. However, for flies raised at a high temperature of 30˚C, *sei* mutants display a slower eclosion time compared to controls, showing an interaction between genotype and environment. Lastly, although *sei* mutants develop faster than controls, we find that *sei* mutant adults have similar or higher weights compared to control flies. Together, this work suggests that lacking *sei* may be beneficial, as faster developmental time at preferred temperatures may allow for flies to sexually mature and reproduce earlier. Future studies will include identifying which subsets of neurons express *sei*, and mechanisms by which *sei* function in these cell types interacts with temperature to impact developmental phenotypes.

We thank the William F. McCall, Jr. '55 Summer Research Fund, the JD Power Center, and the Kenrose Kitchen Table Foundation for their financial support.

Poster 61

Investigating the Expression and Function of the DEG/ENaC, *ppk29*, in Glia of the *Drosophila* Nervous System

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Degenerin/Epithelial Sodium Channels (DEG/ENaCs) are non-voltage-gated ion channels found throughout the animal kingdom, that regulate ionic gradients in various tissues. In *Drosophila*, the (DEG/ENaC) subunit gene *pickpocket 29* (*ppk29*) is found in the central and peripheral nervous systems. DEG/ENaCs are also found in the human nervous system and are implicated in various neurological and psychological diseases. Here, we show that *ppk29* is expressed in glial cells in the brain and along motor neuron bundles in the peripheral nervous system of *Drosophila* larvae. We found that *ppk29* is expressed in cells localized to the distal region of nerve bundles, in the muscle field area (MFA). Our research suggests that three out of the four glial cells found in the MFA of each hemisegment are *ppk29*-positive. Interestingly, we also found that three glial cells in each hemisegment MFA belong to the perineurial glial subtype. Ongoing experiments seek to confirm that these perineurial glial cells express *ppk29*. To begin exploring the function of glial DEG/ENaCs, we hypothesized that *ppk29* could affect brain volume, a phenotype that has been shown to result from dysregulation of ionic gradients. By using a fly line lacking functional *ppk29* (*ppk29*^{P1} fly line), we measured brain volume of *Drosophila* third-instar larvae. Our data suggests that *ppk29* has no significant effect on brain volume as compared to controls. Next steps will be to test additional hypotheses regarding the function of *ppk29* in glia. Altogether, our findings can better our understanding of how DEG/ENaCs in *Drosophila* glial cells modulate the brain, and sensory and motor processes mediated by peripheral nervous system glia. Further, these findings could possibly provide insight into the impact of glial DEG/ENaCs on the human nervous system.

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

Poster 62

The World’s Migration Crisis Through a Theological Lens

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There is an estimated population of over three-hundred million forcibly displaced people in the world today. This study aimed, through the use of historical and theological-ethical methods to determine some causes of the global migration crisis and to reflect on the obligations of individuals, communities, and nations to migrants. I first determined it was necessary to perform an historical inquiry into the causes of the migration crisis in order to more accurately diagnose the problem and discover theological-ethical principles and practices to address it. I also applied a special focus on the role that the USA has played in the crisis; it was through this historical analysis that I determined that the USA has been responsible for creating push factors of migration much more often than pull factors, which is contrary to what most Americans would like to believe. After obtaining a better understanding of what the migration crisis really consisted of, I chose to seek theological-ethical principles in order to address it. The choice of theological ethics as a methodology for the bulk of the research arose from two sources: my own personal faith tradition as a Catholic, and the Jesuit, Catholic mission of Holy Cross, which asks students to consider throughout their studies at the College to uncover what their obligations are to the suffering populations of the world. In concluding this project, I determined that organizations such as Jesuit Refugee Service, which is led by church authority figures yet still mobilizes lay followers of the church into mission work, are absolutely necessary but on a much larger scale than currently exists.

We would like to thank the Weiss Summer Research Program for making this project possible.

Poster 63

Categorization of Artists

C. Babikian, K. Corcoran, and K. Umezaki
Verifi Media

The question of how many active musical artists there are is a seemingly simple question, but one that does not have a clear answer. Through Chartmetric's data, we were not only able to get an estimate of the number of active artists, but also categorize these artists by popularity. The categories that we used were unknown, undiscovered, promising, established, mainstream, and epic. We combined statistics of Instagram followers, YouTube total views, and Spotify monthly listeners in order to see how popular an artist may be, with each social media site representing different aspects of popularity. We were able to notice how many artists fall within each category and trends that they had within the groups as well as across categories. Notably, the number of artists that obtain a certain level of popularity is concave up and decreasing. Overall, the data showed that the vast majority of artists (90%) are unknown and undiscovered to the general public while a very small percentage (>1%) are ones that make it to the mainstream.

We thank Verifi Media for financial support

Poster 64

Are Olympic Gymnasts Out for Individual or Team Glory?

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Incentives are the foundation of human life. Everything we do in our lives is somehow influenced by our own incentives. Whether it be something to eat, something to wear or even someone to talk to, these decisions will ultimately be affected by how much utility we would gain from each option. People also gain utility from helping others, including family, co-workers, teammates, etc. This idea of incentives brought about this question: Do individual incentives drive behavior more than group incentives? To look at this, we use Olympic gymnasts to see if they underperform for the team finals, with their focus on the individual rounds. Olympic gymnasts have both team and individual incentives in the single qualification round, which qualifies gymnasts for the team finals and the individual finals. The team finals take place before both the individual all-around and the apparatus finals. Using that team qualification round as our base, we test if there is an uptick in performance in the individual finals, as opposed to the team finals. We separately analyze the men's and women's gymnastics scores due to the fact that there are different events for each gender. After running our preliminary regression, we do not see any evidence of gymnasts underperforming in the team final, when compared to the individual finals. However, there is slight evidence that suggests the opposite, specifically for the men.

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

Poster 65

The Impact of the Gavi Program in India

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Gavi, the Vaccine Alliance, was started in 1999 with funding from the Bill & Melinda Gates Foundation. One of the program's primary goals is to provide protection to the most vulnerable children through immunization. In partnership with the World Health Organization, UNICEF, and the World Bank, Gavi has been able to vaccinate over 822 million children and prevent 14 million future deaths. Through Gavi funding, countries across the globe have been able to improve nation building efforts and economic stability. Despite these positives, little research in the field has been conducted examining the overall impact of the program. Additionally, no paper has been written specifically focusing on India. As a country with a large birth cohort (approximately 25.6 million), Gavi is not always able to readily fund vaccines for all infants at once. Thus, varied vaccine rollout plans are created which distribute vaccines to different districts in separate years. This variation allows us to examine how Gavi funding impacts vaccine coverage and morbidity in India across time and by vaccine. Using a regression framework with fixed effects at the cohort, household, and district levels, we find that Gavi increased overall vaccine coverage in India by 1.55 percentage points and decreased morbidity by 1.13 percentage points. These results are further confirmed through the employment of an event study. As such, we conclude that Gavi is currently meeting its goal of protecting children with regard to coverage and morbidity.

We thank the Weiss Summer Research Program for financial support.

Poster 66

Peer Effects in StarCraft II

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The goal of our project is to examine the degree to which the quality of an individual's peer group influences that individual's success. The setting for this study is the real-time strategy game StarCraft II (SC2), as professional players compete in tournaments individually but often train as part of teams consisting of other professional SC2 players. The quality and quantity of data on professional SC2 players, teams, and matches make this RTS game a valuable setting to study peer effects. To capture the size of the peer effects, we focus our attention on the change in players' future performance after they switch teams. Our preliminary analysis shows minimal correlation between the change in a player's future rating and the change in team quality. As these team switches are often decisions made based on endogenous factors (such as a player's prior performances, a team's forecasted performance, etc.), our next step will involve focusing our analysis on moments of exogenous team changes.

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

Poster 67

Internal Auditing and Financial Reporting Quality in the Public Sector

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Internal Audit Functions' role in corporate governance is well documented and is considered one of the four cornerstones of corporate governance, along with the board, management and the external auditor. Internal controls and oversight can play a key role in predicting and preventing future accounting and financial reporting issues. In the context of the public sector, IAFs can also play an important role, in that they provide objective assessments of whether public resources are managed responsibly and effectively. A positive and significant relationship exists between the presence of an IAF and the use of an IAF external quality programs, and financial statement audit reportable conditions related to internal controls, and a negative relationship between Internal Audit Functions and restatements, suggesting IAFs help to improve financial reporting transparency.

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

Poster 68

Designing a Quantitative Assay to Identify Critical Amino Acids for APOBEC3G Function

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The anti-HIV restriction factor APOBEC3G (A3G) suppresses HIV proliferation by catalyzing deoxycytidine to deoxyuridine ("C to U") mutations in the viral DNA strand. The catalytic domain of A3G that is responsible for this activity has been well characterized. Introducing amino acid changes within the catalytic domain often results in alterations to enzymatic activity, most commonly resulting in loss of function. We were interested in designing a screening assay intended to identify amino acid substitutions that could contribute to the rarer phenotype of hypercatalysis. Here we discuss a modification of an antibiotic resistance assay that may be adopted for such a screen. For the pilot experiments we focused solely on a single residue within the catalytic domain—amino acid 259. In our initial experiments, we surveyed 43 randomized variants and identified different effects on catalytic activity relative to wild type protein. The observed alterations to catalytic activity covered a dynamic range from loss of function to hyperactivity. Due to the design of the screen, we have not yet identified the specific amino acid substitutions resulting in each observed phenotype. The next stage of the experiment will be to identify each variant. It is anticipated that modifying this antibiotic resistance assay can be applied to further interrogation of regions of A3G beyond the defined catalytic domain.

We are grateful to the J.D. Power Center for Liberal Arts in the World for its invaluable financial support.

Poster 69

Investigating Phantom Dark Energy as a Quantum Field in FLRW Space

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Current research in physical astronomy and cosmology shows that the redshift of light coming from type-1A supernovae, called "standard candles," indicates that the universe's rate of expansion is increasing. The prevailing theory to explain the universe's acceleration is called "dark energy" (DE), and it composes about 70% of the universe. In this project, we investigate a specific type of DE called "phantom" dark energy which is characterized by the equation of state parameter 'ω'. It is sometimes disregarded as a viable theory of the universe due to its implications of instabilities. Cosmological probes have measured ω to include the range ($\omega = -1.006 \pm 0.045$) (Planck collaboration). Prior research has established that the instabilities brought about by phantom DE can be remedied above $\omega = -1.22$. We model the universe using a non-perturbed Friedmann–Lemaître–Robertson–Walker (FLRW) metric and calculate a lower bound for ω with the help of Mathematica packages "xTensor" and "xCoba."

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

Poster 70

Water Practices in the City of Worcester

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College of the Holy Cross

According to the United Nations over two billion people lacked safely managed, clean drinking water in the year 2020. Ensuring availability and sustainable management of water and sanitation for all is one of the UN's Sustainable Development Goals (SDGs). However, water safety, access to clean drinking water, and water practices are rarely thought about in the context of the Global North. This research examined water accessibility and quality in Worcester, MA. We conducted an extensive literature review on water access and quality in the USA and also interviewed the Chief Sanitary Inspector for the City of Worcester. Our study shows that there is a water crisis in our own backyards. Additionally, most people are unaware of this country's water crisis, which is intensified by other circumstances such as poverty, discrimination, racism, and geography. The nature of this crisis is directly related the lack of funding and programming that goes into water efforts in the Global North. In regard to the city of Worcester, immense progress has been made as it pertains to the city's water practices and its striving to provide clean water for all. In the 2020 water quality report, Worcester met all Federal and State standards provided by the Safe Drinking Water Act. Ultimately, while our findings show that the City of Worcester has the facilities to produce safe drinking water, the question of accessibility remains: do all people have access to the clean drinking water produced?

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

Poster 71

Queering the Archive: Worcester's Sexual Asylum Task Force

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Since its inception in 2008, the Worcester LGBT Asylum Task Force has been helping hundreds of individuals from twenty different countries seek asylum on the basis of their sexual orientation. The Task Force is the only one of its kind in the country, uniquely serving its asylum seekers' needs as they transition to life in the United States. Working closely with Pastor Judy Hanlon and Alford Green, director of the Task Force, we documented and archived the program's history through a series of oral histories and physical and digital documents as a piece of the larger history of the queer community in Worcester. With help from the Worcester Historical Museum, we added to their LGBTQ+ Worcester History physical and digital archive and created a 360 virtual tour of *For the Record*, a 2019 temporary exhibition of Worcester's LGBTQ+ history. These steps will ensure these stories are more accessible to the public.

We thank the LGBTQ+ Leadership Fund for financial support.

Poster 72

Optimizing Environmental Law: A Study of Federal Best Practices

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What are the features of an effective environmental review system? Environmental review laws require government officials and the private actors they oversee to assess, limit and mitigate harms to the environment caused by their actions; these laws are particularly influential in the permitting of major infrastructure and development projects. Previous research reveals that these policies vary across nations in terms of quality of environmental protection, transparency and accountability, and speed. These criteria are well-established in environmental review literature. We employ these criteria to examine environmental review laws and practices in the United States, Canada, and Germany. These three countries offer a unique opportunity to compare different approaches to the challenges governments face in executing successful environmental reviews. We find that the most effective systems employ a "one project, one assessment" approach within a centralized permitting agency, reduced statutes of limitations, and earlier public participation. We conclude with recommendations for implementing best practices in environmental reviews, including suggesting that the U.S. Congress enlarge the Federal Permitting Dashboard into an executive agency that oversees the environmental review process within the One Federal Decision Framework for all major infrastructure projects.

We thank Deborah C. and Timothy W. Diggins '80 for financial support.

Poster 73

"The Crusades and the Chertsey Tiles: A Medieval Masterpiece Reconstructed" Exhibition Brochure

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The upcoming *The Crusades and the Chertsey Tiles: A Medieval Masterpiece Reconstructed* exhibition explores aesthetic borrowing and cultural exchange between the Byzantine and Islamic worlds and Medieval Western Europe during the Crusades. The exhibition leverages a wide range of artistic media, from textiles and metalworks, to luxury ceramics, to clarify the impact that art objects manufactured far away, particularly in the Byzantine and Islamic Mediterranean, had on the medieval visual culture of England. The exhibition highlights the Chertsey Combat Tile mosaic as a particularly compelling example of this cross-cultural exchange as the work depicts both King Richard the Lionheart and Saladin in battle and incorporates iconography inspired by eastern silks. As a summer research associate, I had the privilege of writing and designing the brochure for *The Crusades and the Chertsey Tiles: A Medieval Masterpiece Reconstructed*. Synthesizing information from Dr. Luyster's initial exhibition proposal, I was able to draft brochure texts outlining the show's mission and vision, project history, themes and layout, objects, and programming to be included in the exhibit. Using Adobe InDesign, I curated the graphic design template used for the layout of both the texts and object images that are included in the brochure. *The Crusades and the Chertsey Tiles: A Medieval Masterpiece Reconstructed* brochure will ultimately serve as not only a didactic tool for the exhibit, but also a marketing tool for potential investors and financial partners. It is going to print in late Summer 2021.

We thank J.D. Power III '53 P93 and family through the Kenrose Kitchen Table Foundation for their financial support in this endeavor.

Poster 74

Synthesis and Study of Cystine β-sheet Mimics

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β-sheet protein structures are often involved in amyloidosis, including Alzheimer's disease, and thus their stability and aggregation have long been points of scientific interest. Our group has previously evidenced the viability of cystine tripeptide dimers to act as β-sheet mimics, due to their propensity to adopt a comparable conformation when dissolved in organic solvents. This is a direct result of internal hydrogen bonding interactions which have been identified and quantified through hydrogen/deuterium exchange. One of these mimic molecules, comprised of threonine, cystine, and leucine, has been synthesized in order to study the effects of the threonine sidechain on protein stability and aggregation. The possibility for the threonine side chain to occupy the two external NH hydrogen bonding sites could provide insight into the role of these sites in β-sheet aggregation. Additionally, this hydrogen bonding could provide increased rigidity to the overall molecule, with potential ramifications for the relative strength of the backbone interactions. This dimer will be quantified in short order via studies involving concentration and solvent sensitivity, in addition to hydrogen/deuterium exchange.

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Poster 75

Researching COVID-19 in America: A Summer Course Experience

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COVID-19, one of the deadliest pandemics in history, has entirely disrupted social and economic life in the United States. Therefore, we conducted a study to investigate the epidemiology (disease frequency, distribution, and determinants) of COVID-19 in all 50 states between January 2020-June 15, 2021. As a part of a summer "COVID in America" CIS course, 10 students researched COVID cases, test positivity rates, hospitalizations, vaccinations, and deaths in the 50 states. We reviewed various COVID dashboards, such as the State Department of Health dashboard, the Johns Hopkins Coronavirus Resource Center, the Centers for Disease Control and Prevention, and the Harvard GenderSci Lab. We found that California has had the highest number of cases (3,399,455) and deaths (62,565), while Vermont has had the lowest number of cases (24,339) and deaths (256). We also found that midwestern and southern states have had the most COVID hospitalizations, while southeastern and northeastern states accounted for the most COVID deaths. In terms of race, the Hispanic population has been the most disproportionately affected racial group across the United States, accounting for most cases in 28 states. Next is the Black population, which is the most disproportionately affected racial group in 9 states. Our gender distribution data unexpectedly revealed that females accounted for over 50% of COVID cases in 39 states, while males accounted for over 50% of deaths in 31 states. The collection of 10 students' research efficiently consolidated the previously inconsistent COVID data in the United States. The research we conducted contributed towards the efforts to better understand the impact of COVID-19 from an epidemiological perspective. A common challenge that we encountered while researching and collecting data was the many inconsistencies found throughout the COVID dashboards. The class was structured similarly to a workplace with its collaborative nature, which made for a rewarding learning experience.

Poster 76

Investigating the Formation and Impact of Transnational Latinx Migrant Communities in Worcester, MA

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The formation of migrant communities is an ongoing phenomenon occurring across most urban areas of the United States as there continues to be an influx of migrants from the Global South, especially Latin America. Within these migrant communities there is a unique process known as transnationalism, whereby native cultures are preserved by the development of geographical, social, and cultural components that thrive even under the overarching framework of American identity. A possible significant factor behind this community's development is the existence of more than 100 businesses that are owned and operated by Latinx migrants. These businesses were catalogued and mapped via the QGIS mapping software, illustrating both the geographic locations and the theoretical spheres of influence which surround these businesses. According to estimated population data of the City of Worcester from 2019, it was noted that there is an assumed 7.4% increase in the Latinx population. Under the assumption that a growth in the Latinx population would potentially alter the development of transnational communities in Worcester, this investigation analyzes population statistics from the 2010 Census and compares those statistics with the 2019 estimates provided by the U.S. Census Bureau. Finally, a critical component in the investigation of transnational communities within the Latinx migrant population of Worcester was to obtain a collection of stories and personal experiences which will further illustrate how these migrants have contributed to the ongoing phenomenon of transnationalism. In addition, this study included a literature review on the scholarship of transnationalism, on the financial impact of Latinx businesses and on the oral histories and embodied experiences of migrants in order to provide insight into the formation of transnational communities in urban cities like Worcester.

We thank the J.D. Power Center and the Ignite Fund for their financial support in this project.

Poster 77

Motion Same/Different Processing in Pigeons

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Pigeons are able to learn same/different concepts through training. The same/different task can investigate the internal representation that an observer uses when processing stimuli. We used a same/different categorization task to understand how pigeons process and represent visual motion stimuli. We tested three pigeons in a go/no-go paradigm, presenting sequences of videos where random dot patterns moved in the same direction or changing directions. Displays of sequences of motion differences consisted of changes in the rate the dots moved across the screen and the direction the dots moved. After training the motion same/different task, we presented novel stimuli to determine whether a true same/different concept was learned. Future directions include identifying the duration of memory used to make the same/different judgements and the degree of attention to local versus global features of visual motion stimuli, basic processes required for visual action perception.

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

Poster 78

Interactive Effects of Food Availability and Salinity on Phenotypic Plasticity of Sand Dollar Larvae

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The larvae of many marine invertebrates exhibit phenotypic plasticity of traits associated with feeding, development, and growth. Larvae of the sand dollar *Echinarachnius parma* extend the lengths of feeding “arms" when experiencing low food availability to increase the likelihood of food capture. By contrast, larvae in environments with higher food levels can reach metamorphic competence faster because more energy is allocated to food processing structures. Separate recent findings suggest that sand dollar larvae delay their hatching, and subsequent rates of development, when exposed to low salinity levels. While we have a good understanding of how these larvae respond to single parameters, such as food level or salinity, what remains unknown is how these (and many) organisms develop and grow when exposed to multiple environmental variables simultaneously. This study focused on the morphological and developmental plasticity of *E. parma* larvae in response to varied salinity and food level combinations. Larvae were reared under both chronic and acute conditions of low salinity and either low or high algal food levels for 10 days. These treatments simulated the effects of longer-term environmental changes and shorter duration weather events such as heavy rainstorms. Images of larvae were taken every day and morphological measurements were made from these images using ImageJ; developmental stage was noted for all larvae. The results from this study will shed light on our understanding of the ways in which larvae respond to confounding stressors that affect marine environments.

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Poster 79

Who is Worcester? Rekindling the Relationship between Holy Cross and the City of Worcester

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Having attended the college for two years (one of which was purely online), we have felt a sort of disconnectedness: a disconnectedness from not only the College but also with the city of Worcester. Over 2020, we found ourselves becoming more and more interested in both art and the city. We have fallen in love with the murals, the businesses and the people here and want to get more Holy Cross students involved in the good things that are going on here. We are doing this through celebrating individuals whose activism, work, art, leadership, and dedication contributes to Worcester's rich culture, diversity, history, community, and potential. We have created a street art and stencil style painting on a wood panel, a website to accompany the piece wherever it may travel to as well as a documentary to show our process and elaborate on the elements included. In hopes of increasing students' awareness and engagement in the city and appreciating the breathing community, we have carefully selected the individuals to be good role models for students to look to and we have made sure they each have some sort of work or volunteer opportunity for the students to be a part of. The individuals fit in one of four categories: activists who give their lives for a cause, those involved with the aesthetics and beautification of the city, community-oriented individuals working in places such as schools and those in healthcare directly working with those in need. Our project aims to get Holy Cross students more integrated into the Worcester community especially after a year of quarantining in our hometowns.

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Poster 80

The Importance of Having Diverse Representation in Fictional Books

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Over the past few years, the publishing industry has experienced a boom in the production of diverse books. With this increase, many people have debated the value of diverse fiction, with an assortment of polarizing viewpoints. By focusing on four main topics I answered the questions “Why should we care about diverse representation, and how is it beneficial?” and “Does reading diverse stories impact the way we see the world outside of books?” I found that use of counterstereotypes in fiction can reduce bias, reading diverse books positively impacts children, there is a link between reading fiction and empathy, and that being exposed to stereotypes in other forms of fiction (e.g., video games) can increase bias.

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

Poster 81

Public Idioms and Private Love Lyrics: From Catullus to Shakespeare

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Lyric poems, especially love lyrics, express feelings that are unique to the speaker him/herself. What makes such personal lyrics still resonate with others after many centuries? To answer this question, I mainly focus on Shakespeare's 154 sonnets and observe one significant strategy he uses to make his sonnets effective. He relies on commonly accepted idioms as a vehicle to allow the reader the access of the most intimate emotions in each sonnet— through these idioms, Shakespeare uses the reader's pre-existing conceptual knowledge and transforms it to an experiential knowledge: from knowing the idioms to feeling the specific emotions. Such transformation between the knowing and the feeling, just like how idioms once were linguistic peculiarities that later evolved into familiar instinctual expressions, is what enables us to experience the hypothetical, personal emotions in the sonnets as our own. I also look at the Shakespearean sonnets through the comparative lens of the Roman lyric poet Catullus. Different from Shakespeare, Catullus's lyric poems set the contemporary English reader in a less familiar cultural and language environment. This obstacle the reader might face in resonating with Catullus's poems makes one rethink the idioms one takes for granted in Shakespeare's sonnets: without the aid of the familiar cultural consensus, what else makes Shakespearean sonnets effective? Interestingly, Catullus relies rather on the context of a small elite friend circle, which ironically triggers any outsider-reader's curiosity and desire to resonate by imagining and guessing the unfamiliar idioms of the insiders. Catullus's poetry is still effective due to the emotions it raises that are relevant and innate to human nature, regardless of its unfamiliar cultural and language context, just as Shakespeare's sonnets would, to others that come much later than us, who read him in translations.

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Poster 82

Artificial Terracotta Staining and Removal

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A 5th century BCE Greek red-figure terracotta pelike from the Harvard Fine Arts Museum has a stain consisting of a mixture of manganese and iron oxides. While previous studies have examined metal stains on nonporous surfaces, less is known regarding their removal on porous surfaces, like terracotta. The goal of this project is to investigate the safe treatment and removal of manganese and iron stains on terracotta surfaces. The project was split into two sections: creating metal stains on terracotta pieces and removing the stains with chemical chelators. First, two manganese and three iron salt solutions, in series with sodium hydroxide, were brushed onto the surface of the terracotta in effort to develop a stain that was adhered to the terracotta surface. Next, the darkest and most adhered stains were swabbed with three chelators: EDTA, DTPA, and HBED. A chelator can chemically bind to the metal, with a purpose of removing the metal from surface of the terracotta. Each solution was tested with application by either a cotton swab and cotton ball. The DTPA, with a reducing agent, removed the stain quickest and most thoroughly, while the HBED solution was weakest at removing the stain. Based on these results, it is hoped that the DTPA solution will safely remove the stain from the original terracotta and be used in future treatments of other terracotta-based objects.

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Poster 83

Investigating the Mechanisms that Decrease Fertility of *C. elegans* on a High-Glucose Diet

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The amount of sugar in the average human diet is correlated with increases in metabolic diseases such as Type 2 diabetes and obesity. *C. elegans* is a good model organism for studying the effects of increased sugar because 60-80% of genes in the human have an ortholog in the *C. elegans* genome. Among these are the genes that control processes like insulin signaling and glucose storage. Data from our laboratory show that a high-glucose diet leads to decreased fertility in both sexes of *C. elegans* (male and hermaphrodite), but the mechanisms that cause these decreases are unknown. For hermaphrodites, we hypothesize that an increase in apoptosis (programmed cell death) in oocytes on a high-glucose diet leads to decreased fertility. We are investigating the cellular pathways that activate apoptosis, and our data suggest that the pathogen response pathway is not activated by a high-glucose diet to reduce fertility. We are also investigating whether the same factors that decrease fertility on a high-glucose diet decrease lifespan. We used the ced-1::GFP strain to see how apoptotic cells are affected by a high-glucose diet. As a first step, we conducted fertility assays on N2 Hermaphrodite *C.elegans* and ced-1::GFP *C.elegans,* to see if these two strains were affected by a high-glucose diet in the same ways. Our data suggests that fertility is affected in the same way for both strains of *C.elegans*, as both strains had around a 30% decrease in fertility on a high glucose diet. For males, we are investigating factors that could lead to a decrease in male sperm competitiveness on a high-glucose diet. We have found that male sperm size decreases but male sperm morphology is not affected on a high-glucose diet. Spermatids derived from males raised on non-glucose media were scored as significantly more round as a group than were those raised on glucose. Our project will advance our understanding of the cellular mechanisms involved in responding to a large amount of glucose and the consequences of a high-glucose diet.

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Poster 84

Topological Diagrams Distinguish Subtypes of Cancer

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Applied topology, a branch of mathematics, studies relationships between the shape of mathematical and physical objects. We employed the methods of topology to study cancer genomics. Using open source The Cancer Genome Atlas data, we applied topological methods to determine the structure of a prostate cancer RNA-seq data set. TCA Mapper, a topological data analysis library, revealed a unique structure of prostate cancer data with four wings. These wings suggested that prostate cancer had distinct phenotypes due to differing combinations of over and under expression of genes in the dataset. Additionally, the data set contained benign samples for a control. TCA Mapper distinguished between malignant and benign RNA-seq expression. This was evidenced by few benign samples being grouped with malignant samples in the mapper diagram with benign samples being grouped together. This suggests that TDA Mapper possesses the ability to distinguish benign and malignant prostate RNA-SEQ reads.

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Poster S1

Afro-Latin American Representation in Contemporary Colombian and Venezuelan Cinema

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Have you ever wondered why we see a lack of racial diversity and representation in Hollywood films? Did you ever consider how issues of representation in media play out in other parts of the world, specifically Latin America? My interdisciplinary research project focuses on Afro-Colombian and Afro-Venezuelan representation in contemporary Latin American cinema. Historically, Afro-descendant voices, stories, and experiences have been marginalized or stereotyped in Latin American feature films, and there has been a notable lack of Afro-Latin American directors, screenwriters and cinematographers in the world cinema industry. To bring awareness to this issue, I focused on four Spanish-language films with Afro-Latino protagonists, two from Colombia: *Somos calentura* (Jorge Navas, 2018) and *La Playa D.C.* (Juan Andrés Arango García, 2013); and two from Venezuela: *La Soledad* (Jorge Thielen Armand, 2016) and *Pelo malo* (Mariana Rondón, 2014). In addition to conducting research about the films and directors, the history of racism in Colombia and Venezuela, and Latin American national film industries, I also learned how to record, cut and edit sequences from the films using iMovie, Loopback Audio, DaVinci Resolve, QuickTime, and Audacity. My research culminated in the creation of a video essay - an audiovisual production with a more dynamic structure than a traditional written essay. The final product aims to shine light on two lesser-known countries in world cinema and demonstrate the impact of Afro-descendant representation in four contemporary Latin American films.

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Poster S2

Women Shaping Women: Beauty Standards and Rituals in the Age of the Selfie

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The initial goal of my research was to study the role of beauty standards and rituals in contemporary women’s lives and to create paintings on this theme. The research led me to explore why women feel required to follow beauty standards. I then began to investigate how selfies impact my own self-image. In a series of digital drawings, I focused on how interpersonal relationships between women are a main reason why women conform to beauty standards. Women want to impress their friends, connect with the style of other women, all while feeling confident in how they present themselves, which often feeds into beauty standards. Instead of assuming women wear makeup or dress a certain way for the male gaze, I decided to look at the other side; women enforce and impose beauty standards onto other women consistently, simply by following beauty standards. *The Beauty Myth* by Naomi Wolf makes it apparent how beauty standards are incredibly unrealistic, unachievable, and most importantly, not real; yet women (including myself) continuously go after this false ideal. Contemporary artists including Erin M. Riley, Gina Beavers, and Grace Weaver are exploring similar themes and served as my inspiration. My research led me to make multiple paintings, learn how to embroider, and make digital images to provoke conversation around how and why women conform to beauty standards with a special focus on the individual through work which was inspired by selfies. I learned that there is no simple answer to why women often blindly follow and accept beauty standards. Rather, there are so many contributing factors, such as social media and the normalization of selfies, which cause women to feel they must follow these standards in order to be a good person and accepted by other women in society.

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