Colgate University Summer Undergraduate Research Directory

Volume 28
2021

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List of Participants

DIVISION OF THE ARTS AND HUMANITIES (AHUM)

Department of Art and Art History

Name: Madeline Graham 2022 (Arts and Humanities)
Mentor: Carolyn Guile (Art and Art History; Russian and Eurasian Studies)
Title: *Florentine Architecture and Civic Virtue in Renaissance Florence*
Funding: Center for Freedom and Western Civilization

Name: Peter LeRoux 2021 (Economics)
Mentor: Carolyn Guile (Art and Art History; Russian and Eurasian Studies)
Title: *The Presence of Absence: A Study of the Memorialization of 9/11*
Funding: Center for Freedom and Western Civilization

Department of the Classics

Name: Ian Swain 2022 (Classics)
Mentor: Geoffrey Benson (Classics)
Title: *The Lyric Translation: A Perspective Through Sappho 31*
Funding: Center for Freedom and Western Civilization

Name: Jenny Wu 2023 (Theater; Classical Studies)
Mentor: Bill Stull (Classics)
Title: *Reception and Sources of Dante's Divine Comedy*
Funding: Center for Freedom and Western Civilization

Department of East Asian Languages and Literatures

Name: Nancy Xu 2024 (Undeclared)
Mentor: Jing Wang (East Asian Languages and Literatures)
Title: *The Needham Questioning: An Integrative Philosophy of Knowledge*
Funding: AHUM Division; J. Curtiss Taylor '54 Endowed Student Research Fund

Department of English

Name: Claire Prall-Freedman 2023 (History)
Mentor: Jennifer Brice (English)
Title: *Creative Writing Fellowship*
Funding: Jonathan H. Kistler Memorial Curricular Innovation Fund; AHUM Division

Name: Eva Wiener 2023 (Neuroscience)
Mentor: Jennifer Brice (English)
Title: *Creative Writing Fellowship*
Funding: Jonathan H. Kistler Memorial Curricular Innovation Fund; AHUM Division

Department of Philosophy

Name: Kevin Reim 2022 (Philosophy; Economics)
Mentor: David Dudrick (Philosophy)
Title: *The Gulag Archipelago: Truth in a Nation of Lies*
Funding: Center for Freedom and Western Civilization

Name: Duncan Wieland 2022 (Philosophy)
Mentor: David Dudrick (Philosophy)
Title: *The Metaphysics and the Practical Issues of Identity Politics*
Funding: Center for Freedom and Western Civilization

Department of Religion

Name: Virginia Irby MA (Religion)
Mentor: Jenna Reinbold (Religion)
Title: *Foreign, Indigenous, or Both? Complicating the African Political and Religious Narrative of Hostility Towards LGBTQ Communities*
Funding: AHUM Division

Name: Alyssa Kryzelle Reyes 2022 (Peace and Conflict Studies; Asian Studies)
Mentor: Megan Abbas (Religion)
Title: *Seats at the Table: The Criticality of Women's Involvement in Nation-building in Bangsamoro*
Funding: AHUM Division; J. Curtiss Taylor '54 Endowed Student Research Fund

Department of Theater

Name: Miya Kim 2022 (Mathematics)
Mentor: Kyle Bass (Theater)
Title: *Clean: An Original Play on League of Legends and our Shared Loneliness*
Funding: J. Curtiss Taylor '54 Endowed Student Research Fund

Name: Gianna Woods 2023 (Theater)
Mentor: Anna Labykina (Theater)
Title: *Research Assistantship, Production Management*
Funding: AHUM Division

DIVISION OF NATURAL SCIENCES AND MATHEMATICS (NASC)

Department of Biology

Name: Ziad Attia 2023 (Applied Math; Computer Science)
Mentor: Ahmet Ay (Biology; Mathematics)
Title: *Machine learning-based risk factor analysis and prevalence prediction of intestinal parasitic infections using epidemiological survey data*
Funding: NASC Division

Name: Caroline Barnhart 2023 (Environmental Studies; Biology)
Mentor: Tim McCay (Biology; Environmental Studies)
Title: *Distribution and Effects of Invasive Jumping Worms in New York State*
Funding: NASC Division

Name: Zachary Birenbaum 2022 (Computer Science)
Mentor: Ahmet Ay (Biology; Mathematics)
Title: *SealNet: Harbor Seal Facial Recognition*
Funding: James M. Taylor Mathematical Fund; NASC Division

Name: Jenna Borovinsky 2022 (Molecular Biology)
Mentor: Priscilla Van Wynsberghe (Biology)
Title: *Light it up: exploring the lite-1 and gur-3 genes in C. elegans*
Funding: Michael J. Wolk '60 Heart Foundation

Name: Isa Cunio 2022 (Biology)
Mentor: Bineyam Taye (Biology)
Title: *Effect of mass deworming in risk of atopy and alergic disorders among school-aged children, central Ethiopia. Comparative cross- sectional study*
Funding: Michael J. Wolk '60 Heart Foundation

Name: Ejun Dean 2023 (Molecular Biology)
Mentor: Krista Ingram (Biology)
Title: *Genetic Analysis of Mood Disorders in Humans*
Funding: Michael J. Wolk '60 Heart Foundation

Name: Hieu Do 2023 (Computer Science; Applied Math)
Mentor: Ahmet Ay (Biology; Mathematics)
Title: *SealNet: Harbor Seal Facial Recognition*
Funding: NASC Division

Name: Tyson Echols 2023 (Molecular Biology)
Mentor: Engda Hagos (Biology)
Title: *Cells Lacking Functional KLF4 Exhibit Increased DNMT1 Expression and Decreased MGMT Expression*
Funding: Michael J. Wolk '60 Heart Foundation

Name: Graci Galvez 2023 (Molecular Biology; Women's Studies)
Mentor: Priscilla Van Wynsberghe (Biology)
Title: *An investigation of kin-20 mutant phenotypes in C. elegans*
Funding: National Institutes of Health (NIH) Area Grant

Name: Ricardo Hernandez 2023 (Molecular Biology)
Mentor: Engda Hagos (Biology)
Title: *KLF4 maintenance of genomic stability after induced DNA damage with Etoposide and Dox*
Funding: Science and Math Initiative-SMI (NASC Division)

Name: Jackson Hoit 2022 (Environmental Biology)
Mentor: Tim McCay (Biology; Environmental Studies)
Title: *Investigation of the Distributions and Habitats of Native, Wetland-Dependent Earthworms in New York State*
Funding: NASC Division

Name: Lauren Horstmyer 2022 (Natural Sciences)
Mentor: Krista Ingram (Biology)
Title: *Boat-based Photo-ID of Harbor Seals (Phoca vitulina) at Haul-out Sites in Casco Bay to Study Site Fidelity and Social Behavior*
Funding: NASC Division

Name: Juliana Koller 2022 (Environmental Geography)
Mentor: Catherine Cardelús (Biology; Environmental Studies)
Title: *Impacts of White-Tailed Deer (Odocoileus virginianus) Overabundance on Temperate Northern Forest Regeneration*
Funding: Oberheim Memorial Fund

Name: Will Krohn 2023 (Biology; Environmental Studies)
Mentor: Catherine Cardelús (Biology; Environmental Studies)
Title: *Impacts of White-Tailed Deer (Odocoileus virginianus) Overabundance on Temperate Northern Forest Regeneration*
Funding: Oberheim Memorial Fund

Name: Jasper Lim-Goyette 2023 (Chemistry; Molecular Biology)
Mentor: Geoff Holm (Biology)
Title: *The Impact of JNK1 on Metabolic Responses to Reovirus Infection*
Funding: Beckman Scholars Program

Name: Griffin Lunn 2022 (Biology)
Mentor: Bineyam Taye (Biology)
Title: *Deworming and its impact on malnutrition among Ethiopian children*
Funding: NASC Division

Name: Rory O'Brien 2022 (Biology; Spanish)
Mentor: Priscilla Van Wynsberghe (Biology)
Title: *Understanding regulation of miRNAs by LIN-42 and KIN-20 in C. elegans development*
Funding: NASC Division

Name: Hailey Orff 2024 (Undeclared)
Mentor: Krista Ingram (Biology)
Title: *Boat-based Photo-ID of Harbor Seals (Phoca vitulina) at Haul-out Sites in Casco Bay to Study Site Fidelity and Social Behavior*
Funding: NASC Division

Name: Collin Parrow 2022 (Molecular Biology)
Mentor: Priscilla Van Wynsberghe (Biology)
Title: *Insight Into Cellular Timing: KIN-20 is Required for Normal Cyclic Expression of LIN-42 Isoforms in C. elegans*
Funding: National Institutes of Health (NIH) Area Grant

Name: Kailey Paul 2023 (NASC)
Mentor: Ana Jimenez (Biology)
Title: *Thermal relations across body mass in the domestic dog, Canis lupus familiaris.*
Funding: Oberheim Memorial Fund

Name: Sophie Pedzich 2024 (Undeclared)
Mentor: Tim McCay (Biology; Environmental Studies)
Title: *Distribution and Effects of Invasive Jumping Worms in New York State*
Funding: NASC Division

Name: Elisabeth Pezzuto 2022 (Biology)
Mentor: Engda Hagos (Biology)
Title: *Cells Lacking Functional KLF4 Exhibit Increased DNMT1 Expression and Decreased MGMT Expression*
Funding: Michael J. Wolk '60 Heart Foundation

Name: Allen Quizon 2023 (Computer Science)
Mentor: Ahmet Ay (Biology; Mathematics)
Title: *Analysis of Core Gene Networks Controlling Zebrafish Segment Determination*
Funding: NASC Division

Name: Amaan Shaikh 2022 (Molecular Biology)
Mentor: Engda Hagos (Biology)
Title: *KLF4 maintenance of genomic stability after induced DNA damage with Etoposide and Dox*
Funding: Science and Math Initiative-SMI (NASC Division)

Name: Yuntong Sun 2022 (Biology; Art and Art History)
Mentor: Tim McCay (Biology; Environmental Studies)
Title: *Investigation of the Distributions and Habitats of Native, Wetland-Dependent Earthworms in New York State*
Funding: NASC Division

Name: Giovanni Vigilante 2022 (Environmental Studies; Biology)
Mentor: Catherine Cardelús (Biology; Environmental Studies)
Title: *Impacts of White-Tailed Deer (Odocoileus virginianus) Overabundance on Temperate Northern Forest Regeneration*
Funding: NASC Division

Name: Morgan Wynkoop 2021 (Spanish; Molecular Biology)
Mentor: Ana Jimenez (Biology)
Title: *Oxidative Stress in Feral Dogs from the Bosawas Biosphere Reserve in Nicaragua*
Funding: Beckman Scholars Program

Name: Justice Wysinger 2023 (Environmental Biology)
Mentor: Catherine Cardelús (Biology; Environmental Studies)
Title: *Impacts of White-Tailed Deer (Odocoileus virginianus) Overabundance on Temperate Northern Forest Regeneration*
Funding: Science and Math Initiative-SMI (NASC Division)

Name: Julia Zaborowsky 2022 (Physics; Biology)
Mentor: Geoff Holm (Biology)
Title: *Cellular metabolic responses to mammalian orthoreovirus infection*
Funding: NASC Division

Name: Aziz Zafar 2023 (Biology; Applied Math)
Mentor: Ahmet Ay (Biology; Mathematics)
Title: *Machine learning-based risk factor analysis and prevalence prediction of intestinal parasitic infections using epidemiological survey data*
Funding: NASC Division

Name: Isabella Ziolkowski 2023 (Molecular Biology)
Mentor: Krista Ingram (Biology)
Title: *Napping During the COVID-19 Pandemic Mitigated the Effects of Anxiety and Depression on Sleep in Young Adults*
Funding: Michael J. Wolk '60 Heart Foundation

Department of Chemistry

Name: Seth Bingham 2022 (Chemistry)
Mentor: Jason Keith (Chemistry)
Title: *Mechanistic Investigation of Transition Metal Catalysis with Density Functional Theory*
Funding: Miller-Cochran Fund

Name: Harrison Blume 2022 (Biochemistry)
Mentor: Jacob Goldberg (Chemistry)
Title: *Chemical Probes for Detecting Zinc Ions in the Synapse*
Funding: Summer Undergraduate Research Fund (SURF)

Name: Olivia Borden 2023 (Biochemistry)
Mentor: Anthony Chianese (Chemistry)
Title: *Mechanistic Studies of Ruthenium-Catalyzed Hydrogenation Reactions*
Funding: NASC Division

Name: Tarik Cigeroglu 2023 (Physics)
Mentor: Eric Muller (Chemistry)
Title: *Tip-Enhanced Infrared Spectroscopy of Proteins in Solution*
Funding: NASC Division

Name: James Clark 2023 (Biochemistry)
Mentor: Jenny Peeler (Chemistry)
Title: *Utilizing Genetic Code Expansion to Express and Study Selenoproteins in Mammalian Cells*
Funding: NASC Division

Name: Gia D'Erasmo 2023 (Physical Science)
Mentor: Anne Perring (Chemistry)
Title: *Ice Nucleation and Amino Acid Measurements in Upstate New York*
Funding: NASC Division

Name: Camden Di Carlo 2024 (Undeclared)
Mentor: Kevin Siegenthaler (Chemistry)
Title: *Protein Folding During Oxidative Stress*
Funding: NASC Division

Name: Wes Dorow 2023 (Biochemistry)
Mentor: Ephraim Woods (Chemistry)
Title: *Spectroscopy and Photochemistry of Aqueous Imidazole-2-carboxaldehyde*
Funding: Warren Anderson Fund

Name: Maurine Fan 2023 (Molecular Biology)
Mentor: Ernie Nolen (Chemistry)
Title: *Development of Oxime Cyclization and Trifluoromethylation on GalNAc Model*
Funding: National Institutes of Health (NIH) Area Grant

Name: Willow Goff 2023 (Molecular Biology)
Mentor: Jenny Peeler (Chemistry)
Title: *Utilizing Genetic Code Expansion to Express and Study Selenoproteins in Mammalian Cells*
Funding: Warren Anderson Fund

Name: Eric Goodney 2024 (Undeclared)
Mentor: Rick Geier (Chemistry)
Title: *Investigation of a TLC Analytical Method for Monitoring the Synthesis of an Alkyl Substituted Porphyrin and N-Confused Porphyrin*
Funding: NASC Division

Name: Mina Head 2023 (Philosophy)
Mentor: Anthony Chianese (Chemistry)
Title: *Mechanistic Studies of Ruthenium-Catalyzed Hydrogenation Reactions*
Funding: National Science Foundation Grant

Name: Steph Jacoby 2023 (Chemistry)
Mentor: Anne Perring (Chemistry)
Title: *Ice Nucleation and Amino Acid Measurements in Upstate New York*
Funding: NASC Division

Name: Ben Joseph 2023 (Biochemistry)
Mentor: Anthony Chianese (Chemistry)
Title: *Mechanistic Studies of Ruthenium-Catalyzed Hydrogenation Reactions*
Funding: National Science Foundation Grant

Name: Johna Joseph 2022 (Chemistry)
Mentor: Eric Muller (Chemistry)
Title: *Tip-Enhanced Infrared Spectroscopy of Proteins in Soluti*on
Funding: Science and Math Initiative-SMI (NASC Division)

Name: Fallyn Kirlin 2023 (Biochemistry)
Mentor: Anthony Chianese (Chemistry)
Title: *Mechanistic Studies of Ruthenium-Catalyzed Hydrogenation Reactions*
Funding: National Science Foundation Grant

Name: Becca Landry 2024 (Undeclared)
Mentor: Kevin Siegenthaler (Chemistry)
Title: *Functional Analysis of Minor Protein Disulfide Isomerases*
Funding: NASC Division

Name: Kristen Mast 2023 (Chemistry)
Mentor: Matt Hudson (Chemistry)
Title: *Modification of Zeolites for Improved Carbon Capture Performance*
Funding: NASC Division

Name: Colin Miller 2022 (Biochemistry)
Mentor: Ephraim Woods (Chemistry)
Title: *Heterogeneous oxidation kinetics of ozone-iodide interactions on the surface of aerosol particles*
Funding: Beckman Scholars Program

Name: Rachel Schaaf 2022 (Mathematics; Chemistry)
Mentor: Rick Geier (Chemistry)
Title: *Investigation of the Synthesis of an Alkyl Substituted Porphyrin and N-Confused Porphyrin*
Funding: Miller-Cochran Fund

Name: Hunter Schaumloffel 2023 (Biochemistry)
Mentor: Jacob Goldberg (Chemistry)
Title: *New Chemical Tools to Study Biological Systems*
Funding: Warren Anderson Fund

Name: Amelia Seasholtz 2023 (Biochemistry)
Mentor: Rick Geier (Chemistry)
Title: *Investigation of a One-Flask Synthesis of Calixphyrins*
Funding: NASC Division

Name: Nilesh Shah 2024 (Undeclared)
Mentor: Jacob Goldberg (Chemistry)
Title: *New Chemical Tools to Study Biological Systems*
Funding: Picker Interdisciplinary Science Institute

Name: Esther Wu 2023 (Biochemistry; Neuroscience)
Mentor: Jacob Goldberg (Chemistry)
Title: *New Chemical Tools to Study Biological Systems*
Funding: NASC Division

Name: Jessica Zhong 2022 (Chemistry)
Mentor: Ernie Nolen (Chemistry)
Title: *Synthetic effort towards C-linked GalNAc-Ser/Thr analogs as metabolically stable Tn antigen mimic*
Funding: National Institutes of Health (NIH) Area Grant

Department of Computer Science

Name: Nick Bautista 2023 (Computer Science)
Mentor: Aaron Gember-Jacobson (Computer Science)
Title: *Improving network management with machine learning*
Funding: National Science Foundation Grant

Name: Jyotirmay Chauhan 2023 (Computer Science; Mathematical Economics)
Mentor: Aaron Gember-Jacobson (Computer Science)
Title: *Detecting Network Errors: Router Configuration Mining*
Funding: Holden Endowment Fund

Name: Devon Lee 2022 (Computer Science)
Mentor: Aaron Gember-Jacobson (Computer Science)
Title: *Detecting Network Errors: Router Configuration Mining*
Funding: National Science Foundation Grant

Name: Emily Yu 2023 (Computer Science)
Mentor: Aaron Gember-Jacobson (Computer Science)
Title: *Detecting Network Errors: Router Configuration Mining*
Funding: National Science Foundation Grant

Department of Geology

Name: Luke Calderaro 2022 (Molecular Biology; Geology)
Mentor: Paul Harnik (Geology)
Title: *Geographic Variation in Predator-Prey Relationships in Marine Mollusks*
Funding: Doug Rankin '53 Endowment-Geology Research

Name: Jane Carskaddan 2024 (Undeclared)
Mentor: Amy Leventer (Geology)
Title: *Compiling a catalog of Scanning Electron Microscopy images of Antarctic marine plankton for use in future exploratory cruises*
Funding: NASC Division

Name: Katia Childs 2023 (Geology)
Mentor: William Peck (Geology)
Title: *Analysis of Adirondack Graphites and their Origins*
Funding: Bob Linsley/James McLelland Fund

Name: Ryan Ewanow 2023 (Biology)
Mentor: Paul Harnik (Geology)
Title: *Life history variation in the bivalve Ameritella versicolor in coastal Alabama*
Funding: Doug Rankin '53 Endowment-Geology Research

Name: Jessie Farrell 2024 (Undeclared)
Mentor: Alison Koleszar (Geology)
Title: *Colgate BLAST (Bubbles, Liquids, And Silicic Tephras): What Causes Dangerous Volcanic Eruptions?*
Funding: National Science Foundation Grant

Name: Charlie Filipovich 2023 (Geology)
Mentor: Karen Harpp (Geology; Peace and Conflict Studies)
Title: *Virtual Galápagos: An Innovative, Interactive Science Outreach Project*
Funding: Norma Vergo Prize

Name: Darius Hagyan 2024 (Undeclared)
Mentor: Alison Koleszar (Geology)
Title: *Colgate BLAST (Bubbles, Liquids, And Silicic Tephras): What Causes Dangerous Volcanic Eruptions?*
Funding: National Science Foundation Grant

Name: Mateo Inoa 2023 (Geology)
Mentor: William Peck (Geology)
Title: *Passive Carbon Sequestration in Adirondack Mine Wastes*
Funding: NASC Division

Name: Sadie Kasten 2022 (Geology)
Mentor: William Peck (Geology)
Title: *Passive Carbon Sequestration in Adirondack Mine Wastes*
Funding: NASC Division

Name: Izzy King 2023 (Geology)
Mentor: Joe Levy (Geology)
Title: *Geometrical Analysis of Mars Chaos Terrains; Spatial and Temporal Extent of the Water Tracks in McMurdo DryValleys*
Funding: National Science Foundation Grant

Name: Shane Knopp 2023 (Computer Science)
Mentor: Aubreya Adams (Geology)
Title: *Deep Earth Imaging of the Alaskan Subduction Zone*
Funding: NASC Division

Name:	Lingfeng Kuang 2023 (Geology; Geography)
Mentor:	Joe Levy (Geology)
Title:	*Geometrical Analysis of Mars Chaos Terrains; Spatial and Temporal Extent of the Water Tracks in McMurdo DryValleys*
Funding:	NASA Mars Data Analysis Program

Name:	Fred LeClair 2022 (Geology)
Mentor:	William Peck (Geology)
Title:	*Analysis of Adirondack Graphites and their Origins*
Funding:	Doug Rankin '53 Endowment-Appalachian Research

Name:	Sam McCabe 2022 (Economics; Computer Science)
Mentor:	Karen Harpp (Geology; Peace and Conflict Studies)
Title:	*Virtual Galapagos: Design and Development of an Interactive Online Educational Resource for Children to Learn Science*
Funding:	Norma Vergo Prize

Name:	Christopher McElhaney 2022 (Peace and Conflict Studies)
Mentor:	Karen Harpp (Geology; Peace and Conflict Studies)
Title:	*Virtual Galapagos*
Funding:	Bob Linsley/James McLelland Fund

Name:	Abigail Melican 2023 (Geology)
Mentor:	Alison Koleszar (Geology)
Title:	*Colgate BLAST (Bubbles, Liquids, And Silicic Tephras): What Causes Dangerous Volcanic Eruptions?*
Funding:	NASC Division

Name:	Celia Meyer 2022 (Environmental Geology)
Mentor:	Paul Harnik (Geology)
Title:	*Nucula Life History Over Time in the Gulf of Mexico*
Funding:	NASC Division

Name:	Rose Nguyen 2024 (Undeclared)
Mentor:	Karen Harpp (Geology; Peace and Conflict Studies)
Title:	*Virtual Galapagos: Design and Development of an Interactive Online Educational Resource for Children to Learn Science*
Funding:	NASC Division

Name:	Olivia Quartz 2022 (Geology)
Mentor:	Amy Leventer (Geology)
Title:	*Examining Fragilariopsis kerguelensis rectangularity in East Antarctica as a proxy for reconstructing paleoclimate*
Funding:	Norma Vergo Prize

Name:	Charlie Quill 2023 (Geology)
Mentor:	Karen Harpp (Geology; Peace and Conflict Studies)
Title:	*Virtual Galapagos: Design and Development of an Interactive Online Educational Resource for Children to Learn Science*
Funding:	NASC Division

Name: MC Rapoza 2023 (Geology)
Mentor: Joe Levy (Geology)
Title: *Geometrical Analysis of Mars Chaos Terrains; Spatial and Temporal Extent of the Water Tracks in McMurdo DryValleys*
Funding: National Science Foundation Grant

Name: Tom Richards 2024 (Undeclared)
Mentor: Aubreya Adams (Geology)
Title: *Deep Earth Imaging of the Alaskan Subduction Zone*
Funding: National Science Foundation Grant

Name: Jeri Stoller 2022 (Environmental Geology; English)
Mentor: Paul Harnik (Geology)
Title: *Geographic Variation in Shell Preservation Across the Northern Gulf of Mexico*
Funding: NASC Division

Name: Alexa Trubiano 2023 (Environmental Geology)
Mentor: William Peck (Geology)
Title: *Carbon Sequestration Potential of Iron Slag in New York*
Funding: Doug Rankin '53 Endowment-Geology Research

Name: Evie Unger-Harquail 2022 (Geology)
Mentor: Amy Leventer (Geology)
Title: *Antarctic Climate Proxies*
Funding: Doug Rankin '53 Endowment-Appalachian Research

Name: Sydney Walters 2022 (Geology)
Mentor: Aubreya Adams (Geology)
Title: *Deep Earth Imaging of the Alaskan Subduction Zone*
Funding: NASC Division

Name: Max Wang 2022 (Geography; Geology)
Mentor: Joe Levy (Geology)
Title: *Geometrical Analysis of Mars Chaos Terrains; Spatial and Temporal Extent of the Water Tracks in McMurdo DryValleys*
Funding: NASA Mars Data Analysis Program

Name: Martin Welych-Flanagan 2022 (Geology)
Mentor: Amy Leventer (Geology)
Title: *Devonian Paleoclimate*
Funding: Hackett-Rathmell 1968 Memorial Fund

Name: Jessica Wen 2024 (Undeclared)
Mentor: Aubreya Adams (Geology)
Title: *Deep Earth Imaging of the Alaskan Subduction Zone*
Funding: National Science Foundation Grant

Name: Jessica Zehner 2023 (Environmental Geology)
Mentor: Alison Koleszar (Geology)
Title: *Colgate BLAST (Bubbles, Liquids, And Silicic Tephras): What Causes Dangerous Volcanic Eruptions?*
Funding: NASC Division

Department of Mathematics

Name: Chris Cherniakov 2024 (Undeclared)
Mentor: Will Cipolli (Mathematics)
Title: *Data Science Collaboratory*
Funding: NASC Division

Name: Chris Deng 2022 (Economics; Applied Math)
Mentor: Silvia Jimenez-Bolanos (Mathematics)
Title: *Nonlinear neutral inclusions with a spiral coating*
Funding: National Science Foundation

Name: Lakshya Dhurka 2022 (Computer Science)
Mentor: Will Cipolli (Mathematics)
Title: *Data Science Collaboratory*
Funding: Herman T. R. Aude Mathematical Fund; NASC Division

Name: Joakim Jakovleski 2022 (Computer Science; Mathematics)
Mentor: Rob Davis (Mathematics)
Title: *A convex geometry and homotopy approach for power-flow equations*
Funding: National Science Foundation Grant

Name: Qizhe Pan 2022 (Economics; Mathematics)
Mentor: Rob Davis (Mathematics)
Title: *A convex geometry and homotopy approach for power-flow equations*
Funding: NASC Division

Neuroscience Program

Name: Richard Baker 2023 (Neuroscience; Psychological Science)
Mentor: Jason Meyers (Biology; Neuroscience)
Title: *Cavefish vs Surface fish: Does blindness increase sensitivity to the environment?*
Funding: NASC Division

Name: Jane Corcoran 2023 (Neuroscience)
Mentor: Jason Meyers (Biology; Neuroscience)
Title: *What Role do Interneuromast Cells play in the Regeneration of Neuromasts in the Zebrafish Lateral Line System?*
Funding: Michael J. Wolk '60 Heart Foundation

Name: Nick Mecca 2023 (Neuroscience)
Mentor: Jason Meyers (Biology; Neuroscience)
Title: *The Notch and Wnt signaling pathways coordinate retinal regeneration in Zebrafish, but the Notch pathway is downstream of Wnt*
Funding: Michael J. Wolk '60 Heart Foundation

Name: Sara Million-Perez 2022 (Neuroscience)
Mentor: Jason Meyers (Biology; Neuroscience)
Title: *Modulating stem/progenitor cell behavior in zebrafish sensory systems*
Funding: NASC Division

Department of Physics and Astronomy

Name: Sam Adler 2023 (Physics)
Mentor: Beth Parks (Physics and Astronomy)
Title: *Source Apportionment of Ugandan Air Quality*
Funding: Volgenau Wiley Endowed Research Fellowship

Name: Federico Aguilera Gonzalez 2022 (Physics)
Mentor: Patrick Crotty (Physics and Astronomy)
Title: *Supermassive dark matter*
Funding: Volgenau Wiley Endowed Research Fellowship; NASC Division

Name: Ian Bania 2021 (Astronomy/Physics)
Mentor: Cosmin Ilie (Physics and Astronomy)
Title: *Dark Matter in Population III Stars*
Funding: NASC Division

Name: Div Chamria 2023 (Chemistry; Physics)
Mentor: Ramesh Adhikari (Physics and Astronomy)
Title: *Anomalous Conductive Behavior in a Polymer-Amino Acid Composite*
Funding: Volgenau Wiley Endowed Research Fellowship; NASC Division

Name: Riley Corcoran 2022 (Astronomy/Physics)
Mentor: Thomas Balonek (Physics and Astronomy)
Title: *Monitoring Quasars at Foggy Bottom Observatory*
Funding: NASA New York Space Grant

Name: Nick DiBrita 2022 (Physics; Applied Math)
Mentor: Abdel Isakovic (Physics and Astronomy)
Title: *Temporal Graphs and Network Characteristics for Bio-Inspired Network Optimization*
Funding: Justus '43 and Jayne Schlichting Student Research Fund

Name: Daniel Espinosa 2023 (Physics)
Mentor: Ken Segall (Physics and Astronomy)
Title: *Neuromorphic Reservoir Computing with Josephson Junctions*
Funding: Volgenau Wiley Endowed Research Fellowship; NASC Division

Name: Will Friend 2022 (Astronomy/Physics)
Mentor: Ken Segall (Physics and Astronomy)
Title: *Neuromorphic Computing with Josephson Junctions*
Funding: Volgenau Wiley Endowed Research Fellowship; NASC Division

Name: Jeisanelly Hernandez 2024 (Undeclared)
Mentor: Rebecca Metzler (Physics and Astronomy)
Title: *Adult Barnacle Exoskeleton Structure, Composition, and Function*
Funding: Science and Math Initiative-SMI (NASC Division)

Name: Ellie Humphreys 2024 (Undeclared)
Mentor: Cosmin Ilie (Physics and Astronomy)
Title: *Locating Population iii Stars Using the James Webb Space Telescope Data Reduction Pipeline*
Funding: Justus '43 and Jayne Schlichting Student Research Fund

Name:	Heidi Mach (Allegheny College)
Mentor:	Jeff Bary (Physics and Astronomy)
Title:	*Accretion Activity on Spotted T Tauri Stars*
Funding:	Keck Northeast Astronomy Consortium

Name:	Chloe Malinowski 2022 (Astronomy/Physics; Applied Math)
Mentor:	Patrick Crotty (Physics and Astronomy)
Title:	*Supermassive Dark Matter*
Funding:	Justus '43 and Jayne Schlichting Student Research Fund

Name:	Madison Markham 2024 (Undeclared)
Mentor:	Cosmin Ilie (Physics and Astronomy)
Title:	*Determining Dark Core Mass from the Accretion of Dark Matter Particles in Population III Stars*
Funding:	Justus '43 and Jayne Schlichting Student Research Fund

Name:	Eric Matt 2022 (German; Physics)
Mentor:	Ken Segall (Physics and Astronomy)
Title:	*Superconducting Neural Circuits*
Funding:	Justus '43 and Jayne Schlichting Student Research Fund

Name:	Sarah Miller 2024 (Undeclared)
Mentor:	Ramesh Adhikari (Physics and Astronomy)
Title:	*Self-Assembled Diphenylalanine Nanostructures*
Funding:	NASC Division

Name:	Warner Neal 2022 (Astrogeophysics)
Mentor:	Thomas Balonek (Physics and Astronomy)
Title:	*Long Term Optical Variability of Quasar 1308+326*
Funding:	Justus '43 and Jayne Schlichting Student Research Fund

Name:	Thao Nguyen 2022 (Physics)
Mentor:	Kiko Galvez (Physics and Astronomy)
Title:	*Singular Optics*
Funding:	National Science Foundation Grant

Name:	Leon Nichols 2023 (Art and Art History; Physics)
Mentor:	Ken Segall (Physics and Astronomy)
Title:	*Neuromorphic Computing with Josephson Junction Neurons: Fluxon Location & Genetic Algorithm*
Funding:	Justus '43 and Jayne Schlichting Student Research Fund

Name:	Jillian Paulin 2023 (Astronomy/Physics)
Mentor:	Cosmin Ilie (Physics and Astronomy)
Title:	*Analytic Approximations of Velocity Suppression of Dark Matter Capture*
Funding:	Volgenau Wiley Endowed Research Fellowship; NASC Division

Name:	Facundo Perez 2024 (Astronomy/Physics)
Mentor:	Jeff Bary (Physics and Astronomy)
Title:	*Accretion Activity on Spotted T Tauri Stars*
Funding:	Science and Math Initiative-SMI (NASC Division)

Name: Nick Poon 2022 (Physics)
Mentor: Ramesh Adhikari (Physics and Astronomy)
Title: *Optimizing Leaf-Based Pseudocapacitors*
Funding: Justus '43 and Jayne Schlichting Student Research Fund

Name: Kasar Profit 2024 (Undeclared)
Mentor: Beth Parks (Physics and Astronomy)
Title: *Ultrafast Laser Characterization*
Funding: NASC Division

Name: Jeiko Pujols 2023 (Physics)
Mentor: Ramesh Adhikari (Physics and Astronomy)
Title: *Mechanical Properties of Tyrosine Nanofibers*
Funding: Science and Math Initiative-SMI (NASC Division)

Name: JJ Ryu 2024 (Undeclared)
Mentor: Beth Parks (Physics and Astronomy)
Title: *Modeling heat transport in insulation measurements*
Funding: Justus '43 and Jayne Schlichting Student Research Fund

Name: Matt Sampson 2023 (Mathematical Economics)
Mentor: Rebecca Metzler (Physics and Astronomy)
Title: *Biominerals: exploring composition, structure, and function*
Funding: Justus '43 and Jayne Schlichting Student Research Fund

Name: Baibhav Sharma 2022 (Physics)
Mentor: Kiko Galvez (Physics and Astronomy)
Funding: Volgenau Wiley Endowed Research Fellowship

Name: John Slater 2022 (Astronomy/Physics)
Mentor: Thomas Balonek (Physics and Astronomy)
Title: *Periodicity of Quasar 1308+326*
Funding: NASA New York Space Grant

Name: Jack Underhill 2022 (Molecular Biology; Philosophy)
Mentor: Rebecca Metzler (Physics and Astronomy)
Title: *Exploring Structure and Composition of Mineralized Adhesive and Shell Layers in Etheria elliptica*
Funding: National Science Foundation Grant

Name: Wayne Wang 2023 (Physics)
Mentor: Ken Segall (Physics and Astronomy)
Title: *Cryogenic Memory Using Josephson Junction Neurons*
Funding: Justus '43 and Jayne Schlichting Student Research Fund

Name: Keiona Williams 2024 (Undeclared)
Mentor: Rebecca Metzler (Physics and Astronomy)
Title: *Barnacle exoskeleton formation in differing temperatures*
Funding: National Science Foundation Grant

Name: Tony Yap 2022 (Astrogeophysics)
Mentor: Jonathan Levine (Physics and Astronomy)
Title: *Coincidence Counting of Atoms for Spaceflight Rb-Sr Geochronology*
Funding: Justus '43 and Jayne Schlichting Student Research Fund

Name: Zoe You 2022 (Physics; Chinese)
Mentor: Kiko Galvez (Physics and Astronomy)
Title: *Photon Imaging and Quantum State Tomography*
Funding: Volgenau Wiley Endowed Research Fellowship

Name: Emma Zeng 2023 (Biochemistry; Mathematics)
Mentor: Abdel Isakovic (Physics and Astronomy)
Title: *Limitation of Fowler-Nordheim Electron Field Emission Model at Nanoscale*
Funding: Justus '43 and Jayne Schlichting Student Research Fund

Department of Psychological and Brain Sciences

Name: Sofia Beaufrand 2022 (Neuroscience; Spanish)
Mentor: Bruce Hansen (Psychological and Brain Sciences)
Title: *Removing Visual Properties of Images to Understand Their Individual Contributions to Visual Data Processing in the Brain*
Funding: NASC Division

Name: Amelia Bohan 2023 (Psychological Science)
Mentor: Lauren Philbrook (Psychological and Brain Sciences)
Title: *Predictors and Outcomes of Preschool-Aged Sleep*
Funding: NASC Division

Name: Emily DeNunzio 2022 (Neuroscience)
Mentor: Wan-chun Liu (Psychological and Brain Sciences)
Title: *1) Sensitive Period of Song Learning Questioned 2) Could an Enriched Environment Benefit Song Learning?*
Funding: NASC Division

Name: Abigail Flynn 2022 (Middle Eastern and Islamic Studies; Psychological Science)
Mentor: Carrie Keating (Psychological and Brain Sciences)
Title: *Perceptions of Political Charisma: A Cross-Cultural Examination of US and Arab Populations*
Funding: Lampert Institute for Civic and Global Affairs

Name: Max Foote 2022 (Neuroscience)
Mentor: Jun Yoshino (Psychological and Brain Sciences)
Title: *The effect of antidepressants on neuroinflammation in mixed glial cultures*
Funding: NASC Division

Name: Isabel Gephart 2022 (Applied Math; Neuroscience)
Mentor: Bruce Hansen (Psychological and Brain Sciences)
Title: *Developing a brain supervised sparse-coding neural network*
Funding: NASC Division

Name: Tori Gobo 2022 (Neuroscience)
Mentor: Bruce Hansen (Psychological and Brain Sciences)
Title: *Developing a brain supervised sparse-coding neural network*
Funding: NASC Division

Name: Leah Grossman 2022 (Neuroscience)
Mentor: Ann Jane Tierney (Psychological and Brain Sciences)
Title: *Investigating Food Choice and the Effects of Monoamine Neuromodulators on Behavior in the House Cricket Acheta domesticus*
Funding: NASC Division

Name: Hannah Grote 2022 (Neuroscience; English)
Mentor: Ann Jane Tierney (Psychological and Brain Sciences)
Title: *Investigating Food Choice and the Effects of Monoamine Neuromodulators on Behavior in the House Cricket Acheta domesticus*
Funding: NASC Division

Name: Sarah Harris 2023 (Psychological Science)
Mentor: Lauren Philbrook (Psychological and Brain Sciences)
Title: *Predictors and Outcomes of Preschool-Aged Sleep*
Funding: NASC Division

Name: Raina Jung 2023 (Neuroscience)
Mentor: Wan-chun Liu (Psychological and Brain Sciences)
Title: *Development of DCX Staining Protocol*
Funding: NASC Division

Name: Natalie Marcus-Bauer 2022 (Neuroscience)
Mentor: Ann Jane Tierney (Psychological and Brain Sciences)
Title: *Effects of monoamine neurotransmitters and serotonergic receptor subtypes on animal behavior*
Funding: NASC Division

Name: Jeffrey Ran 2022 (Neuroscience)
Mentor: Wan-chun Liu (Psychological and Brain Sciences)
Title: *Protocol Development of DCX Immunohistochemistry on Taeniopygia guttata*
Funding: NASC Division

Name: Lily Sheets 2023 (Neuroscience)
Mentor: Bruce Hansen (Psychological and Brain Sciences)
Title: *Understanding the geometry of mutual information within neuroelectric state-space*
Funding: NASC Division

Name: Emily Stack 2022 (Neuroscience)
Mentor: Jun Yoshino (Psychological and Brain Sciences)
Title: *The effect of antidepressants on neuroinflammation in mixed glial cultures*
Funding: NASC Division

DIVISION OF SOCIAL SCIENCES (SOSC)

Department of Economics

Name: Giancarlo Arcese 2022 (Mathematics; Economics)
Mentor: Benjamin Anderson (Economics)
Title: *Demand for Sports Attendance during a Pandemic: Evidence from Professional Basketball and Hockey*
Funding: SOSC Division

Name:	Kartik Devpura 2023 (Economics; Applied Math)
Mentor:	Yang Song (Economics)
Title:	*Demand and Supply for Computer Science Education*
Funding:	SOSC Division

Name:	Samay Gupta 2024 (Undeclared)
Mentor:	Yang Song (Economics)
Title:	*Trade and the Value of a Second Language*
Funding:	SOSC Division

Name:	Arnab Hait 2024 (Undeclared)
Mentor:	Nicole Simpson (Economics)
Title:	*Worldwide Remittance Response to the Covid-19 Pandemic*
Funding:	Walter Broughton '63 Research Fund

Name:	YJ Lee 2022 (Mathematical Economics; Middle Eastern and Islamic Studies)
Mentor:	Carolina Castilla (Economics)
Title:	*Choosing when it matters: do surrogate decision-makers overcome status quo bias from overchoice?*
Funding:	SOSC Division

Name:	Ayush Sinha 2022 (Economics; Mathematics)
Mentor:	Michael Connolly (Economics)
Title:	*Loan Termination of Fannie Mae Multifamily Mortgages Going Underwater*
Funding:	SOSC Division

Name:	Gabrielle Sorresso 2022 (Environmental Studies; Economics)
Mentor:	Isla Globus-Harris (Economics)
Title:	*Wind Energy and Changing Incentives for Reserve Power in Texas*
Funding:	SOSC Division

Name:	Tedi Totojani 2023 (Mathematical Economics)
Mentor:	Yang Song (Economics)
Title:	*Graduating in a Recession and Job Satisfaction*
Funding:	SOSC Division

Department of Educational Studies

Name:	Carolina Chavez 2023 (Environmental Geography)
Mentor:	Susan Woolley (Educational Studies; LGBTQ Studies)
Title:	*Out for Safe Space: Tracing educational discourse on supporting LGBTQ students in schools*
Funding:	SOSC Division

Name:	Adanya Jeudy 2023 (Peace and Conflict Studies; Educational Studies)
Mentor:	Brenda Sanya (Educational Studies)
Title:	*States of Discretion: Black Migrating Bodies racialization and naturalization in the United States*
Funding:	SOSC Division

Name:	Jordy Medina 2023 (Political Science)
Mentor:	Brenda Sanya (Educational Studies)
Title:	*States of discretion: Black migrating bodies, racialization, and naturalization in the United States*
Funding:	SOSC Division

Name: Sophie Shaffer 2022 (Psychological Science)
Mentor: Meg Gardner (Educational Studies)
Title: *Understanding the role of critical educators in the transformation of schools for justice*
Funding: SOSC Division

Name: Alex Tran 2022 (Educational Studies; Psychological Science)
Mentor: Susan Woolley (Educational Studies; LGBTQ Studies)
Title: *Out for Safe Space: Tracing educational discourse on supporting LGBTQ students in schools*
Funding: SOSC Division

Name: Israel Zarate 2024 (Women's Studies)
Mentor: Brenda Sanya (Educational Studies)
Title: *States of discretion: Black migrating bodies, racialization, and naturalization in the United States*
Funding: SOSC Division

Name: Angela Zheng 2023 (Educational Studies; Philosophy and Religion)
Mentor: Meg Gardner (Educational Studies)
Title: *Globally Competent Teaching Curriculum Development*
Funding: SOSC Division

Department of Geography

Name: Davi Bendavid 2022 (Biology; Geography)
Mentor: Mike Loranty (Geography)
Title: *Variation in Leaf Area Index of Cajander Larch Forests Within a Fire Perimeter*
Funding: SOSC Division

Name: Anna Duerr 2022 (Environmental Geography)
Mentor: Peter Klepeis (Geography)
Title: *Food Access and Inequality in Utica, New York: A Spatial Analysis of Supermarket Redlining*
Funding: Walter Broughton '63 Research Fund

Name: Nikoy Norris 2023 (Russian and Eurasian Studies)
Mentor: Jessica Graybill (Geography; Russian and Eurasian Studies)
Title: *Desolate legacy or hopeful future? Unraveling discourses about the Russian Arctic*
Funding: SOSC Division

Name: Jim Perry 2023 (Computer Science; Russian and Eurasian Studies)
Mentor: Jessica Graybill (Geography; Russian and Eurasian Studies)
Title: *Desolate legacy or hopeful future? Unraveling discourses about the Russian Arctic*
Funding: SOSC Division

Department of History

Name: Saumya Garg 2022 (History; Mathematical Economics)
Mentor: Graham Hodges (History; Africana and Latin American Studies)
Title: *Runaway Advertisements and Enslaved Database*
Funding: Alexander V. Wasson Fund to Support American History; SOSC Division

Name: Jillian Holliday 2023 (History; Educational Studies)
Mentor: Xan Karn (History)
Title: *Religious Freedom: The Christian Right's Weapon in the Culture Wars from the 1990s to COVID-19*
Funding: Center for Freedom and Western Civilization

Name: Will Lam 2023 (History)
Mentor: Graham Hodges (History; Africana and Latin American Studies)
Title: *Runaway advertisements and Enslaved database*
Funding: Alexander V. Wasson Fund to Support American History; SOSC Division

Department of Political Science

Name: Blythe Berk 2023 (Political Science)
Mentor: Bruce Rutherford (Political Science)
Title: *A Royal Family with No Family in An Islamic Kingdom Without Islam: How Crown Prince Mohammad Bin Salman is dismantling the foundations of Saudi Arabia*
Funding: Center for Freedom and Western Civilization

Name: Emanuele DiRubba 2023 (Political Science)
Mentor: Barry Shain (Political Science)
Title: *Researching "Revolutionary-era American Pamphlet Literature in Context: A Documentary History, 1764-1776," and "Recent Scholarship Exploring The Federalist, 1787-1788"*
Funding: SOSC Division

Name: Carson Durdel 2022 (History; Political Science)
Mentor: Bob Kraynak (Political Science)
Title: *Cicero, Civic Virtue, and Collapse of the Roman Republic*
Funding: Center for Freedom and Western Civilization

Name: Jackson Gillum 2021 (English; Political Science)
Mentor: Bob Kraynak (Political Science)
Title: *Just War Theory and Practice*
Funding: Center for Freedom and Western Civilization

Name: Kate Maro 2022 (International Relations; Middle Eastern and Islamic Studies)
Mentor: Bruce Rutherford (Political Science)
Title: *"Security" and Military Aid: The Cases of Egypt, Colombia, and El Salvador (1945-present)*
Funding: Lampert Institute for Civic and Global Affairs

Name: Anthony Palazzola 2022 (Political Science; Economics)
Mentor: Barry Shain (Political Science)
Title: *Researching "Revolutionary-era American Pamphlet Literature in Context: A Documentary History, 1764-1776," and "Recent Scholarship Exploring The Federalist, 1787-1788"*
Funding: SOSC Division

Name: Claudia Pilcher 2022 (International Relations)
Mentor: Dominika Koter (Political Science)
Title: *BRAC internship*
Funding: Lampert Institute for Civic and Global Affairs

Name:	Akshara Ramaseshan 2022 (Middle Eastern and Islamic Studies; Applied Math)
Mentor:	Bruce Rutherford (Political Science)
Title:	*Threshold for Revolution: A Model for the Analysis of Revolutionary Success and Failure*
Funding:	Lampert Institute for Civic and Global Affairs

Name:	Fiona Saunders 2022 (Political Science)
Mentor:	Stan Brubaker (Political Science)
Title:	*Academic Freedom in the American University*
Funding:	Center for Freedom and Western Civilization

Name:	Sam Sporn 2022 (Political Science)
Mentor:	Juan Fernando Ibarra Del Cueto (Political Science)
Title:	*When Next Steps Become Transparent: Open Government Partnership*
Funding:	Lampert Institute for Civic and Global Affairs

Department of Sociology and Anthropology

Name:	Keilani Blas 2022 (Sociology)
Mentor:	Janel Benson (Sociology and Anthropology)
Title:	*Mobility Derailed?: How are Recent Lower-Income, First-Generation Selective College Graduates Navigating the COVID-19 Economic Crisis?*
Funding:	SOSC Division

Name:	Eliza Ge 2023 (Anthropology; Art and Art History)
Mentor:	Nancy Ries (Peace and Conflict Studies; Sociology and Anthropology)
Title:	*Managing Uncertainties: Colgate Chinese International Students' (CCISs) Decisions in the Face of COVID-19*
Funding:	SOSC Division

Name:	Alexa Gutierrez 2022 (Sociology)
Mentor:	Janel Benson (Sociology and Anthropology)
Title:	*Mobility Derailed?: How are Recent Lower-Income, First-Generation Selective College Graduates Navigating the COVID-19 Economic Crisis?*
Funding:	SOSC Division

Name:	Matthew Silver 2022 (Anthropology)
Mentor:	Emilio Spadola (Sociology and Anthropology)
Title:	*On Living: a Reevaluation of Being*
Funding:	Center for Freedom and Western Civilization

DIVISION OF UNIVERSITY STUDIES (UNST)

Environmental Studies Program

Name:	Zhaoyang Liu 2023 (Computer Science)
Mentor:	Linda Tseng (Environmental Studies; Physics and Astronomy)
Title:	*Quantitative microbial risk assessment along coastal Los Angeles*
Funding:	UNST Division

Name:	Cecilia Vu 2022 (Environmental Biology)
Mentor:	Linda Tseng (Environmental Studies; Physics and Astronomy)
Title:	*The Adsorption of Atenolol onto Micro-Polystyrene*
Funding:	UNST Division

Name: Cat Wang 2023 (Environmental Studies)
Mentor: Linda Tseng (Environmental Studies; Physics and Astronomy)
Title: *The Adsorption of Atenolol onto Micro-Polystyrene*
Funding: UNST Division

CENTER FOR FREEDOM AND WESTERN CIVILZATION

Name: Blythe Berk 2023 (Political Science)
Mentor: Bruce Rutherford (Political Science)
Title: *A Royal Family with No Family in An Islamic Kingdom Without Islam: How Crown Prince Mohammad Bin Salman is dismantling the foundations of Saudi Arabia*
Funding: Center for Freedom and Western Civilization

Name: Carson Durdel 2022 (History; Political Science)
Mentor: Bob Kraynak (Political Science)
Title: *Cicero, Civic Virtue, and Collapse of the Roman Republic*
Funding: Center for Freedom and Western Civilization

Name: Jackson Gillum 2021 (English; Political Science)
Mentor: Bob Kraynak (Political Science)
Title: *Just War Theory and Practice*
Funding: Center for Freedom and Western Civilization

Name: Madeline Graham 2022 (Arts and Humanities)
Mentor: Carolyn Guile (Art and Art History; Russian and Eurasian Studies)
Title: *Florentine Architecture and Civic Virtue in Renaissance Florence*
Funding: Center for Freedom and Western Civilization

Name: Jillian Holliday 2023 (History; Educational Studies)
Mentor: Xan Karn (History)
Title: *Religious Freedom: The Christian Right's Weapon in the Culture Wars from the 1990s to COVID-19*
Funding: Center for Freedom and Western Civilization

Name: Peter LeRoux 2021 (Economics)
Mentor: Carolyn Guile (Art and Art History; Russian and Eurasian Studies)
Title: *The Presence of Absence: A Study of the Memorialization of 9/11*
Funding: Center for Freedom and Western Civilization

Name: Kevin Reim 2022 (Philosophy; Economics)
Mentor: David Dudrick (Philosophy)
Title: *The Gulag Archipelago: Truth in a Nation of Lies*
Funding: Center for Freedom and Western Civilization

Name: Fiona Saunders 2022 (Political Science)
Mentor: Stan Brubaker (Political Science)
Title: *Academic Freedom in the American University*
Funding: Center for Freedom and Western Civilization

Name: Matthew Silver 2022 (Anthropology)
Mentor: Emilio Spadola (Sociology and Anthropology)
Title: *On Living: A Reevaluation of Being*
Funding: Center for Freedom and Western Civilization

Name: Ian Swain 2022 (Classics)
Mentor: Geoffrey Benson (Classics)
Title: *The Lyric Translation: A Perspective Through Sappho 31*
Funding: Center for Freedom and Western Civilization

Name: Duncan Wieland 2022 (Philosophy)
Mentor: David Dudrick (Philosophy)
Title: *The Metaphysics and the Practical Issues of Identity Politics*
Funding: Center for Freedom and Western Civilization

Name: Jenny Wu 2023 (Theater; Classical Studies)
Mentor: Bill Stull (Classics)
Title: *Reception and Sources of Dante's Divine Comedy*
Funding: Center for Freedom and Western Civilization

LAMPERT INSTITUTE FOR CIVIC AND GLOBAL AFFAIRS

Name: Abigail Flynn 2022 (Middle Eastern and Islamic Studies; Psychological Science)
Mentor: Carrie Keating (Psychological and Brain Sciences)
Title: *Perceptions of Political Charisma: A Cross-Cultural Examination of US and Arab Populations*
Funding: Lampert Institute for Civic and Global Affairs

Name: J.Y. Khoo 2022 (History; Peace and Conflict Studies)
Title: *Internship*
Funding: Lampert Institute for Civic and Global Affairs

Name: Kate Maro 2022 (International Relations; Middle Eastern and Islamic Studies)
Mentor: Bruce Rutherford (Political Science)
Title: *"Security" and Military Aid: The Cases of Egypt, Colombia, and El Salvador (1945-present)*
Funding: Lampert Institute for Civic and Global Affairs

Name: Sarah Neubecker 2022 (Spanish; International Relations)
Title: *Humanitarian Assistance internship in Costa Rica*
Funding: Lampert Institute for Civic and Global Affairs

Name: Claudia Pilcher 2022 (International Relations)
Mentor: Dominika Koter (Political Science)
Title: *BRAC internship*
Funding: Lampert Institute for Civic and Global Affairs

Name: Akshara Ramaseshan 2022 (Middle Eastern and Islamic Studies; Applied Math)
Mentor: Bruce Rutherford (Political Science)
Title: *Threshold for Revolution: A Model for the Analysis of Revolutionary Success and Failure*
Funding: Lampert Institute for Civic and Global Affairs

Name: Sam Sporn 2022 (Political Science)
Mentor: Juan Fernando Ibarra Del Cueto (Political Science)
Title: *When Next Steps Become Transparent: Open Government Partnership*
Funding: Lampert Institute for Civic and Global Affairs

Name: Tori Sternkopf 2022 (International Relations; Psychological Science)
Title: *Internship*
Funding: Lampert Institute for Civic and Global Affairs

UPSTATE INSTITUTE

Name: Juny Ardon 2023 (Educational Studies)
Mentor: Julie Dudrick (Upstate Institute)
Title: *For the Good and Hamilton Area Antiracism Coalition*
Funding: Upstate Institute

Name: Mohammad Asghar 2023 (Computer Science)
Mentor: Julie Dudrick (Upstate Institute)
Title: *Fiver Foundation*
Funding: Upstate Institute

Name: Dana Bamford 2021 (Peace and Conflict Studies)
Mentor: Julie Dudrick (Upstate Institute)
Title: *Adirondack North Country Association, Saranac Lake, New York*
Funding: Upstate Institute

Name: Victoria Basulto 2021 (History; English)
Mentor: Julie Dudrick (Upstate Institute)
Title: *National Abolition Hall of Fame and Museum, Peterboro, New York*
Funding: Upstate Institute

Name: Kelsey Bennett 2022 (Environmental Economics; Philosophy)
Mentor: Julie Dudrick (Upstate Institute)
Title: *Northern Forest Center*
Funding: Upstate Institute

Name: Lloyd Chinn 2022 (Film and Media Studies)
Mentor: Julie Dudrick (Upstate Institute)
Title: *The Impact Project and Chenango Canal Association*
Funding: Upstate Institute

Name: Meg D'Souza 2023 (Sociology)
Mentor: Julie Dudrick (Upstate Institute)
Title: *The Young Scholars Alumni Society - An Alumni Networking Platform for Young Scholars LPP*
Funding: Upstate Institute

Name: Cassie Ferrante 2021 (Natural Sciences)
Mentor: Julie Dudrick (Upstate Institute)
Title: *Cazenovia Preservation Foundation, Inc.*
Funding: Upstate Institute

Name: Samantha Giuntini 2022 (French; Anthropology)
Mentor: Julie Dudrick (Upstate Institute)
Title: *Community Centers in Earlville and Columbus, New York*
Funding: Upstate Institute

Name: Kelly Glenn 2021 (Environmental Studies)
Mentor: Julie Dudrick (Upstate Institute)
Title: *Analyzing Trail Camera Images to Reveal Threats to the Nesting Success of the Common Loon*
Funding: Upstate Institute

Name: Emma Goldstein 2021 (Sociology)
Mentor: Julie Dudrick (Upstate Institute)
Title: *Closing the Distribution Gap: Increasing Access to Dairy in New York State*
Funding: Upstate Institute

Name: Emily Hazen 2022 (Molecular Biology)
Mentor: Julie Dudrick (Upstate Institute)
Title: *Who Will Answer Their Call? How New York State Can Preserve Rural Access to Emergency Medical Services*
Funding: Upstate Institute

Name: Kat Housewright 2023 (History)
Mentor: Julie Dudrick (Upstate Institute)
Title: *An Homage to the Old Depot: Displaying the History of Hamilton's Railroad*
Funding: Upstate Institute

Name: Andrew Jaworski 2022 (Political Science)
Mentor: Julie Dudrick (Upstate Institute)
Title: *Legal Aid*
Funding: Upstate Institute

Name: Lauryn Johnson 2023 (English; Neuroscience)
Mentor: Julie Dudrick (Upstate Institute)
Title: *STEPtember for Suicide Prevention*
Funding: Upstate Institute

Name: Emma Kaminski 2022 (Environmental Geography; Russian and Eurasian Studies)
Mentor: Julie Dudrick (Upstate Institute)
Title: *Lake Placid Land Conservancy Intern*
Funding: Upstate Institute

Name: Dipesh Khati 2022 (Economics)
Mentor: Julie Dudrick (Upstate Institute)
Title: *Dairy farming in Madison County*
Funding: Upstate Institute

Name: Grace Leightheiser 2022 (Environmental Studies; Molecular Biology)
Mentor: Julie Dudrick (Upstate Institute)
Title: *Adirondack Pollinator Project*
Funding: Upstate Institute

Name: Chang Liu 2024 (Undeclared)
Mentor: Julie Dudrick (Upstate Institute)
Title: *Digitization Project for the National Abolition Hall of Fame and Museum*
Funding: Upstate Institute

Name:	Priya Martin 2024 (Philosophy)
Mentor:	Julie Dudrick (Upstate Institute)
Title:	*Chenango United Way, Norwich, New York*
Funding:	Upstate Institute

Name:	Ellie McDermott 2023 (Religion)
Mentor:	Julie Dudrick (Upstate Institute)
Title:	*Kennedy-Willis Center on Down Syndrome at Pathfinder Village, Edmeston, New York*
Funding:	Upstate Institute

Name:	Corey McLaughlin 2024 (Undeclared)
Mentor:	Julie Dudrick (Upstate Institute)
Title:	*Stone Quarry Hill Art Park, Cazenovia, New York*
Funding:	Upstate Institute

Name:	Marisa Modugno 2022 (Peace and Conflict Studies)
Mentor:	Julie Dudrick (Upstate Institute)
Title:	*Chenango County Historical Society*
Funding:	Upstate Institute

Name:	Wael Mohamed 2024 (Undeclared)
Mentor:	Julie Dudrick (Upstate Institute)
Title:	*Village of Hamilton*
Funding:	Upstate Institute

Name:	Asianna Sample 2023 (Art and Art History)
Mentor:	Julie Dudrick (Upstate Institute)
Title:	*Sculpture Space*
Funding:	Upstate Institute

Name:	Emily Schwartz 2021 (Environmental Studies)
Mentor:	Julie Dudrick (Upstate Institute)
Title:	*Road Salt Reduction Research with AdkAction*
Funding:	Upstate Institute

Name:	Elizabeth Shaw 2022 (Anthropology)
Mentor:	Julie Dudrick (Upstate Institute)
Title:	*Vaccine Confidence among Refugees in Utica*
Funding:	Upstate Institute

Name:	Emma Silverman 2023 (Spanish; International Relations)
Mentor:	Julie Dudrick (Upstate Institute)
Title:	*The Center, Utica, New York*
Funding:	Upstate Institute

Name:	Rebecca Sweigart 2023 (Art and Art History)
Mentor:	Julie Dudrick (Upstate Institute)
Title:	*Hudson Headwaters Health Network*
Funding:	Upstate Institute

Name:	Drew Tompkins 2023 (Political Science)
Mentor:	Julie Dudrick (Upstate Institute)
Title:	*Arts at the Palace*
Funding:	Upstate Institute

Name: Ashley Tourtelot 2022 (History)
Mentor: Julie Dudrick (Upstate Institute)
Title: *Exhibiting the Underground Railroad at OCHC*
Funding: Upstate Institute

Name: Yang Yang 2023 (Educational Studies; Asian Studies)
Mentor: Julie Dudrick (Upstate Institute)
Title: *Earlville Opera House*
Funding: Upstate Institute

Name: Jane Zugarek 2022 (Neuroscience; Geography)
Mentor: Julie Dudrick (Upstate Institute)
Title: *Numbers and Needs in Cornhill*
Funding: Upstate Institute

Research Summaries

Research Fellow: Sam Adler (2023)   **Concentration: Physics**

Faculty Mentor: Beth Parks   **Department: Physics and Astronomy**

Title of Project: Source Apportionment of Ugandan Air Quality

Funding Source: Volgenau Wiley Endowed Research Fellowship

Project Summary:

This research focused on accurately measuring air pollution in Uganda. Human and environmental impacts along with particle toxicity and chemical reactivity depend on the composition of particulate matter (PM) in the air. Metallic and organic components are very perilous to human health. PM_{10} is responsible for negative effects on plants, animals, and the climate. In Uganda, the concentration of ambient airborne PM_{10} at various sites has been reported to be about 5 times higher than the World Health Organization (WHO) guidelines. Although all the studies in Uganda recommend long term chemical speciation and source apportionment, the only report published to date was from two measurements at a single site.

Our study attempted to determine spatial and seasonal changes in PM_{10} and identify source contributors. Air samples were collected at three locations with varying levels of urbanization. PIXE analysis was then used to determine the elemental makeup of these samples. The primary interests of this work were validating TXRF, comparing TXRF and PIXE methods, quantifying contamination, and running PMF analysis.

Right: clean filter. Left: filter after collecting particulate matter from roughly the same amount of air that a person would inhale in a day.

While all the data of Ugandan air samples was collected using the PIXE method, this method was first checked by comparing it to the TXRF method which we validated through analysing a known NIST urban dust sample. Element quantities of NIST samples analysed using TXRF came back within roughly 10% of the NIST Certificate of Analysis.

To compare the PIXE and TXRF methods, seven Ugandan air samples were analysed and the SMAPEs and ratios were calculated. After rescaling the PIXE results to reflect the effective filter area, there was roughly a 20% difference in the quantities measured by PIXE and TXRF.

Spectrum showing the contamination which occurs during the TXRF analysis.

Control tests were used to quantify the contamination during cleaning and preparation. They showed that there was no consistency to contamination levels of any elements and that contamination levels were negligible for air quality analysis.

PMF was used to identify source contributions. PMF is a mathematical model which is able to reduce large numbers of variables in complex data sets into source types and source contributors. It is commonly used during water and air analysis to determine the source of pollutants. The data from the PMF analysis was collected during this research; however, further analysis of this data has yet to be completed. This will require researching potential PM source contributors in Uganda and seeing if they match up with our data.

Research Fellow(s): Federico Aguilera Gonzalez (2022)
Chloe Malinowski (2022)

Concentration: Physics
Concentration(s): Astronomy/Physics; Applied Math

Faculty Mentor: Patrick Crotty

Department: Physics and Astronomy

Title of Project: Supermassive Dark Matter

Project Summary:

Dark matter is an unexplained phenomenon that exists in our universe. It was discovered when the observed masses of systems, such as galaxies, were recorded and regarded as too small to explain other observed gravitational effects. In essence, dark matter was hypothesized to explain the missing mass that was required for these observed gravitational effects to occur; however, there is no solid theory for what dark matter actually may be or how it is produced. This summer, we delved into quantum field theory, which explains the existence of particles through different mathematical fields, such as scalar fields or spinor fields. Certain types of particles within the current standard model correspond to different types of field, and particle production is explained mathematically by an excited field. In the model we studied for dark matter, we assume that inflation occurred after the Big Bang, and that it is explained by a particle called an inflaton. Then, we assume that dark matter itself is explained by another particle called a WIMPzilla, where WIMP stands for Weakly Interacting Massive Particle, and the zilla is added as a suffix to mean that these are superheavy versions of WIMPs.

By studying a system of differential equations that relate the expansion of the universe to the proposed existences of the inflation and the WIMPzilla particles, we can model potential inflation scenarios with different initial conditions. Another important quantity which is predicted and measured by this model is the scale factor, which describes the change in proper distance within the universe with respect to linear time, or the time scale we are all familiar with. With time in general as the independent variable of this system of differential equations, we can change the equations from being in terms of linear time to what is called conformal time, which is calculated by scaling linear time with respect to the scale factor. Through Fourier analysis of the system, Bogoliubov coefficients can be calculated that when squared and multiplied by the square of the mode number and integrated over all modes, the amount of dark matter particles produced by a specific model can be calculated. Since there was no analytical solution to the system we were studying, it was numerically calculated through a code written by previous students and added onto by us. On the bottom right is an example of the scale factor calculated with respect to linear time.
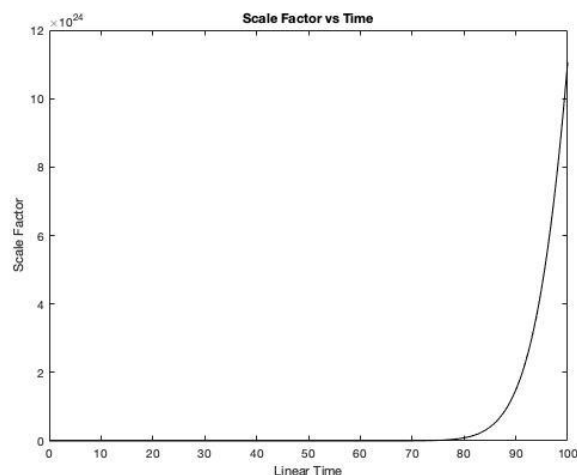
Research Fellow: Giancarlo Arcese (2022)   **Concentration(s): Mathematics; Economics**

Faculty Mentor: Benjamin Anderson   **Department: Economics**

Title of Project: Demand for Sports Attendance during a Pandemic: Evidence from Professional Basketball and Hockey

Funding Source: SOSC Division

Project Summary:

This research project aims to uncover the potential link between COVID-19 infection activity and demand for attendance of NHL and NBA games. Attendance demand is a field of economics research which seeks to discover the determinants of demand for large-scale public events such as professional sports matches. We look to uncover whether the COVID-19 infection rate, measured by the amount of COVID-19 cases and deaths across different counties in the United States, impacted consumers' desire to attend NHL or NBA games. We theorize that increased COVID-19 activity may decrease attendance demand, as the increased infection rate adds the additional cost of potentially contracting the disease by attending a game.

Data for this research is divided into three levels. The first level is daily, county-level data. This includes the FIPS level COVID-19 data collected from the *New York Times*, as well as weather data collected from NOAA Climate Data Online, which is used to control for the weather's effect on attendance demand. The second level is game-level data that includes attendance data for the NHL and NBA collected from Sports Reference, and betting data collected from Odds Portal to be used as a control for expected game quality. The third level is team-level data, which includes data specific to each NHL and NBA team per season, which allows for control over the teams' performance and skill and how that may affect attendance.

In order to prepare the data for econometric analysis, the COVID-19 data was aggregated to both a CSA and CBSA level, each generating a separate set of data. Next, the weather and betting data were merged into these sheets. Finally, the team-level data was added, producing a final set of spreadsheets containing all levels of data together. The data begins in the NHL/NBA 2015-2016 season and ends in the beginning of March of 2020 when the NHL/NBA sports season was suspended. All data collection, cleaning, and merging was done in Excel and Stata.

The next step for the project involves econometric analysis of the relationship between COVID-19 incidence and game attendance. The dependent variable is game-level attendance measured either as a percent of stadium capacity or in natural logs. The explanatory data would be the number of COVID-19 cases or deaths within the CSA or CBSA. The independent controls include the weather conditions on the day of the game, the betting information, and the team-level measures of quality and performance. A two-way fixed effect model is to be employed, allowing us to control for team-season fixed effects. A preliminary model would take the following form:

$$Attendance_{it} = CovidData_{it} + WeatherData_{it} + BettingData_{it} + TeamData_{it} + u_{it}$$

where $u_{it} = \varepsilon_i + \lambda_t + v_{it}$. Preliminary estimations for the NBA, reported in Table 1, indicate that fan attendance did not respond to the local incidence of COVID-19. However, fan attendance significantly decreased for teams located in CBSAs as the number of local deaths reported increased.

Table 1: NBA Attendance and COVID-19

	Attendance (% of capacity)		Attendance (natural log)	
	(1)	(2)	(3)	(4)
Local COVID Cases	-0.000170		-0.000293	
	(0.000362)		(0.000321)	
Local COVID Deaths		-0.104***		-0.106***
		(0.0121)		(0.0136)
Home Win Percentage	0.228***	0.228***	0.267***	0.267***
	(0.0686)	(0.0685)	(0.0709)	(0.0709)
Away Win Percentage	0.0685***	0.0688***	0.0781***	0.0784***
	(0.0126)	(0.0126)	(0.0146)	(0.0146)
Average Temperature	-4.84e-05	-4.88e-05	-7.58e-05	-7.63e-05
	(0.000128)	(0.000128)	(0.000143)	(0.000143)
Constant	0.806***	0.806***	9.617***	9.616***
	(0.0426)	(0.0426)	(0.0487)	(0.0486)
Observations	5,906	5,906	5,906	5,906
R-squared	0.138	0.138	0.134	0.134
Number of Teams	29	29	29	29
Team FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Month FE	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Research Fellow(s): **Ziad Attia(2023)**
Aziz Zafar (2023)

Concentration: **Applied Math**
Concentration(s): **Biology; Applied Math**

Faculty Mentor: **Ahmet Ay**

Department: **Biology; Mathematics**

Title of Project: **Machine learning-based risk factor analysis and prevalence prediction of intestinal parasitic infections using epidemiological survey data**

Project Summary:

Background: Previous epidemiological studies have examined the prevalence and risk factors for a variety of parasitic illnesses, including protozoan and soil-transmitted helminth (STH, e.g., hookworms and roundworms) infections. Despite advancements in machine learning for data analysis, the majority of these studies use traditional logistic regression to identify significant risk factors.

Methods: In this study, we used data from a survey of 54 risk factors for intestinal parasitosis in 954 Ethiopian school children. We investigated whether machine learning approaches can supplement traditional logistic regression in identifying intestinal parasite infection risk factors.

We used feature selection methods such as InfoGain (IG), ReliefF (ReF), Joint MutualInformation (JMI), and Minimum Redundancy Maximum Relevance (MRMR). Additionally, we predicted children's parasitic infection status using classifiers such as Logistic Regression (LR), Support Vector Machines (SVM), Random Forests (RF) and XGBoost (XGB), and compared their accuracy and area under the receiver operating characteristic curve (AUROC) scores. For optimal model training, we performed tenfold cross-validation and tuned the classifier hyperparameters. We balanced our dataset using the Synthetic Minority Oversampling (SMOTE) method. Additionally, we used association rule learning to establish a link between risk factors and parasitic infections.

Key Findings: Our study demonstrated that machine learning could be used in conjunction with logistic regression. Using machine learning, we developed models that accurately predicted four parasitic infections: any parasitic infection at 84.7% accuracy, helminth infection at 89.3%, STH infection at 95.9%, and protozoan infection at 95.0%. The XGBoost (XGB) classifier achieved the highest accuracy when all risk factors were considered. The best predictors of infection were socioeconomic, demographic, and hematological characteristics. Despite its mitigating effect on STH infections, mass deworming was also associated with increased protozoan infections.

Conclusions: We demonstrated that feature selection and association rule learning are useful strategies for detecting risk factors for parasite infection. Additionally, we showed that advanced classifiers might be utilized to predict children's parasitic infection status. When combined with standard logistic regression models, machine learning techniques can identify novel risk factors and predict infection risk.

Figures:
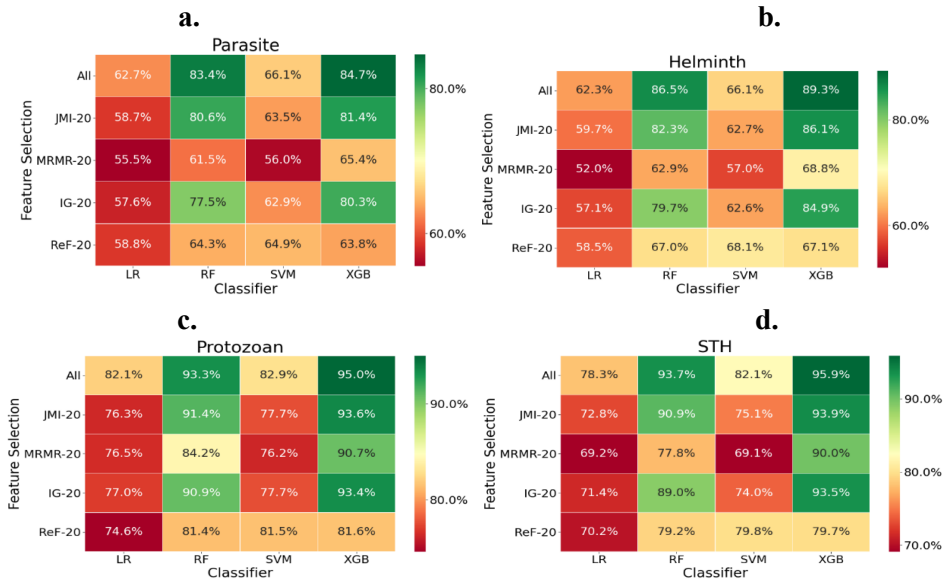
Figure 1. Heatmaps illustrating the accuracy scores for different feature selection and classifier combinations; for infection by (a) any parasite, (b) any helminth, (c) protozoan, and (d) STH. Green indicates a high accuracy, while red indicates a low accuracy. Feature selection include All features, or top 20 features selected through Joint Mutual Information (JMI-20), Minimum Redundancy Maximum Relevance (MRMR-20), InfoGain (IG-20) and ReliefF (ReF-20). Classifiers include Logistic Regression (LR), Random Forests (RF), Support Vector Machines (SVM), and XGBoost (XGB).

Research Fellow: Richard Baker (2023)   **Concentration(s): Neuroscience; Psychological Science**

Faculty Mentor: Jason Meyers   **Department(s): Biology; Neuroscience**

Title of Project: Cavefish vs Surface fish: Does blindness increase sensitivity to the environment

Funding Source: NASC Division

Project Summary:

Most fish use hair cells to sense movement in the water. The hair cells found in fish are analogous to the ones found in the human's inner ear and aid in hearing. However, unlike humans, the hair cells found in fish can be regenerated whereas damage to the inner ear can result in permanent hearing loss. Research around hair cells aims to discover how fish are capable of regeneration and whether those mechanisms can be expressed in humans. Hair cells in the lateral line can be found within structures called neuromasts. Neuromasts are also composed of support cells, which surround the hair cells, and mantle cells which line the structure. Neuromasts make up the lateral line system which stretches throughout the body of fish.

The Mexican tetra is a species of fish that can be found in two variants: the cavefish and the surface fish. The cavefish, as the name implies, live in pitch black caves and have evolved lacking eyes thus rendering them blind. On the other hand, the surface fish have fully functioning eyes and live outside of the Mexican caves. The goal of my research was to determine whether the cavefish shows a difference in hair cell/neuromast count when compared to the surface fish to compensate for its lack of eyes. My hypothesis was that cavefish would show a more extensive lateral line and that difference would be reflected in its behaviors. In other words, it would be more sensitive to movement in water.

Cavefish and surface fish were bred together to form a hybrid. I stained and imaged the hair cells and support cells of the cavefish, surface fish and their hybrid to find differences in neuromast size and count. My results suggest that cavefish and hybrids had more neuromasts when compared to the surface fish. This could provide evidence for cavefish and hybrids being more sensitive to movement. I also designed a behavioral system that ran water using a motor to see how each fish group oriented themselves. Cavefish and hybrids were expected to orient themselves against the current on lower intensities when compared to the surface fish. A couple practice trials with the surface fish and hybrid confirmed that the fish would move against the current when put in the behavioral system. In the future, I plan to run the system with all three fish groups and record how long each takes to orient at varying intensities. This could show how neuromast count may affect the behavior of the fish. I believe that the cavefish and hybrids will orient at lower intensities when compared to the surface fish.

Fig. 1. A picture of my behavioral system with the motor at the top and lanes at the bottom.

Research Fellow: Dana Bamford (2021) **Concentration: Peace and Conflict Studies**

Faculty Mentor: Julie Dudrick **Department: Upstate Institute**

Title of Project: Adirondack North Country Association, Saranac Lake, New York

Project Summary:

The Adirondack North Country Association (ANCA) is a non-profit headquartered in Saranac Lake but serving the northernmost 14 counties in the state of New York. Their mission is to build prosperity throughout the countries they serve, and they do this with three distinct areas of focus: food systems, energy economy, and entrepreneurial economy. In terms of food systems, ANCA is working to reduce food insecurity and promote sustainable, economic growth through involvement with projects like the Drive for 25 Farm to School Grant and the Hub on the Hill. On the energy economy side, ANCA assists local communities through the process of investing in and acquiring clean energy technology. The clean energy program is especially important in the North Country, as it holds a significant portion of New York's renewable energy capacity.

The entrepreneurial economy branch of ANCA, working to create and maintain jobs, as well as reduce inequality, is where I spent most of my time this summer. ANCA's Center for Businesses in Transition (CBIT) helps retiring business owners with their transition plans by providing resources, accessing capital and finding a successor, and helps aspiring entrepreneurs purchase existing businesses and learn more about ownership opportunities. With such broad reach throughout the North County community, CBIT is able to pair entrepreneurs with retiring owners in order to keep local businesses alive and flourishing.

I conducted an overall evaluation of the CBIT program by compiling surveys. The goal of these surveys was to gain insight into the successes and challenges of the program. I drafted three surveys, one for aspiring entrepreneurs, one for retiring business owners, and one for the community liaisons. Because the CBIT program is largely grant-funded, information collected from the surveys is beneficial in finding continued funding.

CBIT is a great option for continued economic prosperity and has helped many established businesses to prosper with new owners. Economic development organizations that work on transitions are incredibly relevant in areas like the Adirondacks, which are highly impacted by the "silver tsunami." As the population ages, more and more business owners will look to retire and will need the services that CBIT has to offer.

Research Fellow: Ian Bania (2021)   **Concentration: Astronomy/Physics**

Faculty Mentor: Cosmin Ilie   **Department: Physics and Astronomy**

Title of Project: Dark Matter in Population III Stars

Funding Source: NASC Division

Project Summary:

After scattering off nucleons, Dark matter (DM) particles may lose enough energy to become gravitationally bound to an astrophysical object. In order to become captured in this manner, super heavy DM may need to experience a number of successive scattering events. Once captured within a star, it is possible for DM to continue to upscatter off of nucleons and gain enough energy to escape the potential well in a process known as evaporation. In the case of captured self-annihilating DM, it then becomes possible for heating from DM annihilations to be a significant source of energy production for Population III (Pop. III) stars. By implementing recently developed formalism of multiscatter capture in the stellar evolution code MESA, I model how Pop. III stars react to heating from captured DM. Furthermore, the local DM densities in the halos within which Pop. III stars form can be significantly increased by the process known as adiabatic contraction (AC). Previous work has explored the ability of DM annihilation from an adiabatically contracted halo to provide an additional heating source, altering the evolutionary outcomes and potentially creating a new class of object known as a Dark star. In this work, I outline a more thorough treatment of DM heating in MESA that considers the effects from limited adiabatic contraction (i.e. where DM is removed from the halo as it annihilates), single and multiscatter capture, and DM evaporation.

Pop. III stars represent the first generation of stars to form in the universe, and are expected to have higher masses and lower metallicities than later stellar generations. In the standard model of Pop. III star formation, protostars begin to coalesce and undergo collapse as governed by the virial theorem inside Dark matter halos of up to 10^6 $M_\odot$. These are often called minihalos, in contrast to the galactic DM halos of our current epoch. Material will continue to accrete as local gas infalls until the core of the protostar reaches a critical temperature of roughly $\sim 10^8$ K when hydrogen burning begins.

In the simplest picture, we can assume Pop. III stars form at the center of their host minihalo. Here, the volume that the star occupies will overlap with the highest Dark matter densities at the center of the halo, allowing for heating rates from the annihilation of Dark matter to be significant enough to alter the evolutionary course of the star. This process will be dictated by local Dark matter densities, the DM-nucleon cross section, the DM pair annihilation cross section, and DM particle mass. Furthermore, high densities provide a ripe environment where transiting DM may collide with component particles of the star and become gravitationally captured. The process of DM capture may further augment DM heating of a Pop. III star. By modifying MESA, a state of the art, 1-D stellar evolution package, this entire process can be modeled self consistently while considering all the relevant stellar physics.

Research Fellow(s): Caroline Barnhart (2023)   Concentration(s): Environmental Studies; Biology
Sophie Pedzich (2024)   Concentration: Undeclared

Faculty Mentor: Tim McCay   Department(s): Biology; Environmental Studies

Title of Project: Distribution and Effects of Invasive Jumping Worms in New York State

Project Summary:

This summer we spent time investigating the spread and impact of three species of invasive pheretimoid earthworms: *Amynthas agrestis, Amynthas tokioensis,* and *Metaphire hilgendorfi*. Commonly known as jumping worms, in the field, they can be easily identified by their greyish color, reproductive band that completely encircles the body, and distinctive snake-like thrashing motion. These worms change soil structure by digesting leaf litter and leaving granular soil castings behind. When invading areas in high abundance, the change in soil structure increases water percolation rates, erosion, and makes it harder for plants with shallow roots to take hold. We sought to better understand the effects of jumping worms on forest ecosystems, speak to community members directly affected, and document invaded areas in the Adirondack and Catskill mountains.

We identified locations within the Adirondack Park that are being invaded by jumping worms. We found sites to search at trailheads, fishing access points, public parks, and privately owned nature centers. After identifying over two dozen sites in both the Lake George and Old Forge regions, we proceeded to travel between sites and search for one person hour at each site for jumping worms. We used a hand searching and sorting method to cover a large area at each site, and collected any worms we found to be processed in the lab and then identified. Of the sites that we searched for jumping worms, about half of the locations had either a beginning or well-established population of jumping worms, which leads us to believe that the invasion front has pushed well into the Adirondack park.

Additionally, in collaboration with SUNY Cortland and Yale University, we participated in the Catskills Project, an experiment seeking to assess the effects of white-tailed deer invasion and jumping worm abundance on perennial plant growth. In forest areas with deer exclusion sites and varying levels of jumping worm invasion, we planted transects of ferns, goldenrod, oak saplings, and bottlebrush both in and out of the excluded areas to be measured over time. In these sites, we also sampled earthworms and collected soil cores to be identified and analyzed. Here we also installed lysimeters, large glass tubes with porous, ceramic bottoms that when suction is applied, would collect ground water beneath the root zone for nutrient analysis. The large scale and multifaceted nature of this experiment should enable us to better understand how multiple factors (deer, earthworms) interact to affect native flora.

We also inspected twenty gardens owned by Syracuse Master Gardeners Extension Volunteers to identify which properties were inhabited by jumping worms. By using hand searching techniques, we found that the majority of gardeners did have jumping worms present. Following the discovery of worms at a garden, we would talk with gardeners about mitigation options.

Our summer culminated in the development of an experiment to better understand how jumping worm diversity, abundance and food availability affect soil-water quality. We established microcosms that will contain combinations of the three different species of jumping worms under different conditions: abundant food supply and limited food supply. We expect this experiment to run through the fall and will collect soil-water weekly.

Research Fellow: Victoria Basulto (2021)   **Concentration(s):** History; English

Faculty Mentor: Julie Dudrick   **Department:** Upstate Institute

Title of Project: National Abolition Hall of Fame and Museum, Peterboro, New York

Funding Source: Upstate Institute

Project Summary:

This summer, I had the privilege of working with the National Abolition Hall of Fame and Museum (NAHOF). The organization's mission is to "honor antislavery abolitionists, their work to end slavery, and the legacy of that struggle, and strives to complete the second and ongoing abolition- the moral conviction to end racism." NAHOF works to fulfill its mission by organizing educational programming on abolitionists, anti-racism, local history, and civil rights. The organization consistently brings in expert speakers to give presentations on various topics pertaining to history and anti-racism work. Likewise, the organization's physical space, located on the top floor of the Smithfield Community Center, welcomes visitors interested in learning more about abolitionist history. NAHOF serves the local community by providing spaces for learning and engagement. However, part of my project's responsibility this summer was to help NAHOF expand its reach to serve any interested individual, regardless of location, by making educational programs available online.

The onset of COVID-19 made NAHOF aware that it needed to provide ease of access to its educational resources online if someone could not visit the museum in person. Therefore, I helped NAHOF to archive and digitize all of the Peterboro Heritage Events that NAHOF had in storage, helping them fulfill their archiving requirements as a non-profit. The digitization process allows NAHOF to have educational videos easily accessible online as a resource. This includes providing subtitles for the programs, editing the raw footage for better viewing, and finding an accessible place to store them online. I completed the full digitization of seventy programs and then transcribed and edited several of them.

I also reached out to potential presenters for the Black History Matters 2022 program, premiering in February. In my time as an Upstate Institute fellow for NAHOF this past year, I organized, recorded, and edited the video programs for the Black History Matters 2021 program. The program met with much success, and I was asked to begin preparations for the second installment. I have now produced a draft list of presenters and am constantly conversing with several as we finalize presentation topics and schedules. Both of these projects will have long-lasting effects. They will help NAHOF with its organization, produce new content to keep the public engaged with abolitionist history, make it easier to provide students and scholars with educational resources online, and ensure that previous programs are maximized.

My time with NAHOF will continue beyond this summer as well, as I have the privilege to serve on NAHOF's Cabinet of Freedom and was recently awarded a lifetime membership to the organization. I hope to use my newfound skills in my graduate studies to help NAHOF expand its research capacity and connections with the local community, students, and researchers alike.

Research Fellow(s): Sofia Beaufrand (2022)   **Concentration(s): Neuroscience; Spanish**
Isabel Gephart (2022)   **Concentration(s): Applied Math; Neuroscience**
Tori Gobo (2022)   **Concentration: Neuroscience**
Lily Sheets (2023)   **Concentration: Neuroscience**

Faculty Mentor: Bruce Hansen   **Department: Psychological and Brain Sciences**

Title of Project: Developing a brain supervised sparse-coding neural network

Project Summary:

When immersed in any visual environment, our brains extract visual information in a way that enables a variety of intelligent behaviors. Depending on the goal of any given behavior, the information that is extracted is differentially coded across a large population of neurons. What this means is that the visual brain does not simply create an internal representation (e.g., a mental picture) based exclusively on the environment, but instead creates a representation that best matches the behavioral goals of the person. Our summer project sought to reconstruct the brain's visual representations under different behavioral goals.

To accomplish this, we built on an existing sparse-coding neural network that learns image structure in a way that mimics the coding principles of the visual brain (e.g., neurons selective for edge structure of different sizes and orientations -- i.e., nonlinear filters). The operations of this network derive the filters based on image structure, and are therefore not as brain-driven as they could be. We explored different ways to incorporate previously collected EEG data into the existing network in order to produce a more biologically driven approach for finding which filters are most important in processing scenes. Specifically, we wanted to alter the network to reconstruct images based on what the brain was doing when a participant viewed an image. To do this, we incorporated an error term into the code that compares the reconstruction of the image to the relevant EEG data. Once the error was calculated we explored different approaches to amplify filters that were successfully reconstructing the brain data, and reduce ones that were not. The ultimate goal is to compare these brain-driven reconstructions with the sparse reconstructions that have previously been published. Our results were promising and showed that it is important to incorporate the brain data when doing these types of investigations, but more work is needed to confirm these findings.
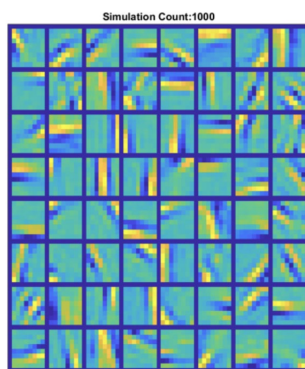
Figure 1: Examples of filters found from our preliminary work
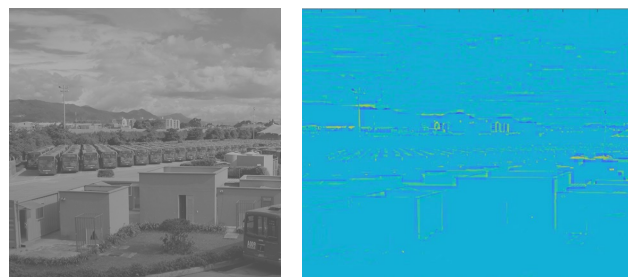
Figure 2: Example of a sample image and an image produced by our brain-supervised sparse-coding neural network

Research Fellow: Davi Bendavid (2022)   **Concentration(s): Biology; Geography**

Faculty Mentor: Mike Loranty   **Department: Geography**

Title of Project: Shrubs compensate for tree leaf area index (LAI) variation and influence vegetation indices in post-fire Siberian larch forests

Project Summary:

Ongoing global climate change is causing rapid vegetation shifts in Arctic boreal forests. Plant canopies act as a primary interface between the atmosphere and the biosphere, facilitating the exchange of carbon, oxygen, and water. Following fire in Siberian larch forests, there can be significant variation in tree density across a single burn perimeter. Understanding the relationship between tree density and leaf area can be useful for ecological modeling, estimating water and carbon dynamics, and improving remote sensing of vegetation. Leaf area index (LAI), a unitless measure of plant canopy cover defined as total leaf area per unit ground area, is a useful metric for characterizing variation in plant canopies. In this study, we calculate LAI using allometry and hemispherical photographs for 26 larch stands that regenerated at varying densities following a single fire that burned in 1940. We compare LAI values estimated using the two methods, investigate relationships between tree and shrub leaf area, and examine the relationships between LAI and two satellite-derived indices, the Normalized Difference and Enhanced Vegetation Indices (NDVI and EVI, respectively). We find that across the density gradient, there is significant variation in tree LAI and shrub LAI individually, but no significant variation in total tree-shrub LAI, as well as a significant negative relationship between tree LAI and shrub LAI. Comparing LAI values to NDVI and EVI data from PlanetScope and Landsat imagery, we find significant positive relationships between shrub LAI and both NDVI and EVI, and a negative significant relationship between tree LAI and Landsat EVI. These findings suggest that in less dense forest stands, shrubs compensate for fewer trees, creating a plant canopy of consistent total LAI across the density gradient. Additionally, our findings suggest that shrub canopies have a significant influence on both NDVI and EVI, and that these indices are more closely related to shrub canopies than to either tree canopies or total tree-shrub canopies. As fire frequency and severity increase with climate change throughout the terrestrial Arctic, understanding the dynamics of plant canopies across fire-impacted boreal forests will become increasingly important.

Research Fellow: Kelsey Bennett (2022)   **Concentration(s): Environmental Economics; Philosophy**

Faculty Mentor: Julie Dudrick   **Department: Upstate Institute**

Title of Project: Northern Forest Center

Funding Source: Upstate Institute

Project Summary:

This summer I am working for the Northern Forest Center, which is based out of Concord, New Hampshire. The mission of the Northern Forest Center is "to create bold possibilities that give rise to vibrant Northern Forest communities." The Northern Forest encompasses northern Maine, New Hampshire, Vermont, and New York. The Center works to strengthen communities, advance rural economies, and provide leadership in the Northern Forest. I was introduced to the Northern Forest Center in the spring 2020 semester as I conducted a comparative analysis between the Northern Forest Center's Attracting New Residents: A Strategy for Adirondack Residents and its Communities and similar national and international models under the guidance of Professor Ellen Kraly. I found that many communities around the world are facing a similar problem where too many young people are leaving rural areas and heading into cities.

This summer, I continue to work with the Northern Forest Center on an implementation of the Attracting New Residents Strategy and a valuation of the recreation assets in rural communities within the Northern Forest. The goal of this project is to create a methodology for rural communities to use to value their recreation without needing the assistance of an expensive outside company. Ideally, this project can be recreated by other small towns with basic assistance and guidance from the Northern Forest Center. My project focuses on Gorham, New Hampshire as a case study to measure the impact of recreation on the community. The goal for Gorham is to determine the income and jobs being brought into the region's economy. My work demonstrates that recreation is an essential component of the Gorham economy and that grant money put towards recreation assets would help bolster the long-term community vitality.

I designed a survey to produce data on how much visitors are spending while in Gorham, how residents perceived tourism, and how both groups value recreation assets. I distributed the survey throughout Gorham both virtually and in-person, and received 990 responses from a variety of individuals including permanent residents, second homeowners, and visitors. I analyzed the survey results to determine the total economic impact for the community in terms of income and jobs brought into the area. Additionally, I examined how the increased tourism negatively results in a housing premium or rise in housing prices and environmental problems such as a faster rates of trail degradation. This experience was a chance for me to think critically about the impacts of recreation on a community and how to balance economic prosperity with environmental health and justice.

Research Fellow: Blythe Berk (2023)   **Concentration: Political Science**

Faculty Mentor: Bruce Rutherford   **Department: Political Science**

Title of Project: A Royal Family With No Family in An Islamic Kingdom Without Islam: How Crown Prince Mohammad Bin Salman is dismantling the foundations of Saudi Arabia

Project Summary:

Behind every strong state are strong relationships and building blocks that keep it standing. For the Kingdom of Saudi Arabia, an alliance between the followers of Muhammad Ibn Abd al Wahhab-Muhammad, himself, died in the 18th century- and the close-knit Al-Saud family, has been the glue that has kept the same royal family and religious code in place today. However, with a new generation in power, everything has changed. My paper follows the ruling style and reforms of Mohammad Bin Salman or MBS, the 35-year-old Crown Prince of Saudi Arabia and now de-facto king alongside his father King Salman. While MBS' predecessors kept the state stable, they left Saudi Arabia years behind the outside world. There are five main crises I point to in Saudi Arabia today: a large youthful population, inefficient education system, economic dependence on oil, religious extremism, and a corrupt ruling family. MBS has set out to fix these problems, giving each its own sparkly plan of action as advised by his international consulting firms. However, by doing so, he has also torn his family apart and turned religious institutions into rubber stamps. Through my analysis, I weigh the benefits of MBS' very necessary reforms, such as the mass housing initiative and public investment fund, against his consolidation of power behind the scenes. Because of MBS' individual ruling style, he has been able to alleviate many of the social, political, and economic problems that the traditional regime would not have come to a consensus on. That being said, his ambitious reform plan and the intensified repression needed to implement it have caused Saudis both on the left and right to be alienated and targeted. When the buzz around Mohammad Bin Salman and his non-traditional leadership style fizzles out, I ultimately argue that Saudi Arabia will be left with a completely new state structure and an angry, frustrated population on all sides.

Jendral Badui, Ibn Saud, Prince Husein, Muhammad bin Abdul Wahab, Sir Percy Cox

The relationship between the Wahhabists and Al Saud family laid the foundation for Saudi Arabia. Pictured center is Muhammad Ibn Abd al Wahhab and behind the books to his right is Ibn Saud.

Research Fellow: Seth Bingham (2022)   **Concentration: Chemistry**

Faculty Mentor: Jason Keith   **Department: Chemistry**

Title of Project: Mechanistic Investigation of Transition Metal Catalysis with Density Functional Theory

Funding Source: Miller-Cochran Fund

Project Summary:

Our research sought to determine the mechanism of catalysis of a reversible iron catalyzed reduction/oxidation of a ketones and alcohols with the direction of the reaction governed by Le Chatelier's Principle (Figure 1). This fairly simple reaction effectively transfers two hydrogen atoms and two electrons (a proton and a hydride) from one molecule to the other, and significant application in large scale process chemistry where the use of compressed gases and external oxidants is

Figure 1: Iron based catalyst with varying ligands

dangerous. We examined the reduction of acetophenone to phenyl ethanol with concurrent conversion of isopropyl alcohol to acetone as model substrates for investigation of the mechanism of catalysis. Our investigation of this catalyst used an application of quantum mechanical electronic structure theory called Density Functional Theory (DFT) to calculate the energy of various points along the catalytic cycle. Thus, we mapped out the reaction coordinate on the potential energy surface for five variations of the catalyst. The gap in energy between the highest and lowest point in the cycle ($\Delta G^{\ddagger}$) would determine the rate of each reaction, and therefore calculate relative rates of reaction for all five catalyst variations. We are in the process of comparing our results with experimental data from our collaborators in Prof. Timothy W. Funk's laboratory at Gettysburg College.

In the calculated mechanism the ketone on the five membered ring participates in the chemistry directly, while the rest of the ligand only affects electron density on the iron. Electron withdrawing groups reduced reaction rate while electron donating groups increased reaction rate. While our mechanism and overall reaction rates seemed to align with the experimental data, we have so far been unable to reproduce the relatively small differences in reaction rate between the catalysts, the magnitude of the $\Delta\Delta G^{\ddagger}$s is simply beyond our current computational precision. The Funk group also provided data on the observed kinetic isotope effect (KIE). Performing the same reaction with deuterated isopropyl alcohol resulted in a slower reaction due to the slower transfer of deuterium atoms as compared to hydrogen. This suggests that proton/hydride transfer is a rate limiting step in the reaction, and agrees with our proposed mechanism, and our results have directly suggested further experimentation with partially deuterated substrates to verify our results. In this way our computational insight works synergistically with our experimental collaborators to elucidate chemical reaction mechanisms.

Research Fellow(s): Zachary Birenbaum (2022)
Hieu Do (2023)

Concentration: Computer Science
Concentration(s): COSC; Applied Math

Faculty Mentor: Ahmet Ay

Department(s): Biology; Mathematics

Title of Project: SealNet: A facial recognition software for seals

Project Summary:

Individual identification of harbor seals is critical for researchers because it enables them to collect data on population size, migration habits, and social structures. Previously used methods for marine animal identification, such as satellite bands and tagging devices, have been found to be unethical, invasive, and expensive. Face recognition software has recently emerged as a more cost-effective and ethical alternative as a result of these shortcomings. Due to the lack of available recognition software for harbor seals, this study aims to contribute a comprehensive pipeline that automates the process of seal identification. Our goal is to create a suite of software (SealNet) that field researchers can use to aid in their study of harbor seals. We began by creating a graphical user interface (GUI) for automating the cropping and alignment of seal faces within raw images of seal groups. This graphical user interface was written in C++ and is based on the imglab tool included in the dlib machine learning library. Following that, we trained a high-performance automatic face detector with 85% precision and 87% recall rates. This detector was then integrated as a core component of the aforementioned graphical user interface. Finally, at the heart of SealNet, we proposed a deep convolutional neural network (CNN) capable of automating seal face recognition on small datasets. Our model is based on PrimNet, a similar project that was successful in identifying primate individuals with a high degree of accuracy (Deb *et al.*, 2018). Preliminary testing results indicate that our improved model consistently achieves classification accuracies of over 85%. Our next steps will be to iteratively add more training data to our CNN by identifying new individuals using the existing model and then retraining the model with the new data following manual inspection. This iterative process will eventually result in the development of an extremely robust recognition model for harbor seals.
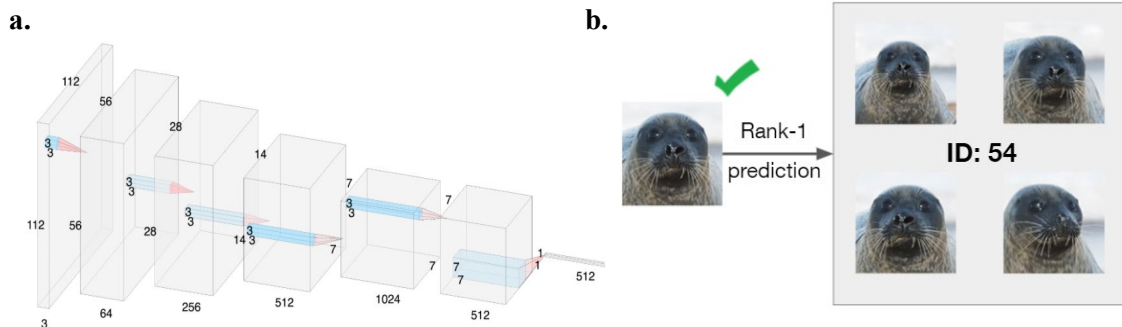
Figure 1: **The architecture of the SealNet CNN and representation of SealNet's prediction for an individual.** (a.) Illustration of the SealNet's CNN architecture that is used to identify individual seals. (b.) A representation of the SealNet's output. SealNet's database contains labels for each individual seal. The photo on the left is a 'probe' that was kept separate from SealNet face prediction software, whereas the photos on the right are those that correspond to the probe's predicted class label.

1. Deb, D., Wiper, S., Gong, S., Shi, Y., Tymoszek, C., Fletcher, A. and Jain, A.K., 2018, October. Face recognition: Primates in the wild. In *2018 IEEE 9th International Conference on Biometrics Theory, Applications and Systems (BTAS)* (pp. 1-10). IEEE.

Research Fellow: Harrison Blume (2022) **Concentration: Biochemistry**

Faculty Mentor: Jacob Goldberg **Department: Chemistry**

Title of Project: Chemical Probes for Detecting Zinc Ions in the Synapse

Funding Source: Summer Undergraduate Research Fund (SURF)

Project Summary:

Zinc ions play important, but poorly understood roles in many neurological processes, including sensory perception, learning, and memory formation. The development of new tools to visualize and track zinc ions in the brain will enable neuroscientists to better understand these complex systems. This project entails the synthesis of chemical probes that can be deployed into synapses, the communication junctions between neurons, to study the release of zinc ions during neurotransmission. In particular, I will attach a small molecule that fluoresces exclusively in the presence of zinc ions to Conantokin-G, a peptide containing 17 amino acids found in some snails that selectively targets the NMDA receptor.

The Conantokin-G peptide contains multiple residues of γ-carboxyglutamic acid, which is an unusual and expensive amino acid. This summer, I began the synthesis of this amino acid from inexpensive starting materials so that we can easily produce large amounts of the peptide. In related work, I also prepared multiple sensor-peptide conjugates using computationally designed peptide sequences to target the NMDA receptor. Pilot experiments with these purified compounds are currently underway. Ultimately, we hope that these tools will be helpful in understanding the fundamental inorganic biochemistry of the brain.
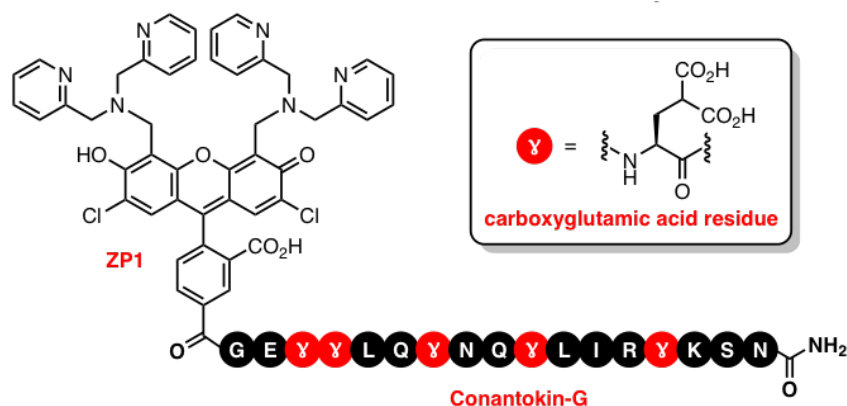
Figure 1: A peptide-sensor conjugate for visualizing zinc ions at NMDA receptors.

Research Fellow(s): Amelia Bohan (2023)   **Concentration: Psychological Science**
Sarah Harris (2023)   **Concentration: Psychological Science**

Faculty Mentor: Lauren Philbrook   **Department: Psychological and Brain Sciences**

Title of Project: Predictors and Outcomes of Preschool-Aged Sleep

Project Summary:

Sleep duration and quality are both predictors of various aspects of child development, including emotional regulation and cognitive outcomes (El-Sheikh, et al., 2019). There has been little prior research concerning how observed parenting is associated with sleep and developmental outcomes in preschool-aged children. Our research explored this potential association through both objective and subjective measures. Utilizing an Actigraph wristwatch, a Fitbit-like device, we were able to gather important information about child sleep quality, such as average wake after sleep onset (WASO) and sleep efficiency. WASO is the number of minutes the child spends awake after falling asleep throughout the duration of the night, and sleep efficiency is the amount of time spent asleep compared to the total time spent in bed. In order to measure the child's executive functioning and cognitive outcomes, two iPad tasks were administered to the children: the Flanker Task and the Dimensional Change Card Sort Task. Furthermore, we asked families to record one night of their child's bedtime routine which we then behaviorally coded, focusing on caregiver practices and environmental variables occurring in each 30 second segment of the video. Examples of these caregiver practices are close physical contact or quiet activities, and examples of environmental variables include ambient arousing noise or light at bedtime. We coupled this measurement with a caregiver survey reporting on variables such as child temperament, home environment, and neighborhood characteristics.

We found several statistically significant bivariate correlations indicating that caregiver practices, environmental variables, child temperament, and bedtime routine structure were associated with child cognitive and sleep outcomes. Specifically, maternal presence and quiet activities were positively associated with child sleep time and sleep efficiency, suggesting that these practices encourage emotional security and acclimate children to a less arousing environment prior to sleep. We also observed interactions between caregiver practices and child temperament on sleep outcomes; for example, caregiver-reported low child energy coupled with low caregiver arousal predicted the most total sleep minutes. This highlights the important bidirectionality between caregiver and child when it comes to child sleep outcomes.

Several interesting correlations were found between environmental variables, such as bedtime organization and TV presence and cognitive, emotional outcomes. In particular, children with more organized bedtime routines scored higher on both cognitive tasks (Flanker and DCCS tasks) as well as caregiver-reported emotional regulation. Negative correlations with TV reveal a different trend; children with more TV in their bedtime routines scored lower on both cognitive tests as well as for emotion regulation. Finally, correlations between child temperament and cognitive outcomes demonstrate the importance of patience and self-regulation during cognitive tasks, as well as during emotion regulation.

Correlations Between Environmental Factors and Bedtime Organization
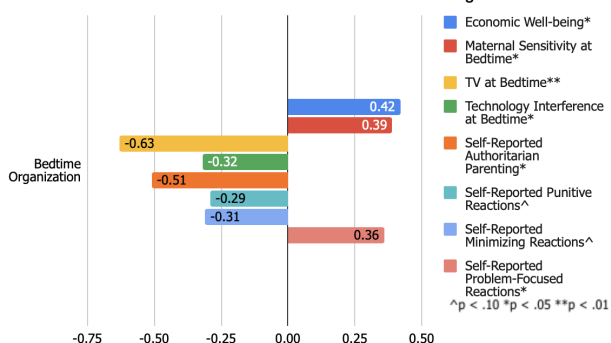
Cognitive and Emotional Outcomes
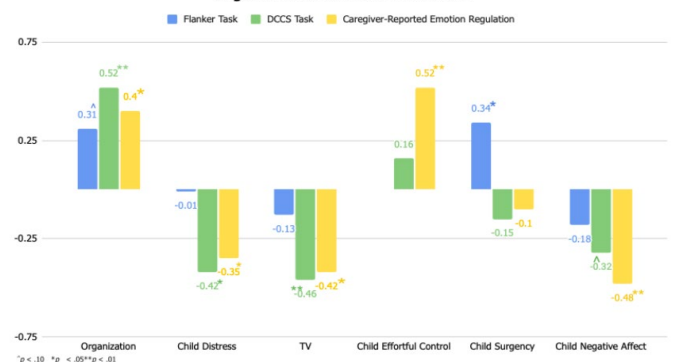
Research Fellow(s): Olivia Borden (2023)   **Concentration: Biochemistry**
                    Mina Head (2023)   **Concentration: Philosophy**
                    Ben Joseph (2023)   **Concentration: Biochemistry**
                    Fallyn Kirlin (2023)   **Concentration: Biochemistry**

Faculty Mentor: Anthony Chianese   **Department: Chemistry**

Title of Project: Mechanistic Studies of Ruthenium-Catalyzed Hydrogenation Reactions

Project Summary:

The Chianese group had previous success in the use of ruthenium catalyst, RuPNN-imine, to promote hydrogenation of esters. This summer, we wanted to further explore the versatility of this catalyst, as well as a few similar catalysts, in the hydrogenation of related functional groups through computational, kinetic, and optimization experiments.

The optimization study manipulated reaction conditions such as temperature, pressure, type and amount of reactant and catalyst, solvent, and the use of additives like acids and bases. This study intended to find the conditions that enabled selective product formation in high yield while remaining mindful of atom economy. We determined the optimal conditions by measuring the conversion of reactant to product as well as the yield of each product.

The computational study utilized density functional theory (DFT) to track the reaction pathway of a ruthenium catalyst with a specific reactant. DFT is unique because it provides the three-dimensional view of the chemical structures of molecules participating in a reaction, as well as an estimation of their free energies. This insight is invaluable to the proposal of plausible reaction pathways. In our experimentation, we used different conformations of reactants and then compared them to one another based on activation energy; we deemed conformations with higher activation energies insignificant, while we incorporated the conformation with the lowest activation energy into the final reaction pathway.

Kinetics investigation complemented DFT, as the rate of reactions provides additional evidence for and against certain energy pathways. Using our Asynt reactor, we monitored reaction progress by collecting aliquots at regular intervals. We conducted exploratory kinetics experiments, including a solvent screen, in conjunction with the optimization study. Once we determined optimal reaction conditions, we began our kinetic study, which involved experiments that examined the effects of substrate and catalyst concentrations and hydrogen pressure on the rate of reaction. Data analysis suggested relative order within reagents and will be further used to develop a kinetic model and rate law.
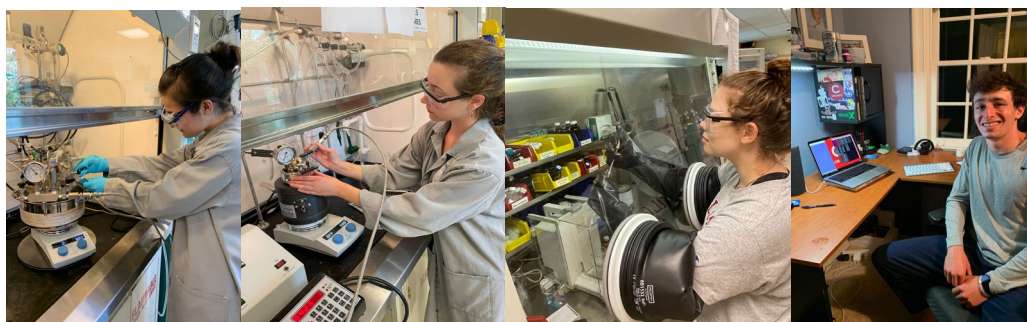
Research Fellow: Jenna Borovinsky (2022) **Concentration:** Molecular Biology

Faculty Mentor: Priscilla Van Wynsberghe **Department:** Biology

Title of Project: Light it up: exploring the lite-1 and gur-3 genes in *C. elegans*

Funding Source: Michael J. Wolk '60 Heart Foundation

Project Summary:

C. *elegans* are simple transparent nematode worms that act as model organisms. MicroRNAs (miRNAs) regulate C. *elegans* development. Let-7 is a heterochronic miRNA essential for normal development and lin-42 is a period protein homolog essential for circadian clock function in C. *elegans*. Despite lacking eyes, C. *elegans* still respond to light. Light sensitivity is essential for all organisms and photoreceptor proteins detect light and chemoreceptors detect chemicals produced by light. Lite-1 is a seven-transmembrane gustatory receptor (GR) homolog within C. *elegans* that acts as a photoreceptor. Lite-1 also controls UV light-induced avoidance behavior and absorbs UV light 10-100 times greater than opsins and cytochromes. Gur-3 is also a GR homolog but acts as a chemoreceptor within C. *elegans*. I am interested in whether mutations in lin-42 inhibit lite-1's or gur-3's ability to mediate UV light avoidance behavior in C. *elegans*, as well as exploring the difference in the lite-1 and gur-3 genes as photoreceptors versus chemoreceptors. I am also interested in whether lite-1/gur-3 regulates lin-42 (and/or miRNAs via lin-42).

This summer I used RNA interference (RNAi) to knock down lite-1 and gur-3. After knocking down each gene, I then extracted the RNA from these worms for future analysis of let-7 levels via qPCR. I am still analyzing my qPCR data. I did not have enough time to collect more data in relation to these genes within C. *elegans,* but my future directions include using CRISPR to force higher expression of lite-1 for analysis by making a transgene. Lite-1 is expressed at low levels in C. *elegans,* so it's hard to analyze otherwise. I also want to photobleach N2 and lin-42 (n1089) worms. I want to determine the response of these worms to UVA and UVB light. Lite-1 mutants don't normally respond to UVA light when photobleached, and I want to know what will happen when lin-42 (n1089) x lite-1 knockdown worms and lin-42 (n1089) x gur-3 knockdown worms are photobleached. Altogether these studies will allow me to better understand the function of lite-1 and gur-3 within C. *elegans*.

Research Fellow: Luke Calderaro (2022)   **Concentration(s):** Molecular Biology; Geology

Faculty Mentor: Paul Harnik   **Department:** Geology

Title of Project: Geographic Variation in Predator-Prey Relationships in Marine Mollusks

Funding Source: Doug Rankin '53 Endowment-Geology Research

Project Summary:

Marine ecosystems in the northern Gulf of Mexico are heavily affected by nutrient pollution from the continental United States. Agricultural and urban runoff deliver excess nutrients to the sea which triggers algal blooms, in a process called eutrophication. Increased energy availability from algal blooms could have a variety of ecological and physiological effects on higher trophic levels in Gulf food webs. Specifically, we hypothesize that enhanced primary production supports larger and more numerous predators and prey. To test this hypothesis, I examined six bivalve genera that are abundant members of marine communities throughout the northern Gulf. Approximately 2,900 dead individuals were picked from samples of seafloor sediment that were collected at -20-meter depth, at fifteen sites spanning coastal Louisiana, Alabama, and Florida. Any drill holes found in the bivalve shells represent successful predation by snails. The body size of each specimen and, if present, their drill holes, were measured, and these sizes were compared among sites. Data on present-day primary productivity and dissolved oxygen concentration were compiled from an online database. I found that the median body size of predators and prey varied across the Gulf, but both tended to be highest at site LA25, the easternmost site sampled in Louisiana. Conversely, drilling frequency was lowest in all Louisiana sites. Environmental data show that LA25 has the greatest primary productivity and lowest dissolved oxygen. Increased bivalve body size in more productive coastal environments could be due to greater food availability and/or oxygen limitation; enhanced food supply could lead to faster growth rates, whereas lower dissolved oxygen levels could reduce predation and result in greater longevity of prey. Larger basal consumers (bivalves) could potentially support larger higher order consumers, like predatory snails, yet hypoxia may also limit the extent of these predator populations.

Figure 1. Six Genera Studied with Drill Holes (Clockwise from upper left: Nuculana, Radiolucina, Caryocorbula, Chione, Lirophora, and Nucula)

Research Fellow: Jane Carskaddan (2024)   **Concentration: Undeclared**

Faculty Mentor: Amy Leventer   **Department: Geology**

Title of Project: Compiling a catalog of Scanning Electron Microscopy images of Antarctic marine plankton for use in future exploratory cruises

Project Summary:

Marine plankton are extremely important in understanding the paleoclimates, or past climates, of Antarctica. The same species of diatoms, dinoflagellates, and other groups are present both today and in the recent past are preserved as microfossils in sediment. Therefore, the modern assemblages of the waters surrounding Antarctica provide a proxy to those found in ancient sediments. For example, modern coccolithophorids are only found in warmer seawater, so when they are found in sediment it shows that the seawater in this location during this time period was warm enough to support coccolithophorids. Such data allows paleoclimatologists to reconstruct past climate trends in order to better understand and predict the coming trends for Antarctica caused by climate change.

A new project, International Collaboration Effort for Improving Paleoclimate Research in the Southern Ocean, ICEPRO, aims to collect more data on modern assemblages by sampling seawater from a wide range of locations surrounding Antarctica. Seawater is passed through filters and the plankton from the water are left behind and can be observed using microscopy. Onboard a cruise, only light microscopy is available. This is sufficient for a rough estimate of which species are present, but optical microscopes often lack the power needed to identify the smallest species, which can be as small as 1-2 microns in diameter. Besides these species, it can also be difficult to distinguish between species of the same genera, since identification often relies on small differences that are hard to detect with light microscopy, when the filters are present. However, when observing the filters using a scanning electron microscope (SEM), it is possible to distinguish between larger species and even determine the identity of the smallest ones. This is exactly what I have been doing this summer. I use an SEM to photograph all dominant species present on filters from a 2020 cruise through the Drake Passage and around the waters surrounding the Shetland Islands and into the Weddell Sea. I typically produce around 10 images from each filter, each showing a different species that is either dominant to that location or is rare and cannot be easily identified even when all detail is visible. I then format these images onto a single page that includes the location of the site, scale bars for each image, and identifications of those species that I identify after referring to available guidebooks and papers. These pages will be shared with micropaleontologists and paleoclimatologists who will assist in further identification. After this, all pages will be compiled into a catalog and published online for public use. This allows both for crowdsourcing of any remaining identifications and easy access for researchers onboard future ICEPRO cruises to reference. For example, if one is observing a filter and notice small centric phytoplankton that their optical microscope cannot magnify, they will be able to refer to the catalog and conclude that these centrics are most likely chrysophytes since they are at a similar longitude and latitude to where I observed chrysophytes (Figure 1). This project is currently ongoing, as there are 85 filters available and I have performed microscopy for approximately a third of them.
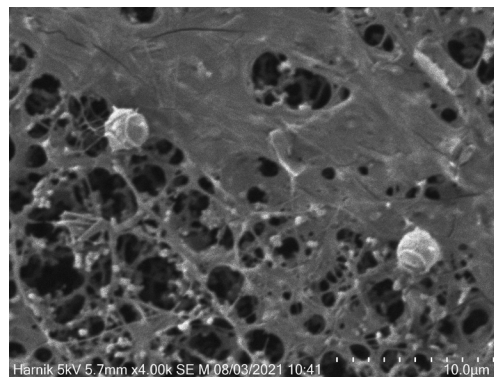
Figure 1: *Tetraparma pelagica* at 4.0k magnification, approximately 2 microns in diameter, only identifiable under SEM

Research Fellow: Div Chamria (2023)   **Concentration(s): Chemistry; Physics**

Faculty Mentor: Ramesh Adhikari   **Department: Physics and Astronomy**

Title of Project: Anomalous Conductive Behavior in a Polymer-Amino Acid Composite

Funding Source: Volgenau Wiley Endowed Research Fellowship; NASC Division

Project Summary:

L-Phenylalanine is an amino acid that self-assembles to form non-conducting nanotubes and nanostructures in DI water. PEDOT:PSS is an organic conductive polymer, which when combined with L-Phenylalanine shows enhanced conductive properties at certain concentrations. These conductive properties show a clear trend with changed proportions, and appear physically distinct. This research project aims to collect more data on this behavior, in order to analyze and explain it.

A probe station was used to measure current, voltage and resistance for 11 different solutions that were made in 10% intervals. The general trend observed via these measurements was that samples between 40% and 70% were most conductive samples, followed by 80% and 90% respectively. Samples that contained L-Phenylalanine between 10%, 20% and 30% samples were less conductive than pure PEDOT:PSS. This can be seen in Figure 1.
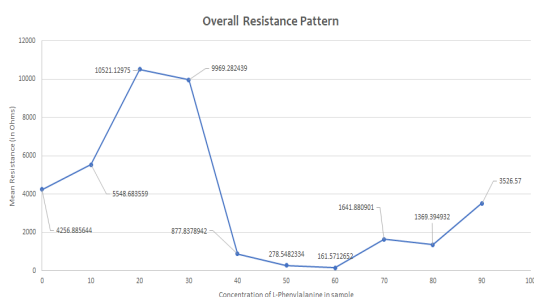
Figure . Resistance vs Concentration Graph

The concentration of the solution also affects the physical nanostructures formed, which play a role in change in conductivity. PEDOT:PSS only has sparse white clusters over a flat black substrate, With the addition of L-Phenylalanine, slight increases in the concentration of the white clusters are observed until the 40% sample. The 50% sample has a dense collection of globules instead. The 60% sample changes drastically to include both globules and clusters. An SEM image of the 60% sample can be seen in Figure 2. Conductive AFM analysis shows that these clusters are hard, and more conductive than PEDOT:PSS. This likely means that the appearance of these structures is related to the increased conductivity. These measurements have allowed us to explore this composite in further detail and learn a lot more about what causes this anomalous conductive behavior. Since L-Phenylalanine is non-conducting itself, it must mean that the globules and clusters formed in the composite provide a more efficient form of charge transport than PEDOT:PSS, and that the globular structures are more conducting than the clusters. However, we still do not know how these structures are formed at different concentrations, or why the samples between 10% and 30% have such reduced conductivity. More analysis of AFM, XRD and EIS data is required to make further conclusions which requires more research into the mechanism by which these composites function.
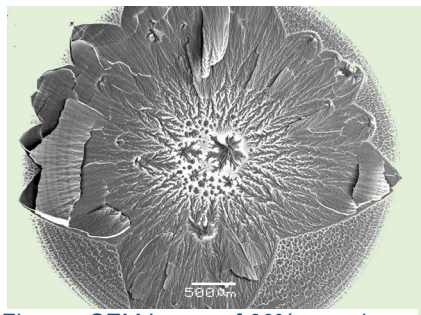
Figure . SEM Image of 60% sample contains clusters and globules

Research Fellow(s): Jyotirmay Chauhan (2023) **Concentration(s):** COSC; Mathematical Economics
Devon Lee (2022) **Concentration:** Computer Science
Emily Yu (2023) **Concentration:** Computer Science

Faculty Mentor: Aaron Gember-Jacobson **Department:** Computer Science

Title of Project: Detecting Network Errors: Router Configuration Mining

Project Summary:

Our work aims to predict network errors using configuration files from routers. A router is a networking device that forwards information between computing devices. Important configuration components include: interfaces, which provide physical connectivity between routers; access control lists (ACLs), which perform filtering to limit the flow of data through a network; and virtual local area networks (VLANs), which are logical groups of computing devices. Since router configurations are (partially) written manually, they may contain errors that can weaken network security and connectivity. Because each network employs different configurations, errors are often subjective and difficult to identify.

Current methods of detecting misconfigurations are often tedious and inefficient because they require a detailed description of a network's expected behavior as input. However, configuration mining enables extrapolation of configuration patterns which can be used to flag potential errors without prior specification of network policies. Unfortunately, existing configuration mining techniques focus on a subset of configuration components and patterns.

Our approach aims to detect, and rank by importance, sophisticated, network-specific errors in any configuration component. We explore three different methods to mine router configurations:

Link Prediction: This method represents a router configuration as a graph, where nodes are configuration components and links define relationships between components. The link prediction algorithm we made is inspired by Facebook, which suggests new friends to users based on their number of mutual friends. Similarly, when certain router configuration components have many similar features, a link can be predicted between components.

Association Rule Mining: This method aims to detect relationships among different variables in a dataset. Each rule, representing an implication, is composed of two sets of variables—the first representing a condition and the second a consequence. Rules with high support (frequency of the condition) and confidence (frequency of both the condition and consequence) implies a network pattern. Consequently, we flag deviations from these patterns as potential configuration errors.

Contrast Set Learning (CSL): This is a form of association rule mining which attempts to sort individuals into meaningful groups based on common attributes. The STUCCO algorithm generates and selects rules based on their ability to identify/highlight a particular group over others. This method of grouping is useful because it can help in identifying suspicious patterns in configurations.

We evaluate our methods using configurations from real university networks. For example, we evaluate our link prediction techniques in terms of precision and recall based on randomly removed edges, and we explore the space of hyperparameters (e.g., similarity measures and thresholds).

Research Fellow(s): Carolina Chavez (2023)   **Concentration:** Environmental Geography
                    Alex Tran (2022)   **Concentration(s):** EDUC; Psychological Science

Faculty Mentor: Susan Woolley   **Department(s):** Education; LGBTQ Studies

Title of Project: Out for Safe Space: Tracing educational discourse on supporting LGBTQ students in schools

Project Summary:

The Gay, Lesbian & Straight Education Network's (GLSEN) research shows that the material conditions and lived experiences of LGBTQ students demonstrate that the U.S. K-12 public schools have very rarely been safe spaces for them. In this project, we trace discourses of "safe space" through the literature and examine how "safe space" as a heuristic has shifted across the past thirty years. We used methods of discourse analysis to examine how discourses of "safe space" offer systems of meaning embedded in educational institutions that are shaped by ideologies in response to larger social structures (Kress, 1985) and "map out what can be said and thought about what they define as their respective domain" (Pennycook, 1994, p. 128).

Out for safe space intervenes in the discussion of decolonizing and deconstructing what it means to operate as well as participating in a safe space. The safety paradigm and the safe school discourse has been focusing on 7 different facets: (1) schools' non-discrimination and antibullying policies, (2) state-wide and federal laws outlining (LGBTQ) students' rights, (3) the organization of Gay-Straight Alliances (GSAs), (4) LGBTQ "safe zones," (5) training for schools' personnel about LGBTQ students' safety needs, (6) inclusive LGTBQ-focused curriculum, and (7) school-wide activities that focus on LGBTIQ issues (Black, Fedewa, & Gonzalez, 2012; Demissie et al., 2018; Griffin, Lee, Waugh, & Beyer, 2005; Griffin, & Ouellett, 2003; Jacob, 2013; Kolbe, 2020; Koschoreck & Allen, 2013; Patterson, 2013; Sadowski, 2017).

In addition to physical safety, research largely conceptualizes "safety" as an emotional aspect. Research focusing on the voice of LGBTQ students and their allies highlights this perception of a safe space as an emotional haven. However, safety is not enough as it is often conflated with comfort. It is almost impossible to invoke questions of privilege, homophobia, and heterosexism or to question authority, epistemologies, and norms without jeopardizing the emotional support that safe spaces offer. Learning is inherently unsafe as K-12 students become exposed to different systematic structures of oppression, such as race, class, and privilege, explicitly and implicitly. Ultimately, we call for an ongoing effort to create a safer community. The concept of *safer* spaces acknowledges that (1) there is no utopia where safety exists without change or contest, (2) safety is not a destination, it's a journey, and (3) systemic change is needed if we are to create sustainable positive transformation of LGBTQ students' experience.

Research Fellow(s): Chris Cherniakov (2024) **Concentration: Undeclared**
 Lakshya Dhurka (2022) **Concentration: Computer Science**

Faculty Mentor: Will Cipolli **Department: Mathematics**

Title of Project: Data Science Collaboratory

Project Summary:

Statistics plays an integral role in research across disciplines. Due to this, researchers require statistical evidence to conclude any given hypothesis. This summer, we developed a suite of statistical analysis web applications for the Data Science Collaboratory at Colgate University. The purpose of this project is to empower researchers -- students and faculty -- to conduct complex statistical analyses. To do this, we provide a set of easy-to-use, efficient tools to perform and interpret such analyses. We developed each of these applications using R -- a statistical programming language -- with RShiny -- a package for making R-powered web applications.

We aim to create an easy-to-navigate web application consisting of comprehensive graphical and numerical summaries that help researchers make decisions.

Specifically, we spent much time developing an application to plot various types of data. Users can create plots ranging from those for one variable (e.g., pie charts) to those containing up to four variables (e.g., bubble plots). To help users choose the most appropriate plot for their data, we wrote a tutorial that demonstrates the available plots and when each makes sense to use. Further, we enable researchers to customize the aesthetic of the graphs they create. The color, size, and theme of each graph are customizable; moreover, the user can download the R-code that creates the plot.

While the plotting application helps in communicating a summary of the data for future analysis decisions, the t-test and the regression analysis applications are useful for analyzing datasets and play significant roles in quantitative research. Through the t-test application, users can test hypotheses regarding the population mean — it enables you to test whether the population mean is different from a specific value (one-sample) or whether the population means of two groups are different (two-sample). Similarly, we designed another application to enable users to make one-sample and two-sample inferences about the population median. The regression analysis application allows you to run specified forms of linear regressions. It generates error plots in addition to provision of detailed statistical summary of regression coefficients and standard errors. Most importantly, the application also checks the assumptions of linear regression for the provided dataset and equation form.

Through this project, we learned to work synergistically in a complete software development life cycle — from planning and designing the structure of the applications to testing each feature and fixing any bugs. This was vital to our experience since we gained a tremendous amount of exposure to real-world software engineering. Moreover, we got the opportunity to learn to work with technologies like GitHub to collaborate and organize code.
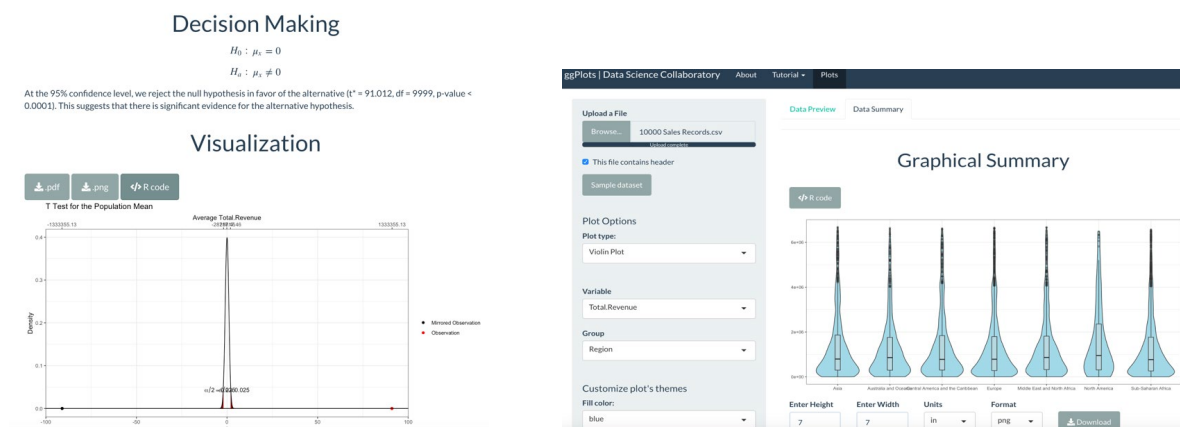
Screenshots from (left) one sample t-test application and (right) plotting application generated using sample datasets

Research Fellow(s): Katia Childs (2023)   **Concentration: Geology**
Fred LeClair (2022)   **Concentration: Geology**

Faculty Mentor: William Peck   **Department: Geology**

Title of Project: Analysis of Adirondack Graphites and their Origins

Project Summary:

During the 18th and 19th century, graphite was an important industrial mineral mined in the Adirondack Mountains. Our study uses a resource assessment survey done in the early 1900's by H. Alling, who visited various reported graphite deposits in the Adirondacks and collected samples of the deposit material, waste rock, and nearby outcrops. Our sample data comprises both rocks from the Alling collection at the New York State Museum and samples we collected ourselves. These samples have been further analyzed for graphite content, major elements, and carbon isotopic composition of graphite, with the goal of learning about the origin of graphite deposits in the region and the types of environments in which they formed.

The rocks we studied formed between 1.0 to 1.3 billion years ago. Near the end of this period, the Amazon craton and North America collided causing a high-grade metamorphic event, which obscured primary features of the rocks and ore deposits. Therefore, to pull effective data from these rocks we utilized an XRF (X-ray fluorescence) spectrometer, a stable isotope mass spectrometer, and microscopic analysis of thin sections. For the XRF we powdered 5 grams of each sample and combusted them at 1000ºC for 3 hours which destroyed all graphite and calcite within the samples. This process also gave us the LOI (loss on ignition) for each sample so we may calculate an estimated weight percent of graphite. We then prepared 0.5 grams of the combusted sample to be mixed with 4.5 grams of lithium tetraborate. This mixture was melted in a crucible to form the glass discs for XRF analysis of elemental compositions of various oxides within each sample. The mass spectrometer required ~0.2mg of pure graphite flakes mixed with copper oxide at ten times the mass of the graphite in a tin canister. The combusted samples produced gas that was used to measure the isotope ratio of carbon and oxygen using the mass spectrometer.

We found that most of our samples have carbon isotope ratios between -10‰ and -30‰, which is consistent with the isotopic signatures of organic carbon. We were also able to use our compositional data from the XRF to constrain what these rocks were before metamorphism. Most of our samples are very silica rich averaging 62% SiO_2 and relatively rich in Al_2O_3 (0.69-21.06%), leading us to believe most of these rocks were clays, mudstones, and shale prior to metamorphism. However, these data are still preliminary with much more work left to be done.
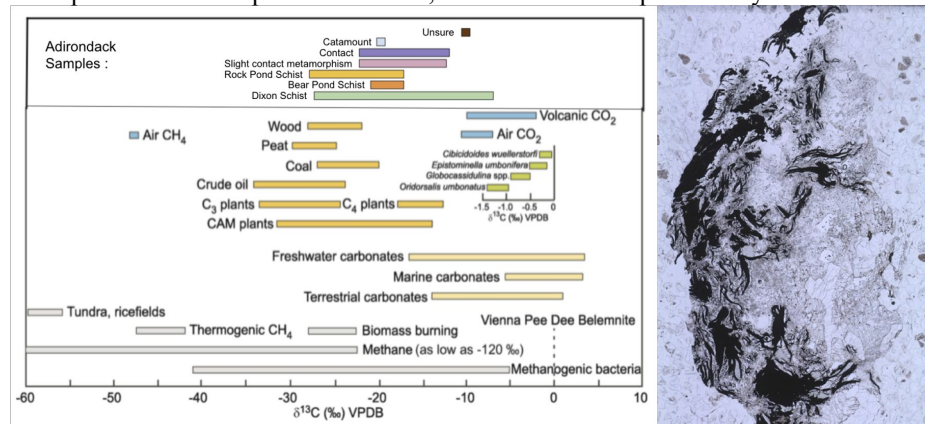
Carbon isotope graph comparing our samples to other common markers from Wagner et al. (Encyclopedia of Geochemistry 2018).

Thin section of sample 664, from Lead Hill (27x36 cm). Graphite - (opaque black streaks)

Research Fellow(s): Tarik Cigeroglu (2023)   **Concentration: Physics**
Johna Joseph (2022)   **Concentration: Chemistry**

Faculty Mentor: Eric Muller   **Department: Chemistry**

Title of Project: Tip-Enhanced Infrared Spectroscopy of Proteins in Solution

Funding Source: NASC Division; Science and Math Initiative (SMI) (NASC Division)

Project Summary:

Interactions between proteins and their solvent environment can affect both protein function and the chemical or physical properties of the surroundings. An important example of this is found in ice-nucleating proteins of *Pseudomonas syringae*, which can control the freezing of water. In agricultural settings, this bacteria can cause frost damage to crops. Similarly, ice nucleation in atmospheric clouds can induce freezing in mixed-phase atmospheric clouds, altering the water-ice balance with significant atmospheric implications. Despite the importance of these protein-water interactions, the mechanism remains poorly understood.

In this project, we worked to develop experimental and theoretical methods to understand the interactions between water and proteins. Our research focused primarily on vibrational spectroscopy, which provides information about molecular structure. Our lab is developing a new approach for in-liquid infrared scattering-scanning near-field optical microscopy (IR s-SNOM) that enables single-protein spectroscopic sensitivity and superresolution <20 nm spatial imaging.

We worked to build this new experimental instrument. Our lab first built a novel infrared light source based upon difference frequency generation from a femtosecond fiber laser. We then built an optical setup to focus that light on a metallic AFM tip and detect the scattered signal. Our results from this summer show that we have obtained the desired 20 nm resolution with our new setup. Towards the end of the summer, we worked to frequency-resolve our detected signal. An interferometer creates interference between light that has traversed two different paths. One path of the interferometer contains a reference mirror on a movable stage. We have programmed a GUI in Labview that allows us to communicate with the amp and move the stage, and we are working to finalize computer automation of our interferometer.
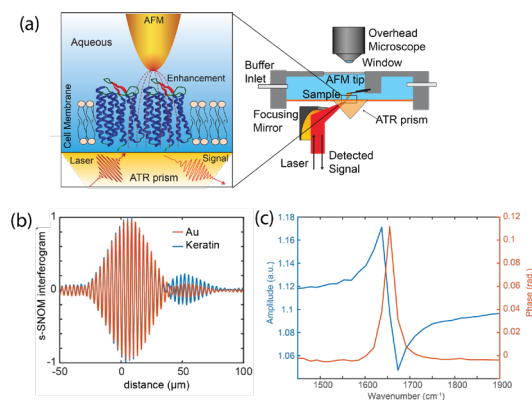
Figure: (a) Schematic representation of measuring proteins in water using in-liquid IR s-SNOM. (b) Interferogram of proteins. (c) Calculated spectrum of proteins using our numerical theory.

We also developed new theoretical tools to bring quantitative understanding of our in-liquid IR s-SNOM spectroscopy. Existing theoretical tools for predicting and interpreting IR s-SNOM spectra in air remain inadequate for calculating spectra using our in-liquid setup. We accomplished this using a new route. We directly solved Maxwell's equations for the electromagnetic fields, calculated numerically using a finite element method approach. Upon successfully developing this new method, we are for the first time able to calculate in-liquid IR s-SNOM spectra. Our new theory provides a solid theoretical basis for experimental measurements.

Research Fellow(s): James Clark (2023)
Willow Goff (2023)

Concentration: Biochemistry
Concentration: Molecular Biology

Faculty Mentor: Jenny Peeler

Department: Chemistry

Title of Project: Utilizing Genetic Code Expansion to Express and Study Selenoproteins in Mammalian Cells

Project Summary:

In introductory biology, we all learn that there are 20 amino acids, but humans and many other species utilize a 21st amino acid, selenocysteine (Sec). Proteins that incorporate this amino acid are called selenoproteins, and there are 25 known selenoproteins in the human genome. Half of these proteins have known antioxidative functions, but the other half have yet to be characterized. The study of selenoproteins has been challenging due to their elaborate process of translation that requires many accessory proteins. To bypass these limitations, our lab is utilizing genetic code expansion (GCE) to incorporate photocaged selenocysteine (DMNB-Sec) into a protein of interest (POI).

GCE utilizes an engineered synthetase to charge an engineered tRNA with a non-canonical amino acid. This amino acid is then incorporated into a growing peptide chain by the endogenous ribosomal machinery. The engineered synthetase that we are using charges the engineered tRNA with DMNB-Sec, and the tRNA suppresses the amber stop codon (TAG), leading to the incorporation of DMNB-Sec into proteins. Utilizing the DMNB caging group allows us to temporally control the activity of our POI.

Before using GCE to characterize selenoproteins, we validated and optimized GCE using enhanced green fluorescent protein (eGFP) as a reporter system. We used a plasmid that contains genes for the engineered tRNA/synthetase pair and a mutated eGFP gene that contains a TAG stop codon in its coding region. We transfected a human tissue culture cell line, HEK 293, with this plasmid. Complete translation of eGFP requires the presence of DMNB-Sec to bypass the TAG codon and produce a functional protein that will fluoresce when excited with 488 nm of light. Absence of DMNB-Sec results in a truncated eGFP that will not fluoresce. We measured fluorescence qualitatively and quantitatively with fluorescence microscopy or with a fluorometer, respectively in order to evaluate ideal concentrations of DMNB-Sec for eGFP expression (Figure 1). We also used a wildtype (WT) eGFP construct with a polyhistidine tag to optimize transfection conditions and nickel resin-based protein purification methods.

The Peeler lab hopes to apply these optimized protocols in future research of native selenoproteins to further explore and characterize their functions.
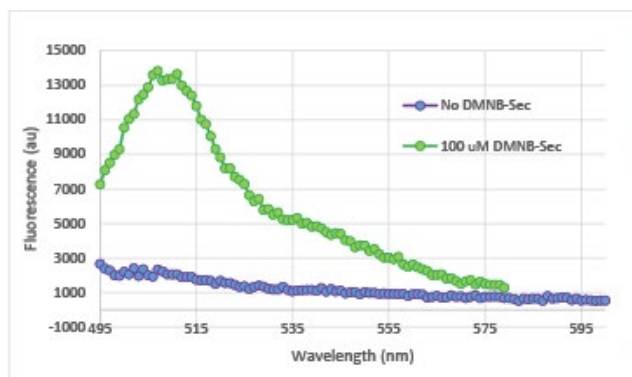
Figure 1. Left graph shows quantitative data for intensity of fluorescence; the green curve with a peak of 13354 au at 509 nm fluorescence for 100 µM DMNB-Sec and the blue curve shows significantly less intensity when DMNB-Sec is absent. Right portion qualitatively compares fluorescence showing significant fluorescence when 100 µM DMNB-Sec is present, but little to no fluorescence when DMNB-Sec is absent.

Research Fellow: Jane Corcoran (2023)   **Concentration: Neuroscience**

Faculty Mentor: Jason Meyers   **Department(s): Biology; Neuroscience**

Title of Project: What Role do Interneuromast Cells play in the Regeneration of Neuromasts in the Zebrafish Lateral Line System

Project Summary:

Zebrafish, similar to other fish and amphibians, have a unique system called the Lateral Line System. This specialized system is made up of mechanosensory organs called neuromasts that run down both sides of the fish (Fig 1A) with interneuromast cells found in between each neuromast. From the outside in, each neuromast is composed of three distinct cell types: mantle cells, support cells, and hair cells (Figure 1B). Most notably, the hair cells found in each neuromast are analogous to the hair cells found in the human inner ear - most commonly used for balance and hearing. Thus, this similarity allows scientists to compare how these cells function across species.

Previous research has shown that, unlike humans, zebrafish hair cells are able to readily regenerate upon injury. That being said, the regeneration capacity of an entire neuromast remains unknown. However, a recent theory by Sanchez et al. proposed that interneuromast cells are what give rise to new neuromasts post-injury. This proliferative ability of interneuromast cells has been studied in the developmental period of the Lateral Line but has never been suggested as a theory for regeneration. Thus, this finding set up my experiment over the summer to see if I could replicate what Sanchez had claimed in his findings.

Using a confocal microscope, I performed entire neuromast ablations on 6-day-old zebrafish and observed the fish over a 24-72 hour period for signs of regeneration. According to Sanchez, "regeneration clusters" should be seen at the sight of ablation within 24-72 hours post-injury. After experiments with roughly 20 fish (3 neuromast per fish), I observed 0% neuromast regeneration post ablation (Fig. 2). Based on this data and the data from Sanchez et al., I wondered if there was a correlation between the age of the fish and its ability to regenerate entire neuromasts. Thus, future research can be directed towards experimenting on 3-day-old zebrafish, consistent with methods by Sanchez et al., rather than 6-day-old zebrafish.
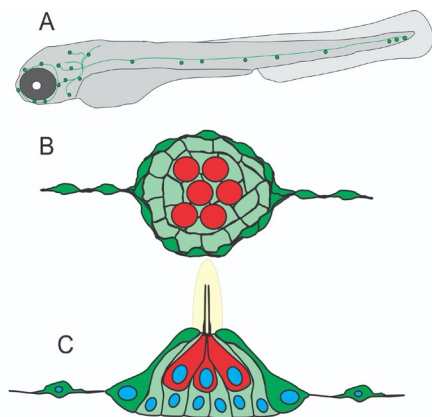
Fig 1. *The anatomy of the lateral line system.* (A) The location of the lateral line on a young zebrafish and the neuromasts (dots) found along this line. (B) The top view of a neuromast showing the hair cells labeled in red, the support cells in light green, and the mantle cells in dark green. (C) The side view of a neuromast (as shown in B) with a hair bundle highlighted in yellow and the interneuromast cells to the right and left of the neuromast.

Fig 2. *0% neuromast regeneration post-ablation after 24-72 hours.* The dotted line depicts the length of the lesioning site where three neuromasts were ablated. The line is bounded on both sides by the closest uninjured neuromast. From this 10X photo taken by a confocal microscope, you can see that there is no red fluorescence in the area outlined by the dotted line. The lack of red fluorescence observed in this area is consistent with my findings of a 0% neuromast regeneration.

Research Fellow: Riley Corcoran (2022)   **Concentration: Astronomy/Physics**

Faculty Mentor: Thomas Balonek   **Department: Physics and Astronomy**

Title of Project: Monitoring Quasars at Foggy Bottom Observatory

Funding Source: NASA New York Space Grant

Project Summary:

One of the objectives of the summer when working under Professor Balonek in the Physics and Astronomy Department is to take more data on the objects we observe, and that requires working with the telescope at the Foggy Bottom Observatory at the top of campus. Every clear night during the summer we will go up to the observatory to take images with our CCD, or charge-coupled device, attached to the 16-inch diameter reflecting telescope. We monitor a number of different quasars, or a type of active black hole at the center of galaxies, and the ones we observe each night depend on which are seen in the night sky at that time of the year and time of the night. By taking a sequence of 12 images for each object we observe, we can minimize any possible errors in our images and get a single final magnitude, or brightness, for the object that night.

We are able to use software on the computers at the observatory to get a preliminary magnitude of the quasars through using the known magnitudes of nearby comparison stars. In order to get images from which fully believable information can be gained, however, our images have to be calibrated and compiled to get a magnitude measurement for each object each night. Our images are saved as FITS files, which saves relevant information for each image in a header. These files can easily be opened by AstroImageJ, a program that can reduce and calibrate images, as well as perform the photometry necessary to get magnitude measurements of the quasars. While observing, we take biases and darks, closed-shutter images needed to help remove structure in the image that could be due to inherent characteristics of the CCD. Skyflats are also taken, which are early morning images of the sky without stars to remove any structure in the image that is due to the characteristics of the sky at the observatory. We subtract the biases and darks and divide the image by the skyflat in order to get a fully calibrated image, and then perform multi-aperture photometry using many known-magnitude comparison stars to get final measurements of the quasar's magnitude.

Graph of the preliminary magnitudes of the quasar 1308+326 as calculated each clear night this summer at the observatory.
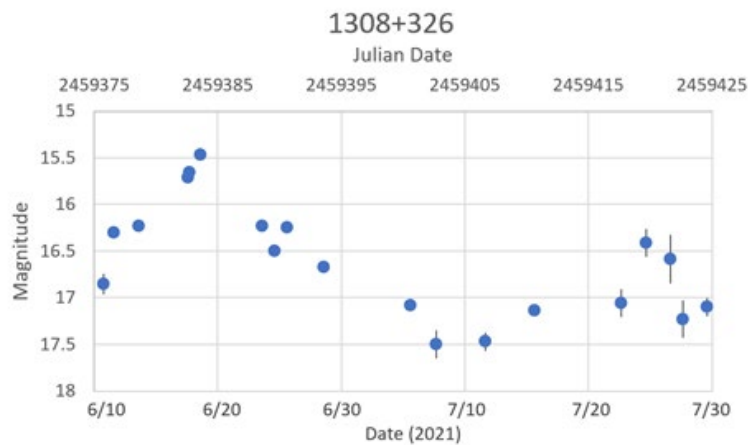
Research Fellow: Isa Cunio (2022) **Concentration: Biology**

Faculty Mentor: Bineyam Taye **Department: Biology**

Title of Project: Effect of mass deworming in risk of atopy and allergic disorders among school-aged children, central Ethiopia. Comparative cross sectional study

Project Summary:

Background: Parasitic helminth infections are recognized as a major global health problem, especially in low income and developing communities due to lesser sanitation and medical practices. Mass drug administration of anthelmintic drugs administered annually/biannually is used to treat schoolchildren independent of infection. Influenced by the hygiene hypothesis, mass deworming treatments have been hypothesized to lead to an increase in allergic disorders such as wheeze, asthma, eczema, and atopy in treated communities.

Objective: To investigate the effects of mass deworming treatment on the incidence of wheeze, asthma, eczema, and atopy within a community of treated and non-treated individuals.

Methods: A cross sectional study was conducted in Sululta town from April 2017 to August 2017 among 549 five to fourteen-year old school children. A questionnaire was completed through gathering socio-demographic and lifestyle information from participants and their legal guardians. Stool samples from each study participant were collected and analyzed for the presence of intestinal helminths and helicobacter pylori (H. Pylori). IBM SPSS 24 was used for all statistical analyses.

Results: The prevalence of allergic symptoms of children reported to have ever demonstrated atopy symptoms was 3.7%, asthma 3.3%, wheeze 8.9%, hay fever 9.8%. Most children included in the study have been dewormed through a school-based mass drug treatment (81.0%). Logistic regression models revealed a statistically significant lowering of wheeze prevalence among participants who had a history of deworming (7.4%) than non-dewormed children (15.5%) (AOR= 0.418; 95% CI: 0.215-0.816; P= 0.011). However, a nonsignificant decrease in the prevalence of asthma, eczema, atopy, and any allergy were not found to be statistically significant (P>0.05).

Conclusions: This study indicated that among school children treated with anthelmintic drugs within six months prior to data collection, an overall decrease in allergic symptoms is found. The findings of our study reject the hypothesis suggesting an increase of allergic symptoms following deworming treatment. Prior helminth infection may allow for long term suppressive effects on allergic disorders independent of later deworming treatment. Longitudinal studies are necessary to further substantiate the relationship between deworming and allergic disorders.

Figure 1. Image found online depicting similar mass distribution of anthelmintic drugs given to those considered "dewormed" in our study.

This image was not taken as part of our study.

Image reference: "The End of Neglected Tropical Diseases within Reach." The End of Neglected Tropical Diseases Within Reach, Light for the World, 24 June 2019, www.light-for-the-world.org/end-neglected-tropical-diseases-within-reach.

Research Fellow(s): Ejun Dean (2023)   **Concentration: Molecular Biology**
Isabella Ziolkowski (2023)   **Concentration: Molecular Biology**

Faculty Mentor: Krista Ingram   **Department: Biology**

Title of Project: Napping During the COVID-19 Pandemic Mitigated the Effects of Anxiety and Depression on Sleep in Young Adults

Project Summary:

The ongoing coronavirus pandemic has negatively impacted the mental health and quality of life of individuals around the world in ways that are long-lasting and still being understood. Researchers have observed an increase in public stress and anxiety over health and the negative economic effects of the pandemic (Ahmed et al., 2020). Social distancing and quarantine measures that were used to control the spread of the novel coronavirus have disrupted the sleeping patterns of individuals (Ji et al., 2021). This summer, our study focused on overall and gender-specific changes in anxiety, depression, and sleep disturbance patterns in a population of Colgate University undergraduate students during the pandemic. We collected FitBit sleep data, PER3 variable number tandem repeats (VNTR) genotype data, and surveys on depression and anxiety from 67 students in the Fall of 2019 and 49 students during Spring 2021.

Overall, our study reveals the far-reaching, and potentially gender-specific, effects the COVID-19 pandemic has had on mental health and sleeping patterns. Our results confirmed recent reports suggesting increases in anxiety, depression, and sleep disturbance scores during the pandemic in both males and females (Silva et al., 2020; Son et al., 2020; reviewed by Lin et al., 2021). During the pandemic, females were 4 times more likely to suffer from high anxiety and 4.5 times more likely to be depressed, while males were both 11 times more likely to suffer from high anxiety and depression.

We further investigated changes to patterns of napping during the pandemic and how this may have influenced the sleep architecture of students, observed through objective FitBit sleep measures of percentage of time of light, deep, and rapid eye movement (REM) sleep, sleep duration, and time spent in bed. We found a significant correlation between anxiety and depression scores and sleep parameters for nighttime sleep. Interestingly, we found a moderating effect of napping on this relationship. During the pandemic, we found that individuals were taking more naps for longer durations. On average, individuals who napped during the day received significantly shorter durations of nighttime sleep on workdays relative to individuals who did not nap. In fact, individuals who napped received comparable total average durations of sleep on workdays relative to those who did not nap. If we include durations of napping in the dataset, we find no correlations of sleep parameters with anxiety and depression. These findings indicate that individuals were able to mitigate some of the negative mental health effects of the pandemic on sleep through napping.
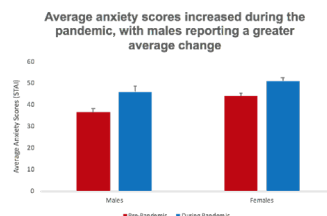
Figure 1: Average STAI anxiety scores by gender pre-pandemic versus during the pandemic. Average STAI anxiety scores increased during the COVID-19 pandemic amongst both males and females, with males reporting a greater average change compared to females (gender: $F_{(1,114)}=8.793$, p gender=0.04). Red-STAI anxiety scores of participants pre-pandemic and blue-during the pandemic.
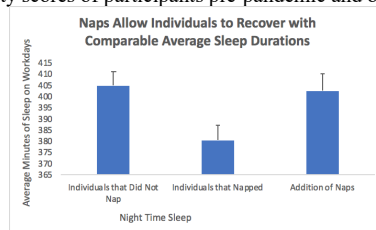
Figure 2: The addition of naps during the day allowed for individuals to recover with comparable average total durations of sleep on workdays relative to those who did not nap. On average, individuals who napped during the day received significantly less minutes of nighttime sleep on workdays as compared to individuals who did not nap ($F_{(1,107)}=2.733$, p=0.007).

Research Fellow: Emily DeNunzio (2022)   **Concentration: Neuroscience**

Faculty Mentor: Wan-chun Liu   **Department: Psychological and Brain Sciences**

Title of Project: 1) Sensitive Period of Song Learning Questioned
**   2) Could an Enriched Environment Benefit Song Learning?**

Project Summary:

Sensitive Period of Song Learning Questioned
        The first experiment looked at questioning the song learning period. It was previously studied to show that zebra finches can only learn songs as early as 20 days. However, the auditory cortex begins to develop around 9 days in embryonic development so we hypothesized that there is some auditory learning that begins in embryos. To test this hypothesis, three song files were made that had been manipulated from father tutors. Each song file consisted of 10 different father's singing a version of the same song for 3 minutes each. The song manipulations were dramatically different in order to see if there was any song learning once the hatchlings reached singing age. The syntax was manipulated in two of the songs and a stutter was made in the third song. Breeding pairs were made and once the eggs had been laid for around 5 days they were transferred to the incubator. The oldest egg always stayed in the nest and around 3-5 eggs were then taken. The eggs that stayed in the nest were used as a control because they were hearing their father's normal song in embryo. The incubator eggs began getting playback on day 9 in embryo. Playback consisted of two 30 minute segments every day until a few days post hatching. Once the birds hatched, usually around day 14/15 they were transferred back to the nest where the father had been removed. Around five days after hatching the family's cage was transferred into a private room to avoid other colony's songs interfering. There are three families that underwent this experiment with 7 birds receiving a manipulated playback and 3 birds that are controls. Once these birds reach 20 days the males will have their learning period recorded. An indication that there is some learning in the embryo would be the bird singing some version of the song that they listened to. For example, the stutter birds would stutter when trying to sing. This would be very different from the normal ABCDE song rhythm zebra finches usually have. This experiment would be the first of its kind to question the already existing song learning period and open the door to many future studies examining the effect of auditory learning in embryos. This could look at stress, tune, pitch, epigenetics, and so many other avenues if zebra finches are able to not only hear but learn sound in embryos.

Could an Enriched Environment Benefit Song Learning?
        The second experiment looked at the effect of the environment on song learning. It is hypothesized that during the song learning period, a bird in a more enriched environment will learn songs better. Therefore, two hatchlings from the same family were split up so that one was in a large cage and the other in a much smaller cage. The experimental setup consisted of the father in one cage teaching the baby while the other bird was being recorded. For example, the bird in the large cage was with the father for two days while simultaneously the bird in the small cage was alone, but being recorded and practicing singing. Then after two days the father would move into the small cage and the bird in the large cage would be recorded. This continued for 60 days which is when the song should be crystallized. The recordings consisted of both video and auditory. The video recording looked at distance and movement whereas the auditory recording looked at the actual syllables being produced. All of this data was compiled and analysis is currently occurring and more samples will eventually be taken as well.

Research Fellow(s): Gia D'Erasmo (2023)   **Concentration: Physical Science**
              Steph Jacoby (2023)   **Concentration: Chemistry**

Faculty Mentor: Anne Perring   **Department: Chemistry**

Title of Project: Ice Nucleation and Amino Acid Measurements in Upstate New York

Project Summary:

Primary biological aerosol (PBA) including bacteria, fungal spores and pollen, can be efficient ice nucleators (IN). These aerosols help water to freeze and form clouds in the atmosphere. While clouds typically freeze at temperatures below -30℃, bioaerosol can cause a cloud to freeze as warm as -4℃. The concentration of IN in the atmosphere can affect the cloud type and precipitation. There is currently a large uncertainty in climate projections due to a lack of measurements of atmospheric aerosols.

We have developed a systematic and repeatable methodology for measuring IN concentrations in ambient samples. A drop freeze assay with an adapted MATLAB code has been automated to detect freezing events in ambient samples. Approximately 60-100 2.0 ul drops are deposited with a sterile autopitte on a copper disk which is covered in a thin layer of vaseline. The plate is gradually cooled and images are taken every ten seconds to capture when the drops freeze. Drops frozen at each temperature are converted to concentration of IN to quantify biological aerosol in the

Figure 1: Drop Freeze Apparatus

samples. Preliminary findings from ambient samples taken in Upstate New York suggest that the most active IN correlate with previous observations of fungal spores.
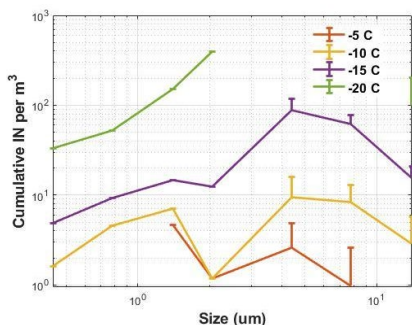
Figure 2: Number size distributions of cumulative IN active above a given temperature.

Oxidation has a noticeable effect on IN, degrading IN especially at warmer temperatures. We have also developed a systematic and repeatable methodology for measuring amino acids (AA) in ambient samples. Amino acids can be measured as biomarkers for biological aerosol in the atmosphere to help further quantify PBA. AA are derivatized using o-phthaldialdehyde mercaptopropionic acid (OPA-MPA) to make fluorescent for later detection. AA are separated and quantified by reverse phase high-performance liquid chromatography (HPLC). A calibration curve for 12 amino acids was created from a standard sample and retention times obtained from samples containing a single AA. An acid hydrolysis of Bovine Serum Albumin (BSA) was performed to determine efficacy of protein digestion to free up bound amino acids. This hydrolysis proved effective and will be used on ambient samples to free bound amino acids for detection. This methodology can now be used to measure both free and bound amino acids in ambient samples.

Further collection and analysis of ambient samples is planned to explore seasonal IN variability over the next year at Bewkes Center. Measurement of ambient aerosol amino acids will further allow us to investigate the link between primary biological aerosol and warm temperature IN.

Research Fellow: Nick DiBrita (2022)   **Concentration(s): Physics; Applied Math**

Faculty Mentor: Abdel Isakovic   **Department: Physics and Astronomy**

Title of Project: Temporal Graphs and Network Characteristics for Bio-Inspired Network Optimization

Project Summary:

Collective intelligence is a phenomena prominent in many natural and man-made systems, ranging from the swarming behaviors of ants to the rise and fall of stock market prices. In such systems, complex behavior is said to *emerge* within collections of comparably simple individuals (individual ants within a colony or investors within a market). These phenomena only emerge after a suitably large number of individuals are involved, after which large scale structures become inextricably linked to a system's behavior. In short, the whole is greater than the sum of its parts.

There has been significant research into developing methods to harness the collective computing powers of such groups. Prof. Abdel Isakovic's group developed a technique for optimizing the coverage of a fully autonomous, mobile wireless sensor network (WSN) within a finite area. Such a network could be practically implemented as a swarm of drones equipped with environmental sensors or communication equipment. Such a swarm is becoming increasingly viable given recent advances in technology and commercial availability, and would find practical use in hazard monitoring. The algorithm of interest, coined Bio-Inspired Self-Organizing Networks (BISON), utilizes a geometric technique called Voronoi tessellation to identify new, improved locations for the drones to relocate to. BISON was later augmented with a Genetic Algorithm (GA), a type of algorithm that mimics biological natural selection for the purpose of identifying near-optimal solutions to complex problems. Previous work identified that the GA variant (GA-BISON) achieves near optimal coverage significantly faster than BISON, at the expense of increased energy expenditure. Both algorithms are capable of maneuvering around a wide variety of obstacles, and have been demonstrated to be resilient in the face of environmental noise.

This summer's work was primarily focused on reexamining this algorithm using the tools of network theory, the study of collections of objects possessing pairwise connections. In traditional network theory, connections are assumed to be unchanging over the time interval being studied. A network representation of BISON is shown in the figure below. Given the evolving nature of our networks, we modelled the swarms as time-evolving networks, also referred to as temporal network graphs (TNGs). Unlike traditional static graphs, TNGs allow for structural changes, like nodes entering or leaving a network and connections breaking or forming. We can view the evolving network as an ordered sequence of static graph "snapshots." With this TNG framework, we were then able to measure and calculate static graph properties for each snapshot, and observe how they evolve in time. In particular, we measured the degree regularity by looking at the eigenvalues of the adjacency matrices. We also looked at the eigenvector centrality (EC) scores of different nodes within the network, as a measure of relative importance to the connectivity of the network. We found that BISON maintains fewer but longer lasting connections throughout its lifetime, while GA-BISON rapidly reorganizes itself with many brief connections. Furthermore, the relative importance (measured by EC) of individual nodes within BISON spikes rapidly after they join the network, then fades as they are pushed to the outer portion of the network. By contrast, the aforementioned reshuffling of GA-BISON means nodes grow and shrink in importance throughout their lifetimes. We also found that both algorithms deviate significantly from regularity, however the GA variant does so much more rapidly. These results seem to agree with earlier work, as these fluctuations seem to correspond to higher levels of activity within the network.

*(below)***Two snapshots of BISON exploring an obstacle-rich environment. The red lines indicate stable connections between nodes. The colored circles represent individual drones' sensor coverage.**
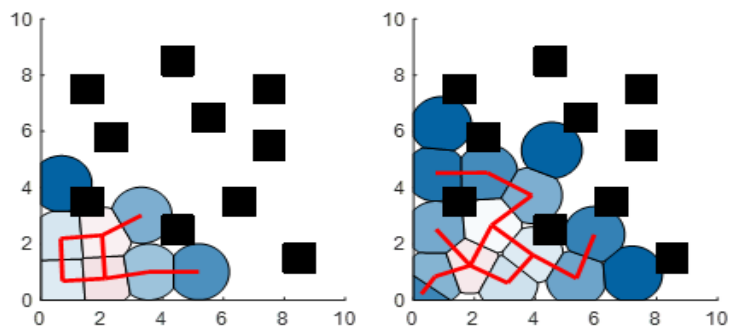
Research Fellow: Camden Di Carlo (2024)   **Concentration: Undeclared**

Faculty Mentor: Kevin Siegenthaler   **Department: Chemistry**

Title of Project: Protein Folding During Oxidative Stress

Funding Source: NASC Division

Project Summary:

Cells often undergo various forms of stress as they adapt to their surrounding environment, leading them to initiate a multitude of chemical pathways that enable them to maintain homeostasis. One form of stress is oxidative stress, in which too many reactive oxygen species (ROS) build up in the cell. These ROS can be extremely toxic to the cell; for example, they interfere with the proper folding of proteins in the endoplasmic reticulum (ER), leading to an aggregation of misfolded or unfolded proteins. Since protein function is dependent on protein shape, without properly folded proteins the cell is unable to perform its essential life functions, eventually contributing to apoptosis (self-initiated cell death). To deal with the negative ramifications of oxidative stress, including preventing apoptosis, cells initiate a pathway called the unfolded protein response (UPR). Basically, the UPR works to increase the cell's ability to fold proteins correctly, thus combating oxidative stress. Without a functioning UPR, proteins are more susceptible to misfolding, which on a large enough scale can lead to severe disease.

The overarching goal of this project is to study aspects of the UPR, in hopes of better understanding what causes (and, ultimately, how to treat or prevent) diseases that result from significant protein misfolding. To do so, we focused on a gene called *IRE1*, which encodes for a transmembrane protein with multiple domains and is present in the yeast *Saccharomyces cerevisiae* (with homologs in humans: *ERN1/2*). IRE1 is thought to splice *HAC1* mRNA, which codes for a crucial transcription factor for the UPR, and is also thought to directly facilitate the proper folding of proteins in the ER via molecular chaperones. We hope that further studying the structure and function of this protein and its individual domains will aid in discovering treatments that further promote proper protein folding.

To study this, the Siegenthaler lab will primarily use a random mutagenesis screen in yeast to observe the effects of mutations on the protein's function. More specifically, we are looking for hyperactive and partially defective mutants. Additionally, the group will work on protein purification of the IRE1 protein and its constituent domains. Research this summer mainly focused on cloning vectors that can be used to express IRE1, IRE1 fragments, and HAC1 in bacteria and yeast cells.

Research Fellow: Wes Dorow (2023)   **Concentration: Biochemistry**

Faculty Mentor: Ephraim Woods   **Department: Chemistry**

Title of Project: Spectroscopy and Photochemistry of Aqueous Imidazole-2-carboxaldehyde

Funding Source: Warren Anderson Fund

Project Summary:

The goal of this experiment was to further investigate the photochemistry involved in reactions involving imidazole-2-carboxaldehyde, or IC. IC is a photosensitizer, meaning that it can be photoinduced into an excited triplet state to react with organic compounds. Previous work with IC-containing aerosol particles in our group suggest that the yield of triplet IC (^{3}IC) increases with decreasing excitation wavelength in the range 250 to 310 nm. This experiment in homogeneous aqueous solution shows that the triplet yield follows the absorption spectrum. We also show that the triplet reacts quickly with dimethoxyphenol (DMP) by a hydrogen abstraction mechanism. This reaction represents the initial step in photochemically generated organic aerosol.
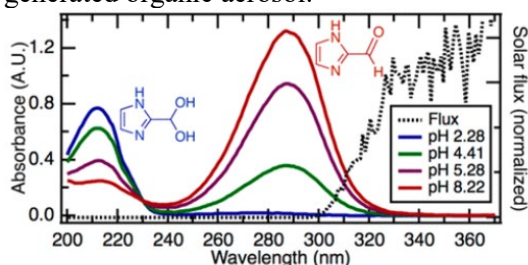
Figure 1) The absorption spectrum for IC. As the absorption of the sample increases, the amount of produced triplet increases as well.
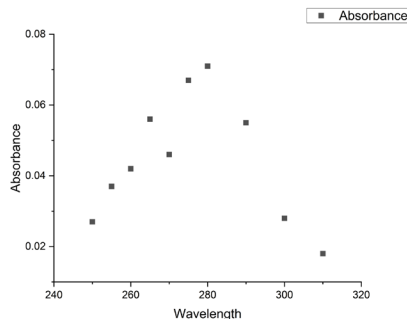
Figure 2) The experimental absorption spectrum for aqueous IC. The trend between absorption and wavelength follows the literature values for the absorbance spectrum of IC.

Research Fellow: Meg D'Souza (2023)   **Concentration: Sociology**

Faculty Mentor: Julie Dudrick   **Department: Upstate Institute**

**Title of Project: The Young Scholars Alumni Society- An Alumni Networking Platform
for Young Scholars LPP**

Project Summary:

This summer I continued my alumni engagement work with the Young Scholars Liberty Partnerships Program (YSLPP). YSLPP is a collaborative program between Utica College and the Utica City School district to help increase the graduation rates and college enrollment rates of a diverse range of students. Each year, in a selective process, a cohort of rising seventh-grade students who will attend James H. Donovan Middle School and John F. Kennedy Middle School is chosen to become a Young Scholar until they graduate from T.R. Proctor High School. The program helps students who have the potential to excel but may not be able to do so for a variety of reasons find academic success and build career readiness. This is achieved through academic tutoring and review sessions, community service opportunities, counseling, exam prep, field trips and college visits, mentorships, and summer programs. Numerous partners assist with YSLPP's programming, internship placement, funding, and staffing needs.

To help its students truly find lifelong professional success, I began working with YSLPP last summer to bolster the program's alumni initiatives. While YSLPP is incredibly successful with helping students meet their academic and post-secondary educational goals while students are still in high school, some alumni have difficulty continuing on this trajectory of success. To mitigate the impact of YSLPP's diminished network of support after high school graduation, YSLPP is building a formal alumni community. YSLPP alumni feel strongly about the program and will seek out opportunities on their own to give back to the program or assist other alumni with their professional journeys. Setting up official pathways for alumni to share their expertise with one another will allow all alumni to find the support they may need.

YSLPP's primary alumni initiative is the Young Scholars Alumni Society (YSAS), a no-fee alumni networking platform designed by the developers of Common Affinity using Jevelin and WordPress. At the end of my 10 weeks as a Summer Field School Fellow, I was hired by YSLPP to continue developing this platform. After spending the past academic year specifying all the technical features YSLPP would like for the platform, this summer I worked to develop content for the platform. Some of the platform's pages include information on mission statements, partners, the pre-existing Graduate Leadership Development Program, volunteering forms, prior community internships. I also helped to develop the pre-registration form and registration page.

The heart of YSAS consists of its alumni directory. This was grown by using existing database information, connecting with alumni, and reaching out to former staff members. A redacted version of the Young Scholars alumni database, the directory provides alumni with contact information so that they can connect with others.

My responsibilities for the summer additionally included regular meetings and correspondence with Common Affinity, as well as updating the platform's main funder, UpMobility Foundation. Thanks to the support from Common Affinity and UpMobility, YSLPP and its alumni have a pathway for finding academic and professional assistance, especially within the Mohawk Valley community.

Research Fellow: Anna Duerr (2022)   **Concentration: Environmental Geography**

Faculty Mentor: Peter Klepeis   **Department: Geography**

**Title of Project: Food Access and Inequality in Utica, New York : A Spatial Analysis
of Supermarket Redlining**

Project Summary:

The ability to access fresh food and other dietary staples is a key factor in health and quality of life. Multidisciplinary research shows that ethnic and racial minorities as well as the socioeconomically disadvantaged often face barriers in accessing fresh food. One of the largest barriers faced is food deserts which are areas of a city where at least 20% of the population falls below the poverty line and 33% live more than one mile away from a supermarket or large grocery store. In addition to other factors that contribute to the presence of food deserts, legacies of racially discriminatory redlining housing policies may also play a key role in shaping an area's food environment. Utica, New York was one of the almost 200 U.S. cities in which the Home Owners Loan Corporation (HOLC) created residential security maps in the 1930s. These security maps graded areas of neighborhoods from best to worst according to their desirability by homeowners and mortgage lenders. While the grading criteria was supposed to be based on quality and age of infrastructure and desirability of the area, the race, ethnicity, and income of area residents were weighted heavily. The theory of supermarket redlining posits that modern supermarkets have followed the patterns of development put in place by the HOLC security maps. The argument is that supermarkets locate themselves in the highest graded areas, leaving the lowest graded or redlined areas without any full-service food retailers. But this argument does not hold for Utica. My research shows that the current pattern of food retail locations and their level of service does not reflect areas in which redlining occurred. Instead, the spatial distribution of supermarkets in Utica more closely follows the most recent city zoning map. Utica's current food environment, while classified as a food desert, has the majority of its supermarkets located in its previously redlined city center where today many of the city's poorest residents live. Other factors potentially inhibiting fresh food access - such as transportation options, income, or food preference - need to be studied, however.

Research Fellow: Carson Durdel (2022)   **Concentration(s): History; Political Science**

Faculty Mentor: Bob Kraynak   **Department: Political Science**

Title of Project: Cicero, Civic Virtue, and Collapse of the Roman Republic

Project Summary:

During the first century BC the Roman Republic was the master of its known world, but it would collapse by the end of the century. It had arisen through a series of military struggles and with the help of an unwritten constitutional system based on the will of the people. The Republic built a system of incentives based on honor, the assigning of military and political offices, which were the greatest social currency of the third century BC. Edward Watts in his book *Mortal Republic*, argues that the Republic collapse was a multicausal event which centered on the loss of civic virtue – placing the public good above private interests – and violation of constitutional norms. Watts goes further and blames Cicero who was a leading philosopher and statesmen of the Republic in its final century. Watts posits Cicero was arrogant of his own abilities, ignorant of the reason for the Republic's collapse, and wholly inadequate to save the Republic, and someone who allowed the Republic's demise. Cicero was a braggart, but Watts is unfair in his assessment of Cicero as ignorant or inept. Cicero agrees with Watts that there had been a golden age for the Republic and there had been a series of crises which slowly eroded the Republic. Most importantly, Cicero believed that the loss of civic virtue and the violation of constitutional norms were the reason for the Republics woes. Although Watts and Cicero are right in their assessment of the reason for the Republic's slow demise, they are unrealistic in their belief that it could be saved by the time of Caesar's civil war. Further, Watts is inaccurate in portraying Cicero as unable to preserve the Republic since he did destroy two major threats to the Republic and opposed the rise of Caesar and the threat of Mark Antony. However, the civic virtue which it took to build up over centuries was largely gone by the time of Caesar and the Republic passed the point of no return. Cicero believed the revitalization of civic virtue could save the Republic, but he was too optimistic that one man within one generation could affect a change which previously took generations. Cicero was a martyr and Watts 'assessment of him does not reflect the real Cicero. The Republic was in crisis and Cicero became a martyr as he did all one could to save it.

Research Fellow(s): Tyson Echols (2023)   **Concentration:** Molecular Biology
                              Elisabeth Pezzuto (2022)   **Concentration:** Biology

Faculty Mentor: Engda Hagos   **Department:** Biology

Title of Project: Cells Lacking Functional Krüppel-Like Factor 4 Exhibit Increased DNMT1 expression and downregulates MGMT expression

Project Summary:

Colorectal cancer is the third most common cancer and results in an estimated 492,000 deaths annually. Krüppel-like factor 4 (*Klf4*) is a zinc-finger containing transcription factor that regulates cellular processes such as cell growth, proliferation, differentiation, autophagy, and genomic instability. In addition, *Klf4* plays key roles in p53-dependent DNA-damage responses. There has been evidence that *Klf4* acts as a tumor suppressor gene in certain cancers such as colorectal cancer. However, the mechanism by which *Klf4* acts as a tumor suppressor is not well understood. The goal of this study was to investigate *Klf4's* role in epigenetic regulation and how this offers insight into *Klf4's* maintenance of genomic stability. We looked to determine whether *Klf4* regulates epigenetic modifications in mouse embryonic fibroblasts (MEFs) and colorectal cancer (RKO) cells. Epigenetic changes are modifications to DNA that regulate whether genes are on or off without directly altering the DNA sequence. Here, we looked to examine two proteins related to epigenetic modifications, DNA methyltransferase1 (DNMT1), a DNA methylating enzyme and O6-methylguanine-DNA methyltransferase (MGMT), a DNA damage repair protein. Using western blot experiment, we carried out drug treatments using FH535, a beta-catenin inhibitor and SW115246, a DNMT1 inhibitor. We found that cells that have functional *Klf4 exhibit* downregulated DNMT1 expression and upregulated MGMT expression. Through immunohistochemistry, we found that RKO cells with induced *Klf4* upregulate the expression of MGMT. Our findings indicate a regulatory relationship between *Klf4*, DNMT, and MGMT. However, further research is necessary to determine the exact mechanism behind this relationship. We plan on conducting more experiments such as ChIP and IP to determine the mechanism behind which *Klf4* regulates the aforementioned proteins. We will also conduct global methylation experimentation to understand methylation patterns within MEFs and RKO cells.
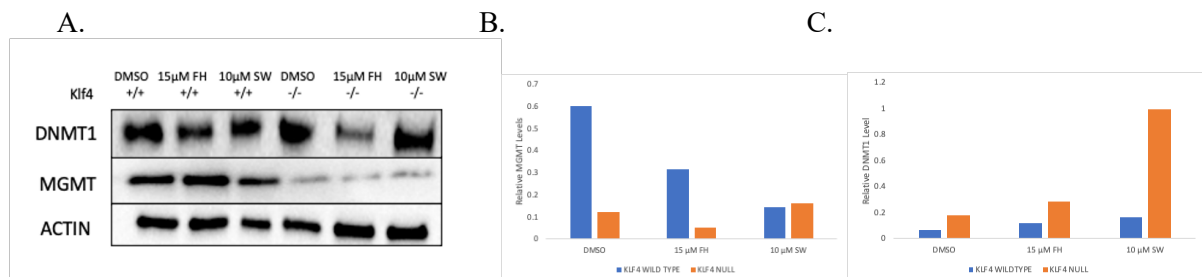
Fig. 1 *Klf4* upregulates *DNMT1* expression and downregulates *MGMT* expression in MEFs. (A) Western blot illustrating expression levels of DNMT1, MGMT, and β-actin (loading control) in protein samples derived from $Klf4^{+/+}$ and $Klf4^{-/-}$ mouse embryonic fibroblasts, with drug treatments of 15μM FH, 10μM SW, and DMSO as a control. (B) Quantification of MGMT levels, normalized using β-actin. (C) Quantification of DNMT1 levels, normalized using β-actin.

Research Fellow: Daniel Espinosa (2023)   **Concentration: Physics**

Faculty Mentor: Ken Segall   **Department: Physics and Astronomy**

Title of Project: Neuromorphic Reservoir Computing with Josephson Junctions

Project Summary:

The rapid development of machine learning in recent years is largely due to the advent of neural networks. The most cutting edge approaches towards applying neural networks involve the use of recurrent connections. These connections allow for the expression of richer dynamics and thus for a better separation of the input space for classification. In our project, we have developed a spiking recurrent neural network in superconducting electronics, and deployed it in a reservoir computing configuration in order to test the intersection between these two ways of processing temporal information.

To this end, we used WRSpice software to test our reservoir using current transient analysis. By combining the established Josephson junction Neuron and Synapse circuit designs, we simulated a four by four neuron-synapse grid affectionately titled "Morpheus" (More Organized Reservoir with PHysical Early Unified Synapses).

Our preliminary tests of the system with parity and channel equalization benchmarks led to inconclusive results regarding the performance of the reservoir: it performed remarkably well under a restrained set of conditions, yet failed when we stopped updating the weights of the output layer given the incoming inputs after the training time, i.e. it could not predict into the future, but could recreate outputs in the past with extremely limited accuracy.

After tweaking our design to conform with the latest single flux quantum i.e. soliton-based superconducting reservoir computing articles, we obtained results worse than expected. The high dependence of the predictive ability of reservoir dynamics based on the output layer of choice, coupled with high sensitivity in internal parameters, leads to a system capable of approximating the behavior of a leaky memory unit—yet its usability is null after just a few picoseconds of data due to its very low rates of accuracy in making future predictions.

We believe that this relegates the usage of reservoir computers to a set of niche applications such as signal correction from pre-trained noise sets, etc. However, due to the constraints of the reservoir as a leaky memory (its memory capacity, time until dismissal of data, etc.), it is still outshined by more commonplace machine learning algorithms such as the long short-term memory, the transformer, attention, etc. in most applications regarding input forecasting and the prediction of time series data. Moreover, in its niche fields of signal correction and channel equalization, it is equally outdone in accuracy by local outlier factor and k-NN algorithms.

Research Fellow: Ryan Ewanow (2023)   **Concentration:** Biology

Faculty Mentor: Paul Harnik   **Department:** Geology

Title of Project: Life history variation in the bivalve *Ameritella versicolor* in coastal Alabama

Funding Source: Doug Rankin '53 Endowment-Geology Research

Project Summary:

Ecosystems in the Gulf of Mexico are at the frontline of many human-induced changes to the environment, including nutrient pollution. Agricultural and urban runoff, containing nitrogen and other nutrients, flows down the Mississippi River into the northern Gulf of Mexico. Elevated nutrients increase marine primary productivity (i.e., algal blooms), which can affect the organisms that rely on primary producers for food. In my study, I examined the impact of increased food supply on one species of bivalve mollusk, *Ameritella versicolor*, in coastal Alabama. When resources are limited, individuals born from larger eggs are more likely to survive. However, when resources are plentiful, selective pressures decrease and all individuals have a higher chance of survival regardless of egg size, therefore organisms that produce many, smaller eggs will increase in frequency over time. Egg size correlates with larval shell (PI) size in these organisms. Therefore, we can compare the egg sizes of past and present populations by measuring the PIs on live and dead shells, and test for changes in its life history as a result of human-induced changes in primary productivity over time.

The larval shell structures are very small - approximately the width of two human hairs - and are measured using a scanning electron microscope. As a result of various post-mortem processes, larval shells show a wide range of preservation. Poorly preserved shells can be difficult to measure, therefore I scored each shell using a categorical grading system, with 4 being the worst preserved, and 1 being the best preserved. After successfully collecting measurements on 98 dead specimens and 30 live specimens, I observed that the average live PI size was significantly smaller than the dead PI size; $p < 0.001$ for both a t-test and a Mann-Whitney U test. These preliminary results demonstrate a temporal trend that is consistent with my hypothesis, however, there were some challenges that need to be addressed through further work. First, the vast majority of measured specimens were poorly preserved (preservation grade 4), and many specimens (171) could not be measured at all due to poor preservation. Not enough shells were well preserved (grades 1 and 2) to assess whether variation in preservation biases PI measurements. More measurements are needed to rule out preservation as a source of error in this study. Additionally, the current sample size of live specimens is limited (30 shells), and additional live measurements are needed to confirm that the observed live-dead difference in larval shell size is robust.
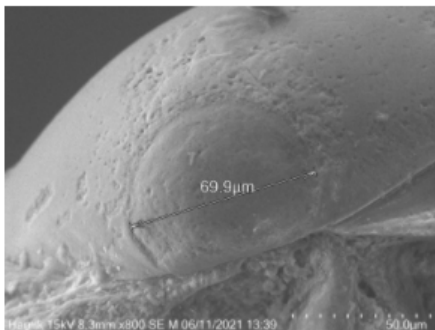
Figure 1. SEM image of dead *Ameritella versicolor* taken at 800x magnification.
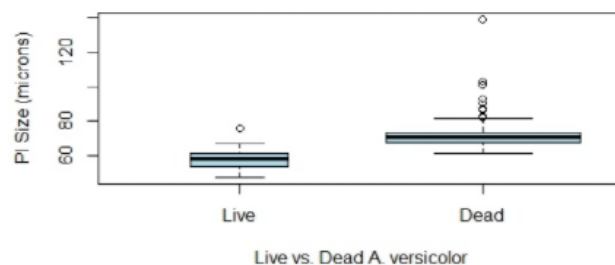
Figure 2. Boxplot showing all live and dead PI measurements. Dead PI sizes are larger on average but more variable.

Research Fellow: Maurine Fan (2023)   **Concentration: Molecular Biology**

Faculty Mentor: Ernie Nolen   **Department: Chemistry**

Title of Project: Development of Oxime Cyclization and Trifluoromethylation on GalNAc Model

Funding Source: National Institutes of Health (NIH) Area Grant

Project Summary:

The goal of the Nolen group is to synthesize a stable mimic of the tumor-associated carbohydrate antigen (TACA), particularly the Tn antigen (O-GalNAc)-Ser/Thr, that can trigger an effective immune response against cancer. Past studies had shown that integrating trifluoromethyl moieties into drug candidates can affect their metabolic stability, lipophilicity, and steric characteristics. Another NMR study acknowledged that the presence of a CF_3 group substituent pushes the peptide to an extended β-sheet conformation that is rod-like, like the O-mucin proteins in which the Tn antigen is found. To study the potential for synthetically introducing a CF_3 group, a simplified model was explored (Figure 1). If this procedure is successful, it will be applied to the Tn-antigen analog system proposed by the Nolen group (Figure 2).
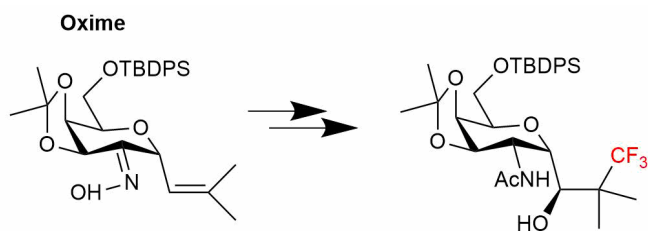
Figure 1. Oxime Cyclization and Reductions to GalNAc with CF_3
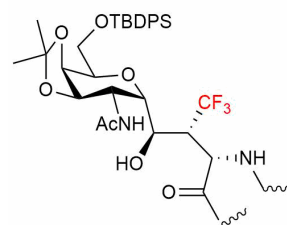
Figure 2. The Overall System with CF_3

This summer, the oxime above was prepared in 6 steps and several oxime cyclization/trifluoromethylation reactions were attempted: a trichloroisocyanuric acid (TCCA) promoted cascade (Figure 3), a photocatalytic radical cascade, and an iodine mediated pathway. The last reaction was able to produce a monofluoro-substituted isoxazoline, though the desired product was not observed in the first two reactions. For the most promising TCCA promoted cascade, the acetate and chlorine substituted products were observed (Figure 3). In the future, this reaction will be attempted again using a preformed [(phen)CuCF_3] complex to promote the *in-situ* production of the essential $CuCF_3$ before the addition of TCCA and the oxime.
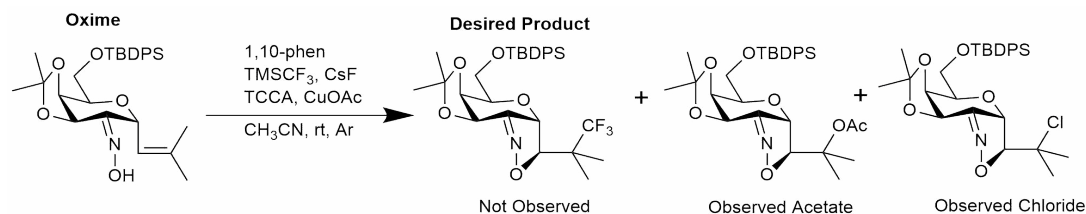
Figure 3. Scheme 1.

Research Fellow(s): Jessie Farrell (2024)   **Concentration: Undeclared**
                      Darius Hagyan (2024)   **Concentration: Undeclared**
                      Abigail Melican (2023)   **Concentration: Geology**
                      Jessica Zehner (2023)   **Concentration: Environmental Geology**

Faculty Mentor: Alison Koleszar   **Department: Geology**

Title of Project: Colgate BLAST (Bubbles, Liquids, And Silicic Tephras): What Causes Dangerous Volcanic Eruptions

Project Summary:

Our project, Colgate BLAST, is researching Augustine Volcano in Alaska. Augustine is a prime example of why volcanic research is essential for social and scientific purposes. Augustine is located 280 km from the major city of Anchorage where thousands of cargo and passenger planes travel to and pass over daily. Ash emitted by volcanoes is extremely hazardous to aircraft; famously, an ash cloud from Alaska's Mt. Redoubt caused all four engines to fail on a Boeing 747 flight. This near disaster led to the formation of the Alaska Volcano Observatory (AVO), which now monitors Augustine; however, there is still little known about Augustine compared to other, more well-studied volcanoes. Augustine's recent history is characterized by small and moderately-sized eruptions, but much larger eruptions occurred in its past. It remains unclear what causes this eruptive variability and what future eruptions for Augustine will be like, but our research may provide some insight into these lingering questions.

We focused on samples from Tephra B and Tephra M, which erupted 400 and 800 years ago respectively, and collected data on bubble number density and microlite number density, which can provide information on factors such as eruptive column height and conditions of the magma chamber. We used Photoshop and the MATLAB script FOAMS to analyze bubbles and microlites within tephra samples. By comparing our data to Augustine's 2006 eruption, we can observe changes in Augustine's behavior before written records existed and identify what processes drove changes over time.
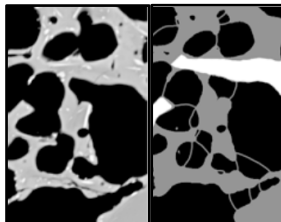
Figure 1, left: A portion of a 500x image before it was processed in Photoshop (left), and after it was processed to highlight phenocrysts, glass, bubbles, and reconstruct broken bubble walls (right).
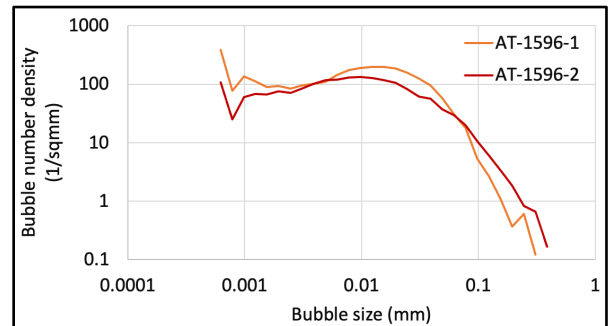
Figure 2, right: Continuous curves on plots of vesicle size versus number density confirm that our selected images include a continuous range of vesicle sizes. The red and orange lines represent the data we collected from the two thin sections, AT-1596-1 and AT-1596-2, of Tephra B.

Backscattered Electron (BSE) images at four different magnification levels (thin section, 75x, 100x, and 500x) were provided to us by our collaborator at AVO, Dr. Matt Loewen. Varying levels of magnification offered a better view of bigger and smaller vesicles at consistently high resolution. We identified three objects in each image: phenocrysts, glass, and bubbles (Fig. 1).

We selected digital number values and size cutoffs in Photoshop for each object for identification and proper image analysis in MATLAB. FOAMS quantifies vesicle measurements and population statistics, generates distribution plots, and ensures efficiency and consistency between studies and researchers. As our summer work set the foundation for this multi-year project, a primary goal was to verify that our different image magnifications overlapped to produce one cohesive set of data across all vesicle sizes. We ultimately were able to produce a complete set of bubble number density curves for two image sets (Fig. 2).

Research Fellow: Charlie Filipovich (2023)   **Concentration: Geology**

Faculty Mentor: Karen Harpp   **Department(s): Geology; Peace and Conflict Studies**

Title of Project: Virtual Galápagos An Innovative, Interactive Science Outreach Project

Funding Source: Norma Vergo Prize

Project Summary:

Children by nature are curious creatures, inquisitive about the world surrounding them. Unfortunately, many primary schools lack sufficient resources to implement appropriate science programs. In the Virtual Galápagos project, the primary goal was to design a way for children around the world to learn fundamental scientific concepts by taking a virtual trip to the Galápagos Islands.

Targeted for a young audience, predominantly between the ages of eight and twelve, the Virtual Galápagos interactive website needs to communicate scientific content in a way that is accurate and engaging. Over the past few summers, previous student teams have worked on the project, designing modules that enable children to explore the Galapagos through a variety of interactive media. This summer, I was tasked with expanding upon this work to increase the website's cohesiveness in design and interactivity.

To make the website more interactive, we changed the presentation of the information from videos to character interactions and clickable items embedded within the content. Basically, the user is able to interact with the characters through a "buddy" of their choosing, to help simulate data collection from their virtual surroundings. This update involved new character development, including scientists to guide the user through the module. The scientist characters possess knowledge in the scientific discipline corresponding to the module's theme. Their avatar correlates to an animal found on different Galápagos islands. A significant foundational concept of the website that we wanted to highlight was the scientific method. Children can now "hold" specimens, collect observations in their "fieldbook," and draw conclusions with their corresponding scientist and buddy. Each of these changes affected how the material was taught, which then led to updating the scripts for the module. Some of the interactive components added include "fill in the blank" exercises and enhanced observation exercises.

Designing the website to enhance interactivity and accessibility was another priority for the summer work. To make the layout more "child-friendly", I designed the characters as anthropomorphised cartoons, and we added maps and other animations to engage the users. I also developed an overall design with more of a video-game-like appearance, with characters located in the corner of the screen at all times and dialogue boxes for users to read and hear. The entrance to the site was also updated, with a colorful, animated sequence involving a popular bird on the island and our naturalist tour guide, a blue-footed booby. An animated summary was also created to ensure the user fully understood the main scientific objectives from the module. Owing to the fact this is an on-going project, sprite sheets of characters, detailed notes, and comments were created for future research students to reference.

The Virtual Galápagos Project is on-going; please contact Karen Harpp (kharpp@colgate.edu) for further information.

Research Fellow: Abigail Flynn (2022)   **Concentration(s):** Middle Eastern and Islamic Studies; Psychological Science

Faculty Mentor: Carrie Keating   **Department:** Psychological and Brain Sciences

Title of Project: Perceptions of Political Charisma: A Cross-Cultural Examination of US and Arab Populations

Project Summary:

This research on political charisma aims to explore what causes an individual to be perceived as charismatic and whether the gender of the politician plays a role in this relationship. One important component of charisma and leadership is non-verbal communication. Some theories posit that it is leaders that show the most formidable behavior, such as fist-shaking and scowling, are perceived to be the most charismatic. Other theories posit that it is leaders who show the most receptive behavior, like smiling and showing open palms, who are seen as the most charismatic. Keating et al. (2020) presents a Status Cues Theory, which suggests that it is a *combination* of receptive and formidable behaviors that causes an individual to be perceived as charismatic. However, this "formula" for charismatic behavior may change based on the gender of the individual. Do viewers prefer women who overcompensate with more formidable behavior? Or do viewers prefer an individual who conforms to gender roles? This research asks whether the status cues that convey charisma are different across cultures with a specific focus on how cultural differences relate to gendered perceptions of charismatic leadership.

Given that each culture has a unique set of expectations for leadership characteristics (Kabasakal, 2012) and each culture has its own conception of gender roles, it seems logical that gender should be an important variable to analyze. In terms of leadership characteristics, an international study of business management styles found that Egyptian respondents indicated that their leadership style had a large power distance and lower gender egalitarianism compared to other cultures (Kabasakal, 2012). Another study of managerial practices in Egypt found an emphasis on institutional collectivism and male dominance. Preferred leaders are those who micromanage employees and make unilateral decisions. U.S. employees see leaders as similar to themselves whereas in Egypt, leaders are viewed as a distinct and superior group (Javidan et al., 2006). Charismatic leadership is important when traditional forms of authority, such as a royal bloodline, are absent (Roberts and Mueller, 2021). This is seen in individuals like Gamal Abdel Nasser, who is widely regarded as one of the most charismatic leaders in recent Egyptian history. Nasser was described as having a dominating presence while also as speaking to the public with a more casual form and dialect (Dorraj, 2017).

To explore this concept, we collected videos of male and female leaders from various sources, including the US Congress, the Egyptian parliament, and the Middle East Institute's panels, noting the ethnicity of the speaker, the language they were speaking, and the topic they were speaking on. To avoid potential political bias, leaders selected for these videos were lower-level politicians or activists who are not generally recognizable to the public. Then we removed the audio from the clip and shortened it to 30 seconds. In the fall, we will present these videos to participants within the United States who are from the US or are Arab immigrants who came to the USA within the past five years. The participants will watch and then rate how trustworthy, charismatic, receptive, warm, attractive, formidable, dominant, and powerful each leader appeared to be.

In the future, we intend to use these videos and their ratings for a second study in which we use electroencephalogram (EEG) data. Previous research has indicated that activation in the left hemisphere is associated with perceiving receptive behavior while activation in the right hemisphere is associated with perceiving formidable behavior (Keating et al. 2020). We intend to analyze the neural responses to these types of behaviors to see whether they are connected to how charismatic a participant rates a leader.

Research Fellow(s): Max Foote (2022)   **Concentration: Neuroscience**
Emily Stack (2022)   **Concentration: Neuroscience**

Faculty Mentor: Jun Yoshino   **Department: Psychological and Brain Sciences**

Title of Project: The effect of antidepressants on neuroinflammation in mixed glial cultures

Project Summary:

Major depressive disorder (MDD) is one of the fastest-growing contributors to the global burden of disease and is traditionally thought of as being the result of monoamine dysregulation. As such, one of the most common treatments for the disorder is selective serotonin reuptake inhibitors (SSRIs), such as fluoxetine (FLX) and paroxetine (PAR), which increase the duration of serotonin signaling in the synapse. The latency of symptom relief after beginning treatment and its low efficacy suggest that, in addition to monoamine dysregulation, other factors may be at play in the etiology of MDD. In order to investigate the effects of PAR and FLX on another possible contributor to disease, neuroinflammation, we cultured primary astrocytes and microglia from neonatal rat pups. Lipopolysaccharide (LPS) treatment induced nitric oxide (NO) production in isolated microglia, indicative of an inflammatory state. This response was minimal in isolated astrocytes. BV2 cells, an immortalized murine microglial cell line, were treated with LPS and produced NO levels that were ameliorated when pretreated with FLX and PAR. BV2s seeded on top of isolated astrocytes produced a similar response, suggesting that the cells must be co-cultured for longer in order to mirror the previously reported potentiation of NO production that occurs after SSRI treatment in mixed glial cultures. Going forward, we would like to investigate the interaction between the different cell types, ideally investigating crosstalk between isolated astrocytes and microglia, as well as BV2 cells.

Research Fellow: Will Friend (2022)   **Concentration: Astronomy/Physics**

Faculty Mentor: Ken Segall   **Department: Physics and Astronomy**

Title of Project: Neuromorphic Computing with Josephson Junctions

Funding Source: Volgenau Wiley Endowed Research Fellowship; NASC Division

Project Summary:

Moore's law, which states the number of transistors in a microchip doubles every two years, has been the driving force behind the development of computers since their creation. However, as the number of transistors on these microchips have increased over the years, it is becoming increasingly difficult to scale down their size to accommodate the growing number. This has resulted in the prediction of 2025 as the termination of Moore's law where it will no longer be financially or physically possible to keep scaling down and adding transistors. This has led to a significant amount of research in alternative computing methods that veer away from the use of transistors in favor of more efficient in terms of speed and power usage. One of the leading candidates in this research is the use of a superconducting element known as the Josephson Junction (JJ). In a collaboration among three Colgate professors, it was discovered that this circuit element can be used to create a biologically accurate artificial neuron, which opens the door to a model of neuromorphic computing.

The ultimate goal of this summer project was to take the previously modeled neuron component, and connect them all to create a fully functional artificial learning synapse. This past academic year, we worked on creating a chip in which one JJ neuron fired an action potential, which was sent down a Josephson Transmission Line (JTL) into a JTL splitter. The splitter sends two copies of the action potential down two JTLs, which enter our modelled synapse (referred to as the "Learning Gate"). These act as the axons in the model of a biological neural network. We are able to control the timing at which the two action potentials enter the learning gate by adjusting the biasing currents along the JTL. It has been shown through simulation that if the two action potentials arrive within a certain time range – on the order of picoseconds – the learning gate will "learn". In our experiments, learning is denoted by the storing of magnetic flux in a large inductor, which we read out by coupling it to a SQUID and measuring the voltage across it. The hope is to test the results of our simulations experimentally with a physical design of the chip this fall. To run an experiment, the physical model of the chip is mounted in the cryostat, and using liquid helium, we bring the fridge into vacuum and cool it down to 4 degrees kelvin.

Data from a 20-hour simulation. Shows there is a dependence on the frequency at which the JJ Neuron is firing, as well as the timing delay between pulses arriving in the learning gate. The blue shows points at which no learning occurred, while the gradient shows a change in the amount learned depending on the parameters of the circuit
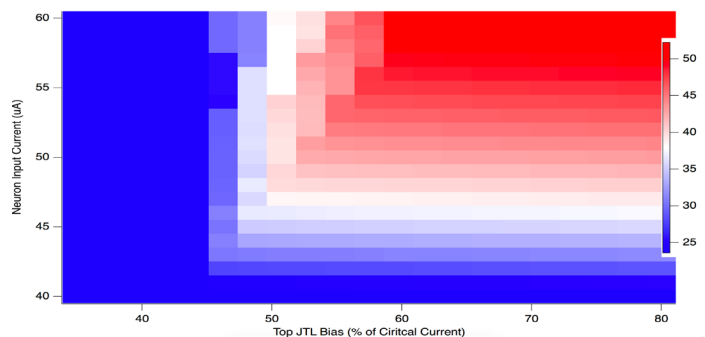
Research Fellow: Graci Galvez (2023)   **Concentration(s): Molecular Biology; Women's Studies**

Faculty Mentor: Priscilla Van Wynsberghe   **Department: Biology**

Title of Project: An investigation of kin-20 mutant phenotypes in *C. elegans*

Funding Source: National Institutes of Health (NIH) Area Grant

Project Summary:

Circadian rhythms are internal processes that respond to the 24-hour cycle. Genes that regulate circadian rhythms are called circadian clock genes. *C. elegans,* a species of nematode, are known to possess an ancestral form of circadian rhythms that are present in the form of daily fluctuations in locomotion and osmotic stress resistance. There is evidence to suggest that the KIN20 is the homolog of the protein kinase doubletime, the product of a circadian clock gene that is responsible for regulating development. *C. elegans* that obtain a mutation in *kin-20* display multiple defects that point to multiple roles of *kin-20* that are largely unknown.

kin-20 mutants display delayed growth, uncoordinated movement, and weakened sensitivity to external stimuli. Screens for gravid adults were performed for both wild-type and mutant strains. By the third day, nearly 85% of wild-type worms had already become adults, while *kin-20* mutants remained in the late larval stages. It wasn't until the fourth day when *kin-20* mutants had developed into adults, and still only about 60% of them had. Strains were also screened for touch sensitivity, and this was done using a poking tool (in this case, an eyelash) to touch each individual worm. All worms were touched at both the head and the tail to identify different responses. As expected, mutant worms moved away from the stimulus in a coordinated manner. *Kin-20* mutants exhibited different responses; while a low number of worms responded in a similar manner as the wild-type, most worms exhibited an "intermediate" response, where while there was a reaction to the stimulus, it was rather delayed, and the movement away was slow and uncoordinated.

We also noticed differences in olfactory responses. Both *kin-20* mutants and wild-type worms were exposed to a number of volatile attractants and pervasive odors using the standard set up of a chemotaxis assay. The most notable findings were that of 1-butanone and zinc chloride. 1-butanone, an established *C. elegans* attractant, was avoided by kin20 mutants. Zinc chloride, a chemical that is highly toxic to *C. elegans*, was not avoided by *kin-20* mutants, but avoided by the wild type worms.

The screens and assays performed provide a bit of information about the role of *kin-20* in terms of developmental timing. However, it's important that we find other genes that work alongside *kin-20*, as it will provide a deeper understanding of its function, and could potentially shed light on the relationship between *kin-20* and *lin-42,* another circadian clock gene being investigated in the Van Wynsberghe lab. To do this, a genetic screen was performed. Mutant *kin-20* worms were mutagenized using ethyl methanesulfonate, and resulting worms were left to grow until the second generation had become adults. The resulting worms are screened to identify worms that seem to have suppressed the *kin-20* mutant phenotype. Future directions include sequencing these candidate worms to identify the suppressor gene.

Research Fellow: Saumya Garg (2022)   **Concentration(s): History; Mathematical Economics**

Faculty Mentor: Graham Hodges   **Department(s): History; ALST**

Title of Project: Runaway Advertisements and Enslaved Database

Project Summary:

This research project, *Runaway Advertisements and Enslaved Database*, involved a study of runaway slave advertisements across different states in the colonial and early national periods. Our study mainly focused on the "Freedom on the Move" database which compiles advertisements regarding fugitives from slavery in North America. Through this database, we collected information regarding the people escaping from slavery into a matrix. We aimed to learn about the lived experiences of enslaved and free African Americans as well as the system of slavery.

We filtered through the advertisements on the basis of the states mentioned in the advertisement and worked on a state by state basis. There were multiple advertisements that came up in the search results for multiple states, and we made sure to include them under each state mentioned in our matrix. Not only did we find advertisements by the enslavers looking for the runaways, we also found a large number of advertisements for the enslavers of apprehended runaways. While a lot of advertisements did not have all the details we were looking for, we found a vast number of them that had rich information beyond what we were expecting.

In our matrix, we first noted down the names of the enslaved runaways followed by the name of the publication and the date on which the advertisement was published. We made sure to note down basic biographical details such as their age and gender. We also tried to trace the paths they took through sections for their area of origin as well as their presumed destination as provided by the enslaver. The matrix then included sections for the skills that the enslaved runaways had and any other crucial information not provided in the other columns.

While we have not been able to go through the complete database, we have gained many insights into the business of slavery as well as the experiences of enslaved African Americans. These advertisements were made to restrict the movement of enslaved people. Now, they function as a source of information regarding details that would otherwise be forgotten.

Research Fellow: Eliza Ge (2023)

Concentration(s): Anthropology; Art and Art History

Faculty Mentor: Nancy Ries

Department(s): Peace and Conflict Studies; Sociology and Anthropology

Title of Project: Managing Uncertainties: Colgate Chinese International Students' (CCISs) Decisions in the Face of COVID-19

Funding Source: SOSC Division

Project Summary:

The COVID-19 pandemic has disrupted life for Colgate students as it has for millions of other college students around the globe. With travel restrictions and quarantine measures, some Colgate Chinese international students (CCISs) have stayed in Hamilton since the outbreak of the pandemic. The information they have received about COVID-19 is wrapped into a larger narrative battle between China and the United States. The unprecedented political pressure has distorted scientific knowledge. CCISs thus are often caught in the middle of the contradictory health instructions sent by their home and host countries. Aside from the opposing official narratives constructed by Chinese and American media, CCISs have received COVID-19 information through their parents and peers in China. In the broad context of political confrontation, CCISs also need to navigate through anxiety and safety concerns about the virus, racism, and violence in the United States. My research project sought to uncover how CCISs make personal health choices about COVID-19 in the face of conflicting information.

I conducted ten semi-structured interviews with CCISs that investigated their strategic decision-making in regard to practices of mask-wearing, vaccination, and international travel. After transcribing and thematic coding, it became apparent that their decisions, associated with travel and health protocols, are shaped by complex factors comprised by state regulation, university policy, and family background. Although state regulations such as border closure and flight curtailment have significant influence on decisions related to international travel, CCISs have been proactively and agentively using resources from their family and Colgate University to manage uncertainties. Being the one-child generation from a privileged social-economic class, CCISs have enjoyed higher autonomy in decision-making due to social (e.g. families' global network), cultural (e.g. gathering information on a transnational scale), and economic (e.g. buying a large amount of expensive masks) capitals of their families. CCISs thus have opportunities to choose different types of masks and vaccines and change their protocols over time to adapt to changes in the environment. My research also demonstrates that universities can mitigate parents' and students' concerns over public health crises, political tensions, and racism by providing reliable information and medical, emotional, and practical support. Many informants hold valuable stories to tell about how Colgate's open dialogue against Asian-hate and quick response to the pandemic have empowered them. One informant stated that "when my parents learned that everyone at Colgate wore masks, they learned a version of America that is different from the one depicted on Chinese media." This quote is an example of many that demonstrates how a university can help correct information bias by providing science-oriented health instructions during the pandemic.

Research Fellow: Samantha Giuntini (2022)   **Concentration(s): French; Anthropology**

Faculty Mentor: Julie Dudrick   **Department: Upstate Institute**

Title of Project: Community Centers in Earlville and Columbus, New York

Funding Source: Upstate Institute

Project Summary:

This summer, I had the pleasure of working alongside two projects dedicated to bringing new life to their communities. One was with the Bell Tree, a community center and indoor children's playspace located in Earlville, NY. The Bell Tree's mission is to create a safe space for children to come together in order to play, learn, and explore. They provide a space for open play, where children can come to interact and socialize with each other while engaging in creative activities. The Bell Tree also hosts different events for all ages in order to bring the community together. My other project was with the Carol Kinne Memorial Columbus Center. In 2018, Bob Huot established a memorial for his late wife, fellow artist Carol Kinne. Bob's hope is for Carol and her work to be remembered and for the Carol Kinne Center to serve as a place where people can gather to appreciate Carol's work and engage with each other. The Carol Kinne Center also hosts occasional talks and presentations that provide opportunities to learn about varied topics.

My work this summer was in service to these two amazing projects, though in very different ways. My work for the Bell Tree focused on their online presence and how to improve it in multiple areas. I spent time fleshing out their Instagram account before creating a guide to using the app, noting different types of Instagram posts, as well as providing suggestions for how the Bell Tree should be building and maintaining their presence. My main project was centered around their website, which was awkward and outdated. I spent time updating and reorganizing the information on the site as well as working to format the site to the Bell Tree's vision. I taught myself how to use and navigate WordPress, and when many of the board members were also unfamiliar with the software, I wrote a guide to using WordPress. My hope was that my work would prepare the Bell Tree to bolster their online presence, take advantage of the opportunities that can arise from being online, as well as build connections with their community via the internet for the future.

At the Carol Kinne Center, I was involved in organizing Carol's work for the future. I spent time in the studio on Carol's property photographing, documenting, and assessing the condition of her body of work. For each work I catalogued, I took note of any available information about the title, date, materials, etc, as well as assessing the condition of the work and noting any damage. I then hung and photographed each piece, before carefully placing each piece in protective packing material for storage. The ultimate goal is to document and preserve Carol's work so that her artistic contributions can be enjoyed by many for years to come. Over the course of this project I learned how to use a DSLR camera and how to light and shoot artwork. I also taught myself how to use Photoshop to edit lighting and blemishes in photos.

Research Fellow: Kelly Glenn (2021)   **Concentration: Environmental Studies**

Faculty Mentor: Julie Dudrick   **Department: Upstate Institute**

**Title of Project: Analyzing Trail Camera Images to Reveal Threats to the Nesting Success
                  of the Common Loon**

Project Summary:

The Common Loon (*Gavia immer*) is one of the most iconic organisms within the Adirondack Park. After years of hunting, loon populations in the Adirondack Park were steadily declining. The passage of the Migratory Bird Treaty Act in 1918 allowed populations across the country to rebound, but loons still continue to face a number of threats other than hunting. In the Adirondack Park, loons are negatively impacted by acid rain, shoreline development, fishing line ingestion and entanglement, and human disturbance. The Adirondack Center for Loon Conservation (ACLC) works to promote the conservation of the Common Loon through research and educational outreach. One research project I undertook this summer interning for the ACLC was analyzing trail camera images captured at various nests from 2013 to 2020 with the ultimate goal of writing a lay paper aimed at educating the public about the threats to loon nesting success.

After analyzing nearly 65,000 photos, some important factors affecting loon nesting success were flooding, human disturbance, and predation. Throughout the study period, cameras recorded four nests flooded by rising water levels. All four instances occurred in June 2015 during an abnormally intense rainstorm. Since the effects of climate change will increase the intensity and frequency of rainfall events in the future, the ACLC has begun placing floating nest platforms that rise and fall with water level changes. Seven of the ten platform nests placed across the study period successfully hatched chicks, indicating the viability of this conservation method in the future.

Human disturbance events occurred whenever an individual passed too closely to a nesting loon, causing the loon to undergo unnecessary stress. Forty-one percent of nests experienced some form of human disturbance across the study period. In three cases, a human disturbance event occurred within 24 hours of nest abandonment, indicating human disturbance was the root cause of nest failure. Similarly, the wake created by motorboats passing too closely can wash eggs from the nest. Cameras recorded this happening on at least one occasion. In order to prevent future conflict between recreational activities and nesting success in the future, it is vital to keep at least 20 meters away from loons at all times.

The last factor negatively impacting nesting success was predation, affecting 16% of nests. Bald eagles, black bears, gulls, raccoons, ravens, crows, and minks are all known to eat loon eggs. Trail cameras caught predation from black bears, bald eagles, and raccoons specifically. Black bear and raccoon populations have been increasing in response to the abundance of dumpsite, creating ample food sources to sustain larger populations. Bald eagle populations have been recovering tremendously across the park after DDT was banned, increasing loon-eagle interactions as a result.

Overall, nearly half of the nests included in the study were unable to successfully hatch any chicks. Conducting additional nest camera studies will help reveal more factors negatively impacting nesting success of the Common Loon in the Adirondack Park.

Research Fellow: Emma Goldstein (2021)   **Concentration: Sociology**

Faculty Mentor: Julie Dudrick   **Department: Upstate Institute**

Title of Project: Closing the Distribution Gap Increasing Access to Dairy in New York State

Funding Source: Upstate Institute

Project Summary:

This summer I worked as a research fellow for Feeding New York State. Feeding NYS is a nonprofit organization dedicated to ending hunger in New York State through grants, education, advocacy, and research. In 2004, Feeding NYS was established as an association to help unify the ten-member food banks in New York. Today, the ten-member food banks across the state have a unified, collective voice for advocacy on hunger issues such as the Farm Bill, Summer Feeding, SNAP, and child nutrition. Feeding NYS partners with state and federal departments as well as organizations with a special interest in hunger issues to gain funding to feed individuals and families in the Emergency Food Network.

One of the largest issues surrounding food insecurity in New York State is access to dairy. In New York, there are over 3,500 dairy farms supporting the food industry. In such a dairy-rich state, it's hard to believe there are problems with diary access and distribution. However, over 2.6 million residents of New York State do not have sufficient access to dairy to maintain a balanced and wholesome diet. As a result, there is a gap of about 67 pounds per person of diary that individuals in the emergency food network are not receiving to maintain a plentiful diet. In order to alleviate this barrier and close that 67-pound gap, I assisted Feeding NYS in analyzing dairy distribution from 2018, 2019, and 2020 to understand which food programs across the state have the capacity to increase dairy distribution.

This past year, Feeding NYS requested dairy distribution data over three fiscal years from its ten-member food banks across the state. I was tasked with analyzing the data from four of these food banks. For this project, I summed the pounds distributed by each food program within these four food banks over three fiscal years and calculated the percent change of dairy distributed by these programs between 2018 and 2020. Now, Feeding NYS has the data to understand which food programs in their network have the capacity to increase dairy distribution. Such information will help break down distribution barriers and assist Feeding NYS in implementing a variety of initiatives designed to assist food banks in dairy dispersion and deliveries.

Research Fellow: Eric Goodney (2024)   **Concentration: Undeclared**

Faculty Mentor: Rick Geier   **Department: Chemistry**

Title of Project: Investigation of a TLC Analytical Method for Monitoring the Synthesis of an Alkyl Substituted Porphyrin and N-Confused Porphyrin

Funding Source: NASC Division

Project Summary:

Porphyrins are heterocyclic organic macrocycles of biological and non-biological relevance. These compounds have a central cavity that is capable of binding to a metal ion, such as iron in heme found in red blood cells. Porphyrins are widely studied for their metal binding, spectroscopy, and other properties. Unnatural porphyrins can be synthesized through a two-step, one flask reaction involving an acid catalyst followed by oxidation. The Geier research lab is interested in a systematic investigation of reaction conditions leading to an alkyl substituted porphyrin and its N-confused porphyrin (NCP) isomer. Key to this work is the development of analytical methods for monitoring the yields of these porphyrinoids.
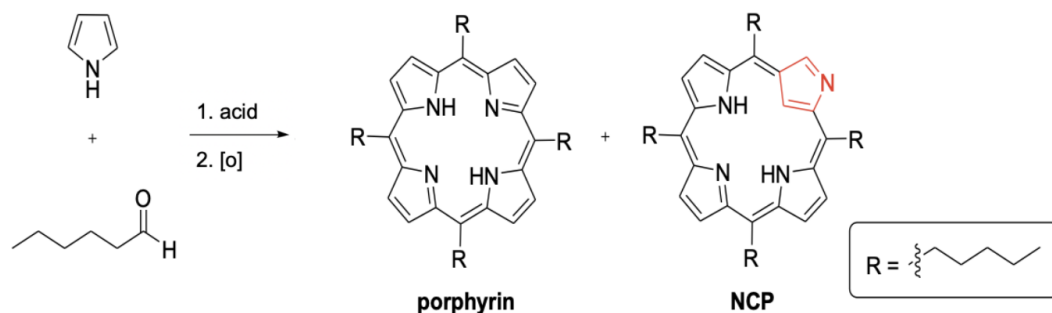
Previous students in our group performed a preliminary survey of a small number of reaction conditions, and they identified a promising starting point condition for the preparation of the NCP. As part of the preliminary work, TLC was investigated as an analytical tool for monitoring the yields of the porphyrin and NCP. TLC is simpler than a commonly used alternative, HPLC, but analysis by HPLC is generally more accurate. Reaction monitoring by TLC was found to be promising, but challenges with reproducibility remained.

The goals for the summer were to further investigate reaction monitoring by TLC, compare accuracy and reproducibility to an HPLC method being developed by another student, and apply both analytical methods to the investigation of reaction conditions in the synthesis of the porphyrin and NCP. First, a synthesis of tetrapenylporphyrin was performed to provide a sufficient quantity of sample for carrying out TLC experiments as part of improving the analytical method. The porphyrin was also used to prepare standards for TLC calibration curves relating pixel intensity to porphyrin quantity. Sources of reproducibility challenges were identified, and linear calibration curves were obtained. The improved TLC method was then used alongside HPLC to assess porphyrin and NCP yields from reaction mixtures. Agreement between the two analytical methods was not perfect, but nonetheless encouraging enough to continue using the TLC method as we expand the survey of reaction conditions in future studies.

Research Fellow(s): Leah Grossman (2022)   **Concentration: Neuroscience**
Hannah Grote (2022)   **Concentration(s): Neuroscience; English**
Natalie Marcus-Bauer (2022)   **Concentration: Neuroscience**

Faculty Mentor: Ann Jane Tierney   **Department: Psychological and Brain Sciences**

Title of Project: Investigating Food Choice and the Effects of Monoamine Neuromodulators on Behavior in the House Cricket _Acheta domesticus_

Project Summary:

Model species such as the house cricket are useful for investigating neural mechanisms of behavior. Understanding feeding behavior in insects is important in both medicine and agriculture as some species act as disease vectors and many species are pollinators or pests. In addition to providing nutrition, eating behavior can directly affect the nervous system as foods may contain chemicals that alter neurotransmitter levels or interact with receptors. Our experiments focused on the monoamines serotonin (5-HT), dopamine (DA), and octopamine (OA) because many studies have shown that they are important in cricket behavior. We investigated monoamine functioning using voluntary feeding of neuromodulators. Feeding was noninvasive and allowed us to investigate the possibility that insects may "self-medicate" by choosing to consume neuroactive compounds. We hypothesized that crickets would differentiate between control and drug-laced food, that ingested drugs would affect behavior, and that monoamine modulators would be chosen or rejected based on the insect's physiological or behavioral state.

First, we tested the effects of monoamine-altering drugs on cricket activity and anxiety-like behaviors. Crickets were housed singly and fed 10-50 mg/g of a drug mixed with control food; drugs included monoamine agonists, antagonists, precursors, and synthesis inhibitors. Following 24 h of feeding, crickets were individually video-taped for 40 minutes and behaviors, including latency to exit a shelter, general activity, and time spent in the arena center, were quantified in drug-exposed and control animals. We found that various drugs were ingested in significantly different amounts indicating that crickets could discriminate among them. Preliminary data identified some interesting trends in behavior. For example, crickets given fluoxetine, a serotonin reuptake inhibitor, spent more time in the center of the arena, suggesting a reduction in anxiety-like behavior.

Our second experiment investigated cricket food choice over time to determine whether their choice was dependent on the taste or physiological effects elicited by the food. Crickets were fasted for 24 h and then each tank was fed either high or low dose L-dopa and control food over 24 h. We repeated the cycle of fasting followed by feeding for three days, and consumption was measured daily. While crickets ate near equal amounts of drug and control food on the first day, there was markedly more control consumption compared to L-dopa in subsequent days. These results suggest that the crickets disliked the physiological effects of L-dopa, rather than being deterred by its taste on initial contact. The crickets also preferred the lower concentration of L-dopa to the higher concentration.

Thirdly, we investigated the distinction between taste and physiological effects on food choice. Crickets were fed monoamine synthesis inhibitors or precursors and recorded for 1 h to measure behaviors associated with food choice, including latency to contact food and length of time eating. A general trend was identified where crickets would frequent certain drugs more than others, indicating preferences based on physiological effects and taste. In future experiments, these results will allow us to investigate how ingestion of monoamine precursors and blockers may be modulated by prior pharmacological or behavioral manipulation of the nervous system.

Research Fellow: Samay Gupta (2024)　　　　　　　**Concentration: Undeclared**

Faculty Mentor: Yang Song　　　　　　　　　　　**Department: Economics**

Title of Project: Trade and the Value of a Second Language

**Funding Source: SOSC Division**

Project Summary:

Introduction:
Our research project investigates the relationship between the salaries of the speakers of a language and the United States' trade with countries that speak that language. The US is a melting pot, with the most immigrants out of any country, according to the United Nations Department of Economic and Social Affairs. It is both interesting and fruitful to analyze how trade influences labor market outcomes of foreign language speakers in the US.

Data:
We use six waves of individual-level survey data between 2003 and 2019 from the National Survey of College Graduates (NSCG), the World Bank's data on the US's export and import partner share, and the CIA World Factbook's data on languages spoken in every country. We assign one language to all the US's major trading partners based on what language is most spoken in those countries: Mandarin to China, Spanish to Mexico, and so forth. We calculate the cumulative trade share of various languages. For example, the trade value of Spanish includes that of Mexico, Spain, and other Spanish-speaking trade partners. Finally, we merge the language and its corresponding trade value to the NSCG by looking at the country where the individual attended high school. We choose this over citizenship as the proxy for second language because many bilingual speakers are US citizens growing up in a foreign country. We also use citizenship as an alternative inference for one's second language and results are similar. The statistics for the six most spoken languages of high school attendance location are plotted below. The number of speakers of these languages increased over time. The import and export shares of countries that speak these languages fluctuated, as well as the inflation-adjusted real salary of these individuals.

Results:
Raw correlations between trade values and salaries are difficult to interpret, because individual characteristics, family background, and original country's economic condition and education quality may be related to both language and labor market outcomes. To isolate these factors, we regress logged salary on import/export share, controlling for race, age, gender, survey year, parental education, field of degree, college characteristics, origin country GDP, and education quality. We find that the export share of a language spoken is positively correlated with salary, and interestingly, the import share is negatively correlated with salary. One potential explanation is that as import value from an origin country goes up, more students come to the US, which lowers the average ability and thus average salary of the speakers of that language.
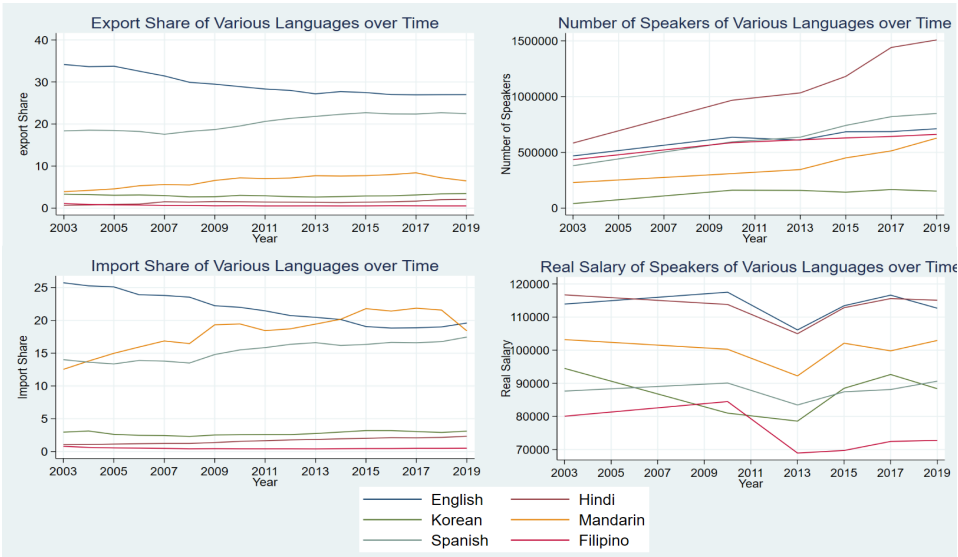
Research Fellow: Arnab Hait (2024) **Concentration:** Undeclared

Faculty Mentor: Nicole Simpson **Department:** Economics

Title of Project: Worldwide Remittance Response to the Covid-19 Pandemic

Project Summary:

Remittances refer to the money which individual residents working in foreign lands send back to their home countries. Some significant functions of international remittances are human capital development, infrastructural investments, improved healthcare, and potentially accelerating economic growth. Given the impact of the pandemic on the health of workers and the conditions of employment, analyzing the behavior of international bilateral remittances during this tumultuous period is of great significance.

The research starts by a thorough review of the literature on the determinants of remittances. There is a tremendous amount of literature on the macroeconomic and microeconomic factors which influence remittance behavior which support the two streams of debate on this subject arena - self-interest motive theory and the altruistic behavior theory. There is limited literature on how disasters or specifically economic depressions affect remittance flows. Most of these base their judgments on the 2007-2009 Great Recession - which underscore the counter-cyclical nature of remittances, further justifying the altruistic underpinnings of remittances.

The literature review indicated the void that exists in the research about how Covid-19 has affected the remittance behavior. This void indicated the research questions which this study primarily aims to answer:

- Are covid-19 related factors determinants of international remittance behavior?
- If they are, how have they impacted remittance flows?
- Are the flows counter-cyclical similar to the Great Recession? If so, then why?

Once the literature review and research questions were established, the research involved searching for the most efficacious data source. We eventually obtained global monthly bilateral flows of approximately 50 countries from the IMF. . We then were able to find monthly Covid data at Github and then decided on which specific covid indicators to be selected for regression based on thorough analysis of various recent working papers.

Once the data was found, the next step of the research was an amazing learning session. I was able to graph various country groupings and their data in Excel to give a primal viewpoint about how remittance flows fluctuate during the global pandemic. We had a session with Professor Simpson to be better able to conduct data cleaning and regression analysis. While we do not have final results to report yet, we plan to continue working on the project this fall semester. Meanwhile, I spent time on writing the introduction, literature review, data description, and providing a full list of citations.

Reflecting on the research, it has made me realize that it was an amazing learning opportunity to be involved in almost every stage of the research process. It helped me learn the technical aspects of a research, from learning to select relevant data sources to conducting regressions. It also made me realize how important the study on remittances is and the significance it carries for the developing countries where basic amenities like healthcare, education, and sanitation depends on the money migrants send back home. Thus, this research helped understand the significance of remittances in the international political economy and sparked my interest in learning and researching more about intersection of politics, migration, and economics.

Research Fellow: Emily Hazen (2022)   **Concentration: Molecular Biology**

Faculty Mentor: Julie Dudrick   **Department: Upstate Institute**

Title of Project: Who Will Answer Their Call? How New York State Can Preserve Rural Access to Emergency Medical Services

Project Summary:

Emergency medical services, better known as EMS, are a relatively new feature in modern healthcare. Formed in the 1970s, ambulance services were originally a transportation service to hospitals. Since its origin, emergency medical services have evolved greatly, providing crucial emergency care on the site of the call and in transport to emergency rooms. Modern medicine refers to the hour after an emergency medical situation as the "golden hour," in which the patient's fate is often determined by whether they receive the necessary care or not. EMTs, paramedics, and other first responders are absolutely crucial to the safety of their communities, especially in rural communities where the nearest hospital can be farther than twenty miles away. Despite its evolution and clear necessity for a healthy society, policy regarding EMS has been minimally updated since its origins as a mere transportation service. EMS agencies are heavily dependent on volunteers, especially in rural areas. Impacted by the national decline in volunteerism and the financial hardships of the COVID-19 pandemic, emergency medical services in rural communities are under threat of closing or consolidating with other agencies, which may increase wait time for ambulances in emergency situations.

The New York State Association for Rural Health is a statewide advocacy group that works to preserve and improve rural communities' access to healthcare as well as increase public health education. This work often involves advocacy at state and federal levels. In order to advocate for rural communities' access to emergency medical services, NYSARH conducted a ten-week research project to draft a policy paper with actionable policy change recommendations. The first six weeks of the project involved primary literature and policy review and interviews with EMS professionals, insurance experts, and local government officials. Over Zoom and telephone calls, we were able to conduct dozens of interviews with EMS professionals and volunteers to hear their stories and perspectives of the current EMS climate. From these interviews, we were able to identify three areas of interest:

1. Inadequate reimbursement: Medicare currently reimburses ambulance services less than a third of the actual cost, resulting in agencies losing thousands of dollars a year. Private insurance does not sign reimbursement checks to the agency but to the patient, which are often pocketed and never paid. In addition to this, EMS professionals across New York are paid up to 222% less than their first responder counterparts, including firefighters, police officers, and registered nurses.
2. Low volunteerism: Highly dependent on volunteers, agencies are struggling to fill shifts and answer calls. New York State currently offers a mere $200 tax break for EMS volunteers, hardly making up for gas costs volunteers often take on to get to the station each day.
3. The underdeveloped utilization of EMTs and paramedics: EMS agencies are currently only reimbursed if a patient is transported to a hospital/medical center. EMTs and paramedics undergo intense training and possess valuable skills that can be utilized outside of emergency calls.

The final four weeks of the project involved interviewing NY government officials as well as the Office of the New York State Comptroller, in which we received advice in drafting a strong policy paper and learned representatives' own interests in public health. These meetings also presented the opportunity to share our findings to guide future government research and committees addressing emergency medical services. With this advice, we were able to draft a six-page policy paper and develop an informational poster that will be shared with NYS and the Office of the New York State Comptroller.

From the three identified areas of interest, we have made the following recommendations. Firstly, we suggest that Medicare adjust its reimbursement rate to the model utilized by Medicaid, which covers close to 80% of the actual cost taken on by the agency. Although not perfect, it will greatly improve budget limitations. We also recommend a dual-signature or direct reimbursement policy for private insurers to ensure agencies are properly reimbursed. Secondly, we recommend New York State provide tuition breaks to volunteers and their families at SUNYs, decreasing the financial barricade volunteerism often presents as well as encouraging generational volunteerism. Lastly, we recommend New York State adopt community paramedicine initiatives being implemented across the country and especially in rural communities, which will utilize the skills of EMTs and paramedics by involving them in primary care. These initiatives have shown to reduce emergency medical situations by addressing medical issues before they are emergencies. We hope to see our work both recognized and utilized by NYS for policy change and further investigation so that rural New York communities can continue to receive crucial emergency healthcare.

Research Fellow: Jeisanelly Hernandez (2024)　　　　**Concentration: Undeclared**

**Faculty Mentor: Rebecca Metzler**　　　　**Department: Physics and Astronomy**

Title of Project: Adult Barnacle Exoskeleton Structure, Composition, and Function

Funding Source: Science and Math Initiative-SMI (NASC Division)

Project Summary:

Barnacles are sessile crustaceans that settle themselves onto ships, rocks, and even other sea animals such as snail shells and whales. This project looked at the composition of the barnacle species *Balanus eburneus*, *Chthamalus stellatus*, *Tetraclita rubescens*, and *Balanus newburnensis*. The structure and function of the *Balanus newburnensis* was also examined.

The exoskeletons of barnacles are made up of different calcium carbonate polymorphs such as aragonite, dolomite, calcite, and vaterite. To examine the possible different calcium carbonate polymorphs in the exoskeletons of the different species of barnacles, Infrared (IR) Spectroscopy was used. IR spectroscopy is used to identify organic and inorganic compounds and determine molecular structure and orientation through absorption of certain wavelengths of light to show vibrational motions of molecules at specific energy levels. Each species had peaks within the wavenumbers of 1403.08-1404.68, 873.17-876.42, and 711.80-712.78, showing that there is calcite in their exoskeletons.
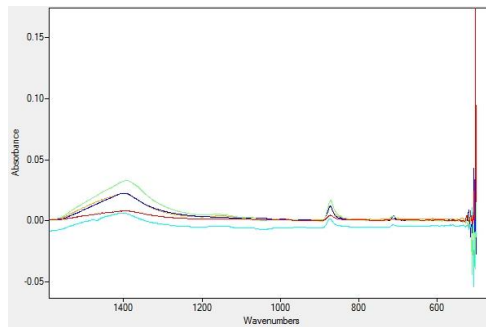
IR Spectra showing Calcite in exoskeletons. Key: Red= T.rubescens, Yellow= C.stellatus, Dark blue= B. newburnensis, Light blue= B.eburneus Baseplate, Green = B.eburneus Parietal shell.

To examine the hardness and structure of the materials in the exoskeleton of the *B. newburnensis*, Microindentation was used on sample BN1-JH which was divided into three sections: A, B, and C. Microindentation is when a force is applied to a material using a diamond pyramid leaving a certain size indent that can be used to determine the hardness at the microscopic level of the material. The indents of *B. newburnesis* showed larger indent fractures near the outer layers of the exoskeleton compared to the inner layers. Considering that the IR spectroscopy data showed that the exoskeleton was made up of a majority of calcite, the large indent fractures suggest that the outer layers of the *B. newburnesis* exoskeletons have a different crystal orientation/structure of calcite than the inner layers. Despite having one of the largest fracture radii out of the 3 sections for the shell, there were fewer large fractures in section C compared to sections A and B, suggesting that a different crystallography of these inner sections of exoskeleton was able to withstand the indent pressure.
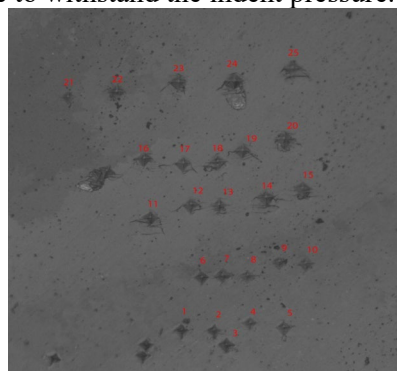
Sample BN1-JH, section B indents.

Research Fellow(s): Ricardo Hernandez (2023)   **Concentration:** Molecular Biology
                       Amaan Shaikh (2022)   **Concentration:** Molecular Biology

Faculty Mentor: Engda Hagos   **Department:** Biology

Title of Project: KLF4 maintenance of genomic stability after induced DNA damage with Etoposide and Dox

Project Summary:

Krüppel-like factor 4 (*Klf4*) is a zinc finger-containing transcription factor that is involved in a variety of cellular processes including cell growth, proliferation, differentiation, apoptosis, autophagy, and genomic instability. Depending on context, *Klf4* can act as a tumor suppressor gene or an oncogene, affecting the progression of certain cancers. We examined the expression of gamma-H2AX, a marker for DNA double stranded breaks, and cleaved caspase-3, which propagates an apoptotic pathway. The goal of this study was to investigate the role of Klf4 in DNA damage repair and how this may offer insight into Klf4's maintenance of genomic stability. Different techniques used in order to get some insight into the role of Klf4 were Tissue Culture, Western Blotting, Drug Treatments, and Chromosome Spreading. Tissue Culture aided in the ability to have a supply of cells to generate samples from for treatment groups. This was done by crossbreeding mice that were heterozygous for the Klf4 allele (Klf4+/-). Mouse embryonic fibroblasts (MEFs) that were wildtype (+/+) or null (-/-) for the Klf4 allele were derived. After initial plating, both genotypes of cells were grown in Dulbecco's modified Eagle's medium (DMEM). Cells were washed using Dulbecco's Phosphate Buffered Saline and suspended for further passaging using trypsin. RKO human colorectal cancer cells were also utilized and maintained using the same aforementioned process. The cells were housed in an incubator kept at $37℃$ and 5% $CO2$. Cells were passed every three days. Drug treatments aided in forming treating groups that had induced DNA damage compared to treatment without any drug used as a control. Mouse embryonic fibroblast samples and RKO samples were treated with different drugs prior to several experiments in order to investigate *Klf4*'s role in the DNA damage response. DMSO, etoposide (ETO), and doxorubicin (DXR) were calculated using a known working concentration as etoposide and doxorubicin are antitumor drugs that target TOP2 and induce DNA damage, and DMSO was used as a control. Western Blotting aided in detecting the presence of proteins from the cell treatment groups and quantifying that against a baseline protein. Levels of β-actin Cyclin D, gamma-H2AX, cleaved Caspase-3 and LC3 were examined using western blot analysis for samples collected from *Klf4* wildtype and *Klf4* null MEF cultures. Samples were also collected from RKO samples for western blot analysis. β-actin was used as a baseline for quantification. Chromosome Spreading aided in the visualization of the chromosomes in order to locate aberrations and quantify them. Using these techniques, we found that western blots show that *Klf4*$^{-/-}$ MEFs treated with 2 uM DXR also showed a decrease in DNA damage marker gamma-H2AX. MEFs treated with 60 uM ETO expressed more chromosomal aberrations such as aneuploidy than the control. *Klf4*$^{-/-}$ MEFs that were treated with the drugs showed the most abnormalities, while *Klf4*$^{-/-}$ control-treated MEFs had the second most. *Klf4*$^{+/+}$ MEFs treated with DXR consistently showed lower expression of both gamma-H2AX, while *Klf4*$^{-/-}$ MEFs showed more, especially as dosage of DXR increased. *Klf4*$^{+/+}$ MEFs treated with DXR also demonstrated higher levels of cleaved Caspase-3. Some future directions we had were caspase staining of MEFs treated with DXR, to follow up on Western blot data karyotyping of MEFs and RKO cells treated with DXR, to compare to ETO data and to see if *Klf4*$^{+/+}$ drug-treated exhibit chromosomal abnormality.

Research Fellow(s): Jackson Hoit (2022)
Yuntong Sun (2022)

Concentration: Environmental Biology
Concentration(s): Biology; Art and Art History

Faculty Mentor: Tim McCay

Department(s): Biology; Environmental Studies

Title of Project: Investigation of the Distributions and Habitats of Native, Wetland-Dependent Earthworms in New York State

Project Summary:

Our summer research revolved around two native earthworm species: *Sparganophilus eiseni* (mud worm) and *Eisenoides lonnbergi* (bog worm). The main objective was to find new populations of both species in various regions of New York State. We travelled to the Catskills, Adirondacks, Syracuse, Albany, and much of Madison county. At each location, we performed worm sampling at multiple sites. The sites ranged from state fishing areas to stops on the side of the road. Every site was marked with coordinates using gps or google maps. After sampling, the worms were brought into the lab for processing and identification. The secondary goal was to establish an experiment to learn more about mud worms specifically. This involved keeping sampled worms alive in the lab and developing a methodology to test for gas exchange rates and worm behaviors at multiple dissolved oxygen concentrations.
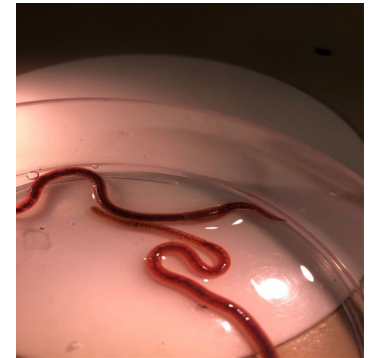
Figure 1. S.*eiseni* in the lab
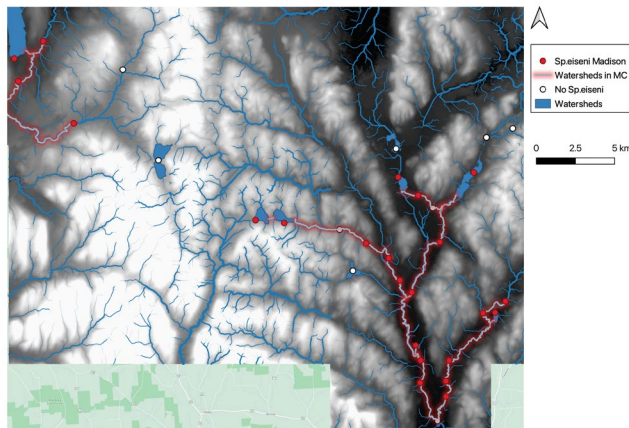
Figure 2: S.*eiseni* distribution in Madison County in DEM

S.*eiseni* and *E.lonnbergi* are both found in the sediments underneath water and along the banks of streams and rivers. Worms respire through their moist skin where air dissolves on the mucus. We came up with questions about how they adapt their gas exchange process to the water saturated soil where the oxygen level is low relative to soil in non-riparian environments. Compared to other worms, S.*eiseni* have a distinctively long and thin body which suggests that their surface area to volume ratio is high and gas exchange is more efficient on their skin. Based on our observations, we hypothesized that S.*eiseni* change their body surface area to adapt to different oxygen level environments, along with the question: What is the oxygen consumption pattern for S.*eiseni*?

We designed an experiment to answer this question that we hope to perform in the 2021-2022 academic year.

We were able to identify the first documented samples of mud worms in the Adirondack Park. Locally our group was able to construct a distribution map within Madison county that connects sampling locations across local creeks, rivers, ponds, and lakes. Combined with elevation data, the map shows the possible mechanisms for population expansion and rationale for why they are less frequent outside of valleys. There is little literature written on either species which makes our research very exciting. Finding mud worms farther north than their published range indicates possible expansion past the last glacial maximum. Studies on native aquatic worms could also be used to promote wetland conservation.

Research Fellow: Jillian Holliday (2023)   **Concentration(s): History; Educational Studies**

Faculty Mentor: Xan Karn   **Department: History**

Title of Project: Religious Freedom: The Christian Right's Weapon in the Culture Wars
from the 1990s to COVID-19

Project Summary:

Religious freedom is a point of contention in contemporary American politics because of its connection to debates about the significance of Christian values in the foundations of the United States as well as the battle to balance group rights and individual rights. Debates about religious freedom began at the Constitutional Convention when the founders of the nation decided that the separation of church and state was an important aspect of individual freedom for citizens. Thus, the First Amendment clarified the constitutional meaning of religious freedom with the Free Exercise Clause and the Establishment Clause. These clauses ensured that Americans could practice the religion of their choice without governmental interference. The meaning of these clauses in court cases transformed over time as the political state of the nation shifted, meaning that in periods like the 1940s and 1950s the courts were much more accommodating towards minority religious groups but in the 1990s they became more sympathetic to majority religious groups. In the 1990s, a major turning point occurred in the history of religious freedom when the courts shifted from a strict separationist view on the Free Exercise Clause and Establishment Clause to a much more accommodating view in the midst of the Culture Wars. The Culture Wars of the 1990s were political and moral battles between the conservative right and the progressive left about major issues concerning the nation's values like abortion. This broadening divide between the two major political groups as well as the tension that this divide created led the Christian Right to harness the power of religious freedom rhetoric legally and politically to fight for the reflection of their morals and values in laws and policies.

The politics surrounding the morals of certain religious practices often dictate the opinions and decisions of the court, and those morals that guide their decisions are often influenced by majority religious and political groups. This, in turn, demonstrates the court's inability to truly remain neutral in religious cases despite their constitutional obligation to do so. When political groups and religious groups unite like in the case of the Christian Right, religious freedom becomes a means through which the majority fights for laws and policies to match their own values at the potential cost of the rest of the general public. When the actions and goals of the Christian Right align with a more accommodating court, the Christian Right actually denies others the same kind of freedom of choice that they so heavily depend on, demonstrating how the religious freedom of groups like the Christian Right limits the more general freedoms of other individuals. As church and state become more and more intertwined, individuals, especially those who are not religious, lose their individual rights and freedoms as religious majorities gain more power and influence.

Research Fellow(s): Lauren Horstmyer (2022)   **Concentration: Natural Sciences**
Hailey Orff (2024)   **Concentration: Undeclared**

Faculty Mentor: Krista Ingram   **Department: Biology**

Title of Project: Boat-based Photo-ID of Harbor Seals (*Phoca vitulina*) at Haul-out Sites in Casco Bay to Study Site Fidelity and Social Behavior

Project Summary:

Harbor seals (*Phoca vitulina*) are abundant in the Gulf of Maine and are commonly found resting on rocks exposed at low tide, referred to as haul out sites. These sites serve as a place for the seals to rest, thermoregulate, and avoid predation, which are all important for survival. Current research on behavior and abundance of harbor seals in the Gulf of Maine is mainly being conducted via tagging, a traditional identification method that is costly, invasive, and disruptive. Our study focuses on developing and refining SealNet, a facial recognition technology specifically designed for harbor seals to identify individuals within Casco Bay, Maine.

We collaborated with other students to develop and refine the facial recognition program SealNet, which provides an efficient, low cost, alternative technology for population-based studies of harbor seals. This program allows us to identify seals through photo identification and create a database of individuals that frequent Casco Bay annually. We will use this database to better understand the abundance and behavior of harbor seals in the wild, including a) an estimation of population size, b) estimates of regional and local haul-out site fidelity, c) associations between haul-out occupation and environmental parameters, and d) measurements of social proximity at haul out sites. Our research was conducted in Casco Bay, where our team studied several haul-out sites via boat-based photography over the course of three weeks. In order to optimize data collection, we refined our photographic techniques. In addition to taking photographs of the seals, we recorded ecological data such as air temperature, water temperature, and wind speed, along with seal abundance at each haul-out site to determine any relationships.

SealNet assesses each seal individual photographed computationally in sequence, with a face-chipping process, followed by a facial recognition analysis. The face chipping process is an automated process of cropping, reorienting, and resizing individual seal faces. This process is necessary in order to compare the facial biometrics of individual seals to one another. Once these chips are gathered, the facial recognition software can be run as shown in Figure 1 to create a database of the harbor seal residents of Casco Bay. This automated process allows for seal identification in a non-invasive and timely manner, something that is essential to effective conservation strategies.

Figure 1. SealNet stores the face chips of each seal photographed to create a database of individuals. The facial recognition software compares new chips against chips of known individuals using facial biometrics to determine if it is a new seal or if it is a seal that is already stored in the database.
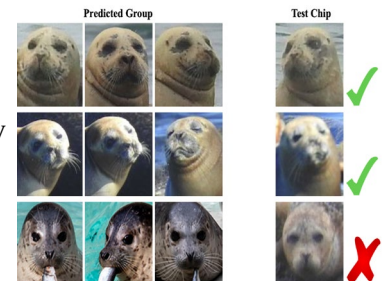
Research Fellow: Kat Housewright (2023)   **Concentration: History**

Faculty Mentor: Julie Dudrick   **Department: Upstate Institute**

Title of Project: An Homage to the Old Depot Displaying the History of Hamilton's Railroad

Project Summary:

This project entailed a summer filled with research, planning, and eventually curating an exhibit that is now displayed in the Town of Hamilton's new building. The new building on 38 Milford Street was modeled after the 1870 Hamilton train depot that stood in the same location for over a century prior to its demolition in 2015. With the loss of the historical building, the Town of Hamilton wishes to ensure that the history of the railroad in Hamilton is preserved, which is the driving force behind this project. This project required several weeks of research surrounding everything to do with the depot, from how the railroad in Hamilton came to be, to its 1958 demise, to how the building was used by the Hamilton community post-railroad. After the research phase came actually putting together the display, which was thankfully helped along by local sources Sarah Keen, head of Archives at Colgate, and John Taibi, local railroad historian who wrote most of the books utilized in the research phase. Overall, this time and effort, from several different parties, culminated in an exhibit to showcase the history of Hamilton's railroad to the Town of Hamilton, for the Town of Hamilton.

The exhibit took the form of four distinct shelves. The top shelf of the case, titled "The Building Over the Years," uses photographs of the depot to show a visual timeline of the building as it served various roles throughout its existence. The second shelf of the case, "The Railroad in Hamilton," includes documents from the railroad, newspaper articles featuring the depot, and photographs that showcase the community that surrounded Hamilton's railroad. The third shelf, entitled "The Great Chocolate Train Wreck," covers the train wreck that occurred in Hamilton on September 27, 1955 that is known elsewhere as the Wreck of the Flying Diesel. The non-fatal wreck has been given these names due to the engine of train #308 bursting out of the Leland coal shed at high enough speed to briefly fly and, when it returned to Earth, toppling some of its freight cars in the landing, including some from a Nestle factory, spilling chocolate onto the lawn which was quickly snatched up by the townsfolk of Hamilton. Due to the local celebrations of this wreck, combined with the third shelf being too low for adults' line of fight but great for children, this wreck was granted an entire shelf to itself within the display. The bottom shelf, also including the artifact located on top of the display case as well as several other historical artifacts located in the building, was titled "Artifacts from the Depot". This houses the physical artifacts affiliated with the depot, such as railroad spikes, freight car seals, and a lightning arrestor, that are sturdy enough to last and make up for the replicas that fill the upper shelves. These four shelves and beyond combine to showcase the depot's extensive history for the public as the Town of Hamilton operates in its new yet deeply historical space.

Research Fellow: Ellie Humphreys (2024)   **Concentration: Undeclared**

Faculty Mentor: Cosmin Ilie   **Department: Physics and Astronomy**

Title of Project: Locating Population iii Stars Using the James Webb Space Telescope Data Reduction Pipeline

Funding Source: Justus '43 and Jayne Schlichting Student Research Fund

Project Summary:

Population iii (Popiii) Stars are the first generation of stars formed in the universe, and a significant source of energy for these stars could possibly be from dark matter (DM), making Popiii stars very good stellar objects to research. DM does not interact with light, hence the dark in the name, however it is still matter that can be captured by a star when a DM particle interacts with a baryon inside the star and becomes gravitationally bound within the core of the star. From researching Popiii stars, we can figure out how much DM is bound within the star as well as multiple other variables. However, finding and identifying Popiii stars is the important first step.

The James Webb Space Telescope (JWST) and JWST data reduction pipeline is one of the ways I was researching how we could locate Popiii stars. The pipeline is a three-stage process that allows the telescope to find and identify astronomical objects. Stage 1 processes the raw data to produce count rate (slope) images. Stage 2 calibrates the slope images. Stage 3 does processing of ensembles of slopes images. This research is shown on the right depicting the main image and then the process of the pipeline helping to detect and identify individual objects. These data images show the JWST NIRCam Multiband Photometry manipulation on simulated WST images from JADES JWST GTO extragalactic blank field. Through the JWST Pipeline, detections of objects and galaxies in NIRCam deep imaging are made and can be examined further. The first image is the original image of the captured field of view and color corrected with F200W, F150W, and F090W. Detections are first made in a F200W image, as seen in the second photo, then isophotal photometry is obtained in all 9 filters (F090W, F115W, F150W, F200W, F277W, F335M, F356W, F410M, F444W). The third image depicts the detection through Image Segmentation, which shows the individual objects and filters out all the background noise. Each colored segment shown represents the isophotal footprints of each source. This detection is done through photutils requiring 5 connected pixels 2-sigma above background to be considered one object. With the already detected segments, we can then zoom in on individual objects as seen in images 4-6. This allows us to then find more information about that one object such as the spectral energy distribution and the magnitude fluxes.
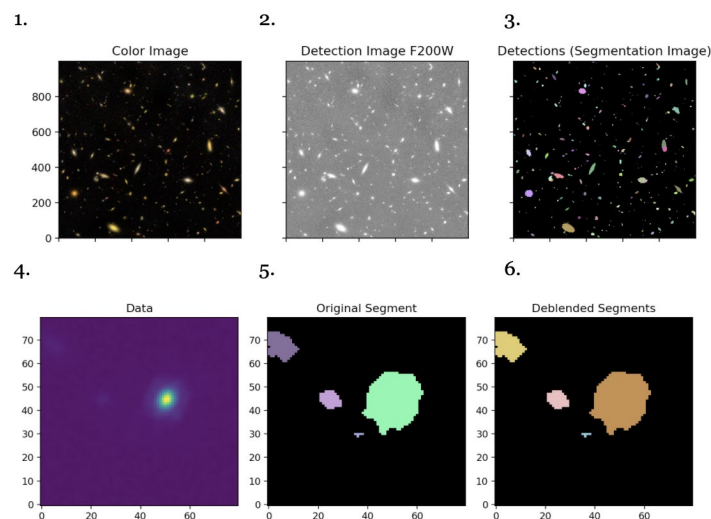
Research Fellow(s): Mateo Inoa (2023)   **Concentration: Geology**
Sadie Kasten (2022)   **Concentration: Geology**

Faculty Mentor: William Peck   **Department: Geology**

Title of Project: Passive Carbon Sequestration in Adirondack Mine Wastes

Project Summary:

Mining operations in the Adirondacks of New York are the sole US source of the industrial mineral wollastonite. As a calcium silicate, wollastonite has the chemical composition $CaSiO_3$ and dissolves in acidic conditions. With increasing CO_2 levels in the atmosphere promoting acid rain, in-situ dissolution of wollastonite at mine tailing locations may become more efficient. Dissolved calcium ions can sequester carbon from atmospheric CO_2 through the formation of calcite: $CaSiO_3 + CO_2 = CaCO_3 + SiO_2$, despite this reaction being most efficient under basic conditions. To assess the feasibility of in-situ wollastonite dissolution and passive carbon sequestration at mine sites in New York, a rooftop experiment was established at Colgate in 2019. The experiment consisted of ore stockpile material sieved into different grain sizes in containers with different water flow conditions. Tubs also included sacks of isolated pure wollastonite and all materials were left undisturbed and exposed to the atmosphere for almost two years.

The main goal of this project was to determine how much, if any, calcite had formed under various experimental conditions on a short-term time scale. To do this, we made core samples of different experiments and then sampled the cores by depth. Some experiments appeared to show a crust made possible by calcite cementation and those depths were also sampled. We powdered these rock samples for x-ray diffraction analysis to determine likely minerals present in the samples. We simultaneously worked on modifying the existing MATLAB program RockJockML to accommodate the mineral standards we were using in this project. RockJockML allowed us to determine the weight percent composition of our samples based on the diffraction pattern scans. We repeated this procedure for our samples of isolated pure wollastonite, but separated out significant clumps of wollastonite that we thought were cemented by calcite, to be analyzed later. We also measured the carbon and oxygen isotope ratios of calcite in some samples. Isotope ratios in these experiments are indicative of the source of carbon and oxygen, and can reflect biological processes during mineralization.

The samples from the ore stockpile consist mainly of garnet and wollastonite and contain too little calcite to be detected by x-ray diffraction. These samples did however show wollastonite dissolution across every grain size relative to control materials that we analyzed. The pure wollastonite samples contain detectable amounts of calcite in scans for the uncemented material alone. Pure wollastonite samples were included in the stable isotope measurements and also indicated new calcite growth. Experimental samples l have calcite with carbon and oxygen isotope ratios similar to those observed in cemented samples from the mine. Newly-grown calcite formed from pure wollastonite has distinct values that suggest a microbial component, similar to what is observed in cemented samples from the mine site. A longer time-scale extension of the project was reinstated on the rooftop and may be used to determine how these results change over time.

Research Fellow: Virginia Irby (MA)   **Concentration: Religion**

Faculty Mentor: Jenna Reinbold   **Department: Religion**

**Title of Project: Foreign, Indigenous, or Both? Complicating the African Political and
                    Religious Narrative of Hostility Towards LGBTQ Communities**

Project Summary:

This research project explores an important contemporary debate concerning the status of, and the impediments to, LGBTQ rights in Africa. Many think of Africa as an intolerant, and downright hostile, region for LGBTQ individuals. This is largely true, as many African LGBTQ individuals face criminalization and, in rare cases, the death penalty in their home countries. In fact, most African political and religious leaders argue that homosexuality is not only foreign, but actually dangerous, to African traditions and cultures. These arguments have served to inform laws and social practices which criminalize and marginalize LGBTQ individuals throughout much of Africa. Often times, homosexuality is viewed as such a large threat to African morals and values that efforts to combat homosexuality are presented by political leaders as a national security crisis as pressing as terrorism. Interestingly enough, when pressured by the international community to advance LGBTQ rights, African leaders will often, in their defense, describe homosexuality as fundamentally extrinsic to African social, religious, and sexual practice, claiming that homosexuality was imported into Africa via European colonial influence in the region. As a result, African political leaders blame the presence of LGBTQ communities in Africa, as well as the erosion of African morals and values, on European colonialism.

This project focuses on the truth of these claims by analyzing two main questions. First, is homosexuality inherently un-African? To address this question, one must contend with the possibility that it is European colonialism itself -- particularly the influence of Christian missionary projects -- that is responsible for current anti-LGBTQ discourses and politics in Africa. My second research question focuses on this possibility: What role did European colonization and Christian missionary work play in not only establishing a narrative of hostility but also in forming and advancing violent state practices towards LGBTQ communities in Africa? To answer these two questions, I narrow my focus to Kenya, a state which has received some international attention for its state violence against LGBTQ individuals but has been largely overshadowed by its East African neighbor, Uganda. Overall, I argue that evidence of acceptance of and indifference towards same-sex actions among some African indigenous religions counters the narrative that homosexuality is inherently unAfrican. Furthermore, I conclude that Kenya provides a primary example of the ways in which the rise in Christianity due to colonial influence has impacted the increase in state and religious discrimination/criminalization towards LGBTQ individuals and same sex practices in Africa.

To address these questions, I make use of a variety of sources, including ethnographies, political speeches, court cases, legal documents, academic research, human rights reports, and print media. These sources allow me to gain an understanding of this complex topic while also providing an interdisciplinary vision of LGBTQ rights in Africa.

Research Fellow(s): Joakim Jakovleski (2022)   Concentration(s): Computer Science; Mathematics
Qizhe Pan (2022)   Concentration: Economics

Faculty Mentor: Rob Davis   Department: Mathematics

Title of Project: A convex geometry and homotopy approach for power-flow equations

Project Summary:

In engineering, the study of power-flow networks, also known as load-flow networks, is concerned with modeling the balance of electric power on a network of power generation or delivery "buses". Of particular importance are the alternating current (AC) variations, which produce nonlinear equations that are notoriously difficult to analyze. The attempt to model the interaction between these buses creates a mathematical structure known as a *graph*: a set of points called vertices, some of which are connected with lines known as edges. We can use this graph to create another structure called a *polytope*: a higher-dimensional analogue of the polygons and polyhedra we know from daily life, like squares, triangles, cubes, pyramids, etc. This polytope can give us very useful information about the power-flow networks we were initially interested in; specifically, its normalized volume can provide the number of solutions to a set of equations, known as *power-flow equations*, that give a way to balance the power that is given to and taken from each of the buses. The first to note this were Chen and Mehta.[1]

Our paper builds on the work of Davis and Chen, which provides a combinatorial method of calculating the volume of this kind of polytope. Specifically, its normalized volume is always equal to the cardinality of the set of *draconian sequences* of the underlying graph. Namely, for a graph G, a sequence of nonnegative integers is draconian if it abides by the following three rules:
- it has one entry per vertex
- the sum of its entries is V-1, where V is the number of vertices in G
- for a given correspondence between the vertices of the graph and the entries of the sequence, the sum of any subset of entries is strictly less than the number of vertices that are connected to at least one vertex in the corresponding set of vertices

Davis and Chen give explicit and recursive formulas for calculating the number of draconian sequences of several subclasses of graphs, and therefore the normalized volumes of the polytopes that they create.

One of the main motivations we had for expanding upon this work was looking into certain graph constructions that were not explored in the initial paper, all the while producing unique graphs for which other simple formulas could exist. We investigated the change in number of draconian sequences resulting from subgraph addition (mostly by adding subcliques by identifying a certain edge of the initial graph with an edge of the subclique), edge deletion (by deleting certain non-induced subgraphs from a complete graph), edge contraction (underlying certain conditions about the degrees of the endpoints of the edge) and edge addition. Our method of determining formulas for the resulting graphs mainly consisted of determining specific classes of sequences that were added or removed to the graph in question once we altered it, and we were successful in finding simple formulas and subset arguments for edge deletion and contraction respectively. As for adding subcliques, while we were able to prove a weaker version of our argument, our main goal eluded us in the entire duration of our research, and we leave this as an avenue for further exploration on the topic.

Sources:
Robert Davis and Tianran Chen. Computing volumes of adjacency polytopes via draconian sequences. 2021.
Tianran Chen and Dhagash Mehta. On the Network Topology Dependent Solution Count of the Algebraic Load Flow Equations. IEEE Transactions on Power Systems, vol. 33, no. 2, pp. 1451-1460. March 2018.

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[1] Tianran Chen and Dhagash Mehta. On the Network Topology Dependent Solution Count of the Algebraic Load Flow Equations. IEEE Transactions on Power Systems, vol. 33, no. 2, pp. 1451-1460. March 2018.

Research Fellow: Adanya Jeudy (2023)   **Concentration(s): Peace and Conflict Studies; Educational Studies**

Faculty Mentor: Brenda Sanya   **Department: Education**

Title of Project: States of Discretion: Black Migrating Bodies racialization and naturalization in the United States

Project Summary:

Led by Professor Brenda Sanya, the States of Discretion project followed migrants from Anglophone African countries whose non-precedent immigration appeals had been denied. Using discourse tracing (Redden 2017) methods we spent our time analyzing and annotating immigration appeal cases presented to the Administrative Appeals Office (AAO) branch of the United States Citizen and Immigration Services (USCIS) with the intention of discerning how the appeals process and documented decisions were conveyed and how that impacted migrants from these countries. Our efforts focused on redacted non-precedent cases readily available on the USCIS website. From here, we compiled a database of 134 cases and created case summaries, which included not only information on the case numbers and status, legal representation status, and corresponding service center data, the summaries also featured the central reasons of the appeals decision. This database allowed us to find themes and discuss employment-based immigration policy as a whole, citizenship, and what the United States' policies meant for the people applying for citizenship to the United States.

Countries like Nigeria, Ghana, and Kenya were central to our study. The cases we filtered through these countries were specifically appeals of extraordinary ability professional visas (O-1 & O-2 respectively.) The extraordinary classification applied to appellants who "possesses extraordinary ability in the sciences, arts, education, business, or athletics, or who has a demonstrated record of extraordinary achievement in the motion picture or television industry and has been recognized nationally or internationally for those achievements." (USCIS, n.d.) We looked at how the understanding of "successful" differed from the origin countries and the United States. This was particular interesting because it provided insight that even appealants originating from formerly colonized Anglophone nations still struggled to progress through the US immigration process. The data opened questions about what the US valued in its citizens but also about what was at the core of the sometimes appeared to be arbitrary criteria. Professor Sanya and I are working on an essay that addresses these questions with a focus on the significant role of legal representation (or the lack thereof) in the O-1 & O-2 immigration processes.

Research Fellow: Lauryn Johnson (2023)   **Concentration(s): English; Neuroscience**

**Faculty Mentor: Julie Dudrick**   **Department: Upstate Institute**

Title of Project: STEPtember for Suicide Prevention: Raising Awareness in Madison County

Funding Source: Upstate Institute

Project Summary:

This summer, I worked with BRiDGES, the Madison County Council on Alcoholism & Substance Abuse. BRiDGES is a local nonprofit organization based in Madison County that works to connect community members to support and resources concerning issues like substance abuse, suicide, addiction, and mental health. My main responsibility was to help plan and prepare for the second annual STEPtember for Suicide Prevention Walk hosted by BRiDGES' Suicide Prevention Coalition. This is just one of the many events and programs that BRiDGES provides to Madison County, where the death by suicide rate per 100,000 people exceeds the New York State average by nearly 6 percent (NYS DOH data, 2009-2018).
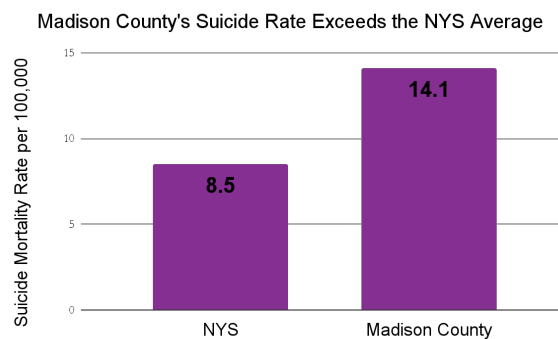
Since starting my work with the staff at BRiDGES, I have learned a great deal about the ways in which a nonprofit works to serve a community, especially within the limits imposed by Covid-19. The 2020 STEPtember for Suicide Prevention Walk took on a virtual format that relied on social media to engage participants and advocate for suicide prevention efforts in Madison County.

As the state of the pandemic began to improve, however, BRiDGES decided to host the first in-person STEPtember Walk in September 2021. In order to accommodate as many participants as possible, I, along with my coworkers, decided to maintain the virtual platform created for the previous year's walk in addition to holding an in-person event to accommodate as many participants as possible. This required updating the walk's social media platform and remodeling the website and registration process for remote and in-person participants. After focusing on these organizational aspects, I moved to planning the day-of logistics of the walk, including ordering shirts, requesting in-kind donations from businesses, and coordinating with the venue.

The donations received from the event and the increased awareness of suicide rates in our local community will help BRiDGES continue to offer programming like grief support groups and educate Madison County about suicide prevention.

Research Fellow: Raina Jung (2023)   **Concentration: Neuroscience**

Faculty Mentor: Wan-chun Liu   **Department: Psychological and Brain Sciences**

Title of Project: Development of DCX Staining Protocol

Project Summary:

Neurogenesis, the process in which new neurons are generated and incorporated into the brain circuit, is a crucial part of brain development. A clear understanding of neurogenesis is important as it supports the correct functioning of the brain and the absence or alterations of neurogenesis could lead to neurodegenerative diseases such as Alzheimer's disease, Parkinson's disease, Huntington's disease, etc. Currently, neurogenesis can be measured from the immunodetection of Bromodeoxyuridine (BrdU) or doublecortin (DCX). DCX is a valued marker of new neurons as it labels developing, immature neurons continuously without requiring subsequent injection.

This summer, I had the incredible opportunity to develop a DCX staining technique for zebra finch (*Taeniopygia guttata*) in Professor Liu's lab at Colgate University. Zebra finch is one of the most common bird species studied for neurobehavioral research due to its sociability and ability to develop songs. After obtaining brain samples from the zebra finch, we first washed free-floating brain samples using PBST and boric acids. After the wash, the brain samples were incubated with a blocking buffer overnight. On day 2, the blocking buffer was washed and the primary antibody for DCX was applied. On day 3, the primary antibody was washed and a secondary antibody for DCX was applied. Free-floating samples were then incubated with ABC solution and reacted with a DAB+ kit. Brain samples were mounted on slides and were examined on day 4.

We studied DCX staining protocols from different papers for various types of avians to complete the troubleshooting process. We varied concentrations of solutions we used, tried utilizing different solutions, adjusted incubation time, tried free-floating techniques, and made fresh solutions to identify the problem and develop a successful DCX staining technique that works for zebra finch. With this new technique, we aim to examine how wing clipping in juvenile birds that restrict their mobilization could influence neurogenesis, especially in each hemisphere of the brain, in the fall semester.
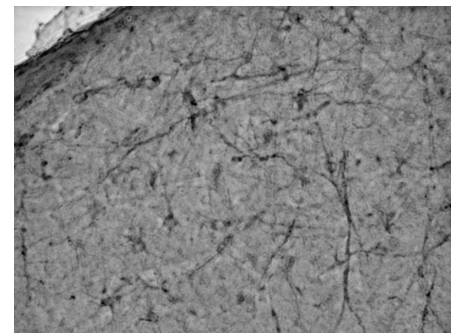
Fig. 1 DCX staining (20X)

Research Fellow: Emma Kaminski (2022)   **Concentration(s): Environmental Geography; Russian and Eurasian Studies**

Faculty Mentor: Julie Dudrick   **Department: Upstate Institute**

Title of Project: Lake Placid Land Conservancy Intern

Funding Source: Upstate Institute

Project Summary:

This summer I had the opportunity to work for the Lake Placid Land Conservancy through the Upstate Institute Summer Field School. The Lake Placid Land Conservancy is an accredited non-profit Land Trust located in Lake Placid, New York, serving the Lake Placid area, both its residents and natural surroundings. LPLC works alongside local landowners and communities in the Ausable and Saranac River watersheds within the Adirondack Park to conserve land, habitats, and resources, creating opportunities for people to interact with the wild Adirondacks. Conservation work is crucial to this area of the Adirondack park; while much of the High Peaks region is permanently protected as Forest Preserve, lowland forest communities like that of the Lake Placid area are still predominantly under private ownership, and these highly diverse and ecologically valuable lands are extremely susceptible to land development. The Lake Placid Land Conservancy helps landowners place conservation easements on their land to help keep it "forever wild", in addition to managing and protecting lands that have been donated to, or purchased by, the conservancy.

My work with the Lake Placid Land Conservancy this summer is centered around two projects which LPLC recently received grant funding to complete. One of these projects, Keeping Track, is an initiative to set up trail cameras on private property around the town of North Elba, in order to better understand the species, habitats, and other natural resources that make up this area's ecological landscape. I work mainly in reaching out to landowners with property suitable for monitoring, creating desktop assessments of their land and its suitability for wildlife monitoring and conservation, and then installing cameras on these properties. The second of these grant-funded projects that I've been assigned to, the "Wild Waypoints" program, is a citizen science initiative encouraging people to get outdoors, see the region, and monitor both environmental and human-caused changes to the land. I assist the LPLC team in recruiting locations all over the Ausable and Saranac watersheds to become Waypoint sites, where visitors can use one of our specially made signs to take precise images of the landscape, which are later used to document and analyze physical changes over time.

Much of the day to day work consists of monitoring the conserved lands that reside under LPLC's protection, documenting them, and creating reports on land condition and management methods. But there are also countless other responsibilities that come with maintaining a land trust, the staff and board are constantly working together to create management plans, programs, workshops, and educational materials that engage the community in their work, as well as promote awareness of how land can be conserved and protected. This work requires close collaboration with the community and other local nonprofits in order to be at its most effective. From what I've seen in my time at LPLC, there is also another equally important side to working in land conservancy, one heavily concerned with fundraising, environmental law, and property law, that acts as the real driving force in placing land under the care of a land trust. The opportunity to work closely with the dedicated staff and board members at the Lake Placid Land Conservancy allowed me to gain real insight into the world of nonprofits and land conservation, and the support I received from the Upstate Institute was invaluable along the way.

Project Summary:

Dairy farming has seen unprecedented changes in the past 50 years. The average herd size of dairy has grown from just 74 in 1992 to 234 in 2017. Factors like milk prices, availability of land, opportunity cost of land, availability of feed, climate, demand for dairy products, etc. were the primary causes of increase in dairy herd size. This increase in size of dairy herd has in turn given larger firms an advantage in the cost of production fronts via economies of scale.

Dairy milk and dairy products are more or less perfectly competitive products. Usually an individual dairy farmer has no control over the prices of milk and other dairy products. Since milk sold by one farm is easily substitutable with milk sold by another farm, customers usually buy from farms that offer products at lower prices. This phenomenon has resulted in a spiral where more of the smaller farms that have higher average cost of production are getting out of business, getting acquired by larger farms and the average size of farm is in turn getting larger.

This trend is visible in Madison County dairy where the average herd size for a farm size rose from 238 cows in 2012 to 249 cows in 2017. Dairy farming is a major industry for Madison County. 62% of all agricultural revenues in Madison County comes from dairy farming. While 82% of all livestock sales in Madison County comes from dairy farming. There were a total of 18,300 cows producing a total of 33,388 hundredweight of milk. Despite the importance of the dairy industry in Madison county, many dairy farms are not breaking even. In a survey carried out by Yellow Wood Associates, 30% of the farmers were just breaking even while 30% of farmers were losing money. If the trend is likely to continue, many of the small dairy farm farmers will lose their source of livelihood.

With little control over price dairy farmers have much more room to work on their cost of production than the milk prices to earn profits. The trend to increase the size of farms is unlikely to halt or reverse, thus small dairy farmers can either choose to get help from USDA farm agency to expand, or try to increase their efficiency as a small farm. USDA farm agency provides a number of resources to acquire loans to expand farm operations. On the other hand, farmers can also maintain their small farm and make profit. For this, small farms have to be extremely efficient. According to a study by Tauer and Mishra the lower cost of production that larger farms face is due to their ability to be efficient rather than as a consequence of economies of scale. For small farms to be efficient they have to keep track of all the fixed costs, variable costs, opportunity costs, maintain a good supply of working capital, maintain an up to date business plan, etc.

Research Fellow: Miya Kim (2022)   **Concentration: Mathematics**

Faculty Mentor: Kyle Bass   **Department: Theater**

Title of Project: Clean: An Original Play on League of Legends and our Shared Loneliness

Project Summary:

This research was a 10-week project into studying and writing a creative interpretation of the culture surrounding *League of Legends* and its players in the form of a play. *League of Legends*, developed by Riot Games in 2009, is a popular multiplayer online battle arena (MOBA) video game, where players incorporate both strategy and mechanical dexterity. The game includes over 160 champions (or game characters), who team up to create a unique composition in a 5 vs 5 battle.

This summer, I particularly researched and interviewed players who were highly competitive, invested in *League of Legends*, and were (or have experienced) competing in a foreign environment. I attempted to answer questions such as: what could make *League of Legends* your home? How does competitiveness impact your life, either positively or negatively? What kind of people find themselves so attached to a video game? The finished product is the first draft of *Clean*, a play in one act, with a running time of roughly 90 minutes---a choice I made in order to deliver on stage an unbroken flow of action.

I hoped to explore the dramatic potential in the structure of *League of Legends* in writing my play. The stage is divided into four cubicles, each representing the four lanes (Top, Jungle, Mid, and Bot). There are 5 main characters, each corresponding to the different champion types: the tank, the damage carry, the healer, the assassin, and the control mage. There are also Minions, highly anonymous but crucial beings on stage, present anywhere through time and space. For instance, in Scene 4, Minion acts as a dark figure from Salome's past that haunts her; in Scene 6, Minions act as online figures preying on Nikki Miaow's sexuality. Taking advantage of the live nature of theatre, I seek to provide an indirect, real-time experience of the game to the audience. *Clean* jumps between different timelines that all coexist on stage, with the past and present and future blending into one another. Problems fester. There is satisfaction, but very rarely; most are frustration, anger, confusion, sometimes plain helplessness, all designed to be performed in a very monotonous fashion by the actors.

The process of writing this play is still incomplete. I have completed my first draft, and now am working on a hard revision process to bring more evolution to the characters and provide a more engaging, theatrical structure for their conflicts. I am also experimenting with new ways to integrate the digital game world with the physical world on stage. I wrote *Clean* with pride and love more than anything else. Despite their flaws and harms, these are the markers of our generation---the Internet, questionable relationships, loneliness, violence, competitiveness---and I am hopeful to write a story to make those around me proud.

Research Fellow(s): Izzy King (2023)   **Concentration: Geology**
Lingfeng Kuang (2023)   **Concentration(s): Geology; Geography**
MC Rapoza (2023)   **Concentration: Geology**
Max Wang (2022)   **Concentration(s): Geography; Geology**

Faculty Mentor: Joe Levy   **Department: Geology**

Title of Project: Geometrical Analysis of Mars Chaos Terrains

Project Summary:

Introduction: Chaos terrains are large collapsed areas on the Martian surface characterized by irregular mesa tops and fractures.

While chaos terrains have wide geographic occurrences and variety, their geologic evolution has yet to be fully understood. Numerous chaos formation models have been proposed; however, not one has been adopted by the scientific community.

Our study takes a comprehensive approach to chaos formation by taking all prior models into account. Our study created a large data set through the digitizing of five chaos terrains. The scale of the mapped chaos terrains is revolutionary in the field. Therefore, this study allows us to look at chaos formations through a wider lens in which we can discuss numerous sites and models.

For this study, we focused on five named chaos terrains on Mars: Atlantis (182° N, -34° E), Aureum (-26° N, -4° E), Eos (313° N, -16° E), Gorgonum (-37° N, 189° E), and Pyrrhae (331° N, -10° E).

Methods: We viewed the surface of five Mars chaos terrains by using Global CTX Mosaic (supplemented by HIRISE imagery), and MOLA HRSC Blended DEM Global (200m per pixel) imagery to further map the geometry of the surface using the Spatial Analyst Toolbox in ArcMap. Specifically, we digitized the chaos edge, mesa tops, and valley networks larger than 200m x 200m present in the chaos. Specific morphologies were measured for each feature to examine the previously identified chaos formation hypotheses.

For mesa tops, area, thickness, distance from the center of the chaos, and slope orientation were measured using Zonal Statistics.

For valley networks, area, thickness, distance from the center of the chaos, and line orientation were measured using Zonal Statistics.

Result:

1. There is a moderate positive correlation between the area (in log10) and mean thickness of the valley blocks across all sites.
2. Fracture length by direction plots for all sites show a trend of favoring fractures with a direction of ~90 degree and ~180 degree. This indicates that the fractures could be forming sequentially.
3. In terms of fracture density, our results show that the denser fractures are concentrated at the chaos rim (besides Pyrrhae chaos).
4. Our result shows that across all sites, the tilting direction of the mesa tops are random.
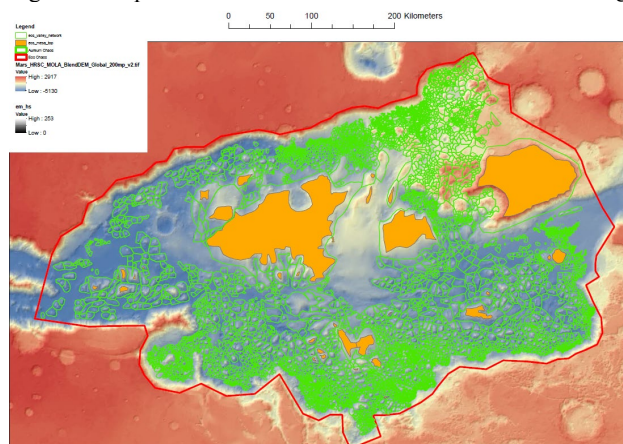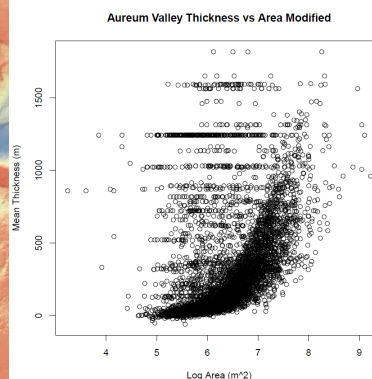
Figure 1: Map of Eos Chaos   Figure 2: Valley block Area (log 10 m^2) vs Valley block thickness.

Research Fellow(s): Izzy King (2023)   **Concentration:** Geology
           Lingfeng Kuang (2023)   **Concentration(s):** Geology; Geography
           MC Rapoza (2023)   **Concentration:** Geology
           Max Wang (2022)   **Concentration(s):** Geography; Geology

Faculty Mentor: Joe Levy   **Department:** Geology

Title of Project: Spatial and Temporal Extent of the Water Tracks in McMurdo Dry Valleys

Project Summary:

Introduction: Water tracks are zones of high soil moisture where melt-water from the snow and pore-ice is actively transported above the permafrost downslope, following the local terrain during each austral summer (Oct-Feb) (Levy et al, 2011). Comparing to dry soil, water tracks appear to be darker and can be distinguished by in situ observation and satellite images. Even though the water discharge volume of water tracks is lower than streams of glacial melt, the higher ionic concentration in water tracks makes them efficient "salt highways" in the McMurdo Dry Valleys and a crucial part of the hydrologic circle (Levy et al, 2011).

Because solute transport, summer thaw depth, weathering of the sandy soil, and nematode occurrence are linked to the presence of water tracks, it is important to gain further knowledge on their lifecycles. Our goal is to gain a better understanding of the presence time and spatial extent of the water tracks how their occurrence relates to surface and subsurface temperature.

Studied Area: McMurdo Dry Valleys area– the largest ice-free region in Antarctica. Lying above the permafrost, Sandy soil composed of glacial drift, valley-wall colluvium, and marine sediments is exposed (Levy et al, 2011), allowing glacial streams and water tracks to form. We chose 5 regions (Water Track 1, Wormherder Creek, North Bonney, Goldman Glacier Basin, and Coral Ridge) from Taylor valley where water track activities are recorded and analyzed satellite images from 2009 oct until now.

Methods: First, we loaded in satellite images (Quickbird and Worldview data; 0.7 m per pixel) of the selected sites and the Digital Elevation Models (2014andUSGS.tif; 1m per pixel) of the McMurdo Dry Valleys region. In order to differentiate the dark water tracks from the shadows cast by the mountains, we created hillshade maps that recreate the sun angles and thus shadow location when the satellite images were captured. Then we subtracted the hillshade layer from the original satellite image and created Terrain-corrected (or shadow-removed) images for analysis.

Results: Across multiple sites, it is found that water tracks' active season can last from early November to mid-February, thus lasting the whole austral summer. Previous studies thought the water track active season was around December to January. Compared with soil temperature data, we also found that water tracks can begin to form even as soil temperature is below zero, probably due to the high salinity and thus lower melting point of the pore-ice in the soil.
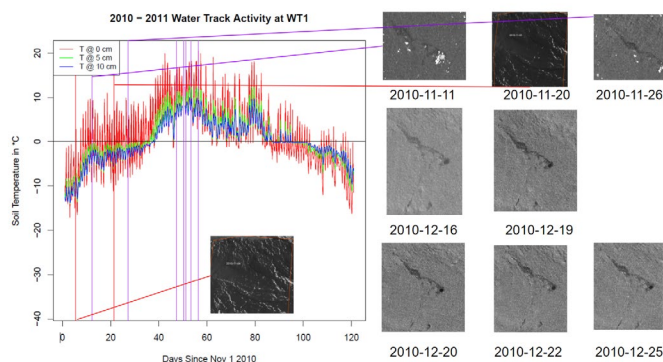

Figure 1: water track activity status with days of austral summer and soil temperature for 2010-2011 at Water Track 1 (WT1) Red line: not sure whether water tracks are present; Purple line: water tracks are present.

Research Fellow(s): Shane Knopp (2023) **Concentration:** Computer Science
Tom Richards (2024) **Concentration:** Undeclared
Sydney Walters (2022) **Concentration:** Geology
Jessica Wen (2024) **Concentration:** Undeclared

Faculty Mentor: Aubreya Adams **Department:** Geology

Title of Project: Deep Earth Imaging of the Alaskan Subduction Zone

Project Summary:

The Alaskan Subduction Zone (an area where one tectonic plate slides beneath another) is home to numerous seismic and volcanic events, including the historic 1964 magnitude 9.2 Great Alaskan Earthquake and the recent magnitude 8.2 event in July 2021. However, the generation of these earthquakes and volcanic eruptions is not uniform across the subduction zone. For instance, the Semidi Segment of the subduction zone regularly generates great earthquakes, but the Shumagin Segment does not appear to have generated a great earthquake for thousands of years. This undergraduate summer research experience consisted of four undergraduate researchers using surface wave tomography from data collected by several regional seismic networks to image the upper mantle structures associated with the Alaskan Subduction Zone. The imaging technique used in this study parallels closely with CAT scans in the medical field; however, instead of using x-rays as the power source to image the study area the researchers utilized earthquake records.

Students from a range of class years developed and applied computational skills including command line computing, data retrieval and management, Unix/Linux scripting, Matlab scripting, data preparation (including quality control, seismogram tilt and compliance removal, surface wave isolation at different frequencies) and time series analysis to build an initial model of the subsurface. Primary findings from the preliminary model include the delineation of thicker crust beneath mountainous area and pronounced low velocity zones in the mantle wedge along the system. For instance, slow velocities at short periods correspond to where the crust is thicker (see red/pink area in A and B). Medium periods have a clearly defined line of fast velocities parallel to the Alaskan Peninsula that shifts northwest as the period increases (see dark blue in C and D). This images the subduction of the Pacific Plate down to the northwest. It is important to note that the model will be further refined, incorporating additional data and model parameters, and will be combined with complementary tomographic models, to determine why this variability occurs within the Alaskan Subduction Zone, lending important insights into hazards and risk management.
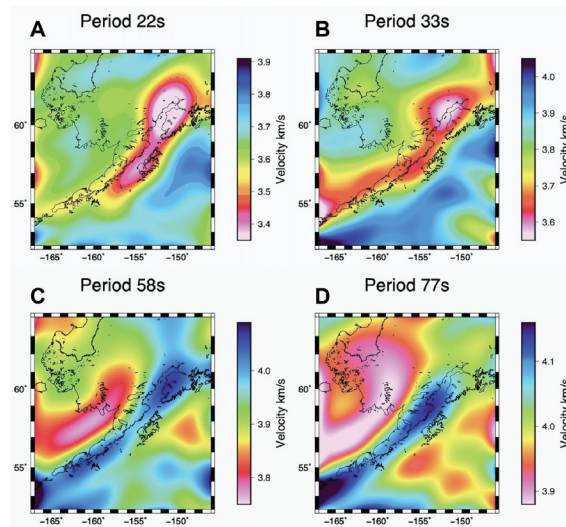
Research Fellow(s): Juliana Koller (2022)   **Concentration: Environmental Geography**
Will Krohn (2023)   **Concentration: Biology**
Giovanni Vigilante (2022)   **Concentration: Environmental Studies**
Justice Wysinger (2023)   **Concentration: Environmental Biology**

Faculty Mentor: Catherine Cardelús   **Department(s): Biology; ENST**

Title of Project: Impacts of White-Tailed Deer (*Odocoileus virginianus*) Overabundance on Temperate Northern Forest Regeneration

Forests are important ecosystems as they provide habitat for organisms, maintain biodiversity, and mitigate global warming by sequestering carbon through photosynthesis. Forests worldwide are threatened by deforestation, however Northeastern forests are threatened by one mammal in particular, the White-tailed deer.

Overhunting in the American Northeast during the 20th century dramatically reduced populations of white-tailed deer and extirpated its predator, the grey wolf (*Canis lupus*). Conservation efforts have since allowed deer to make a dramatic recovery. Deer densities now exceed 10 deer/km^2 in mixed forests, compared to pre-colonial estimates of 3.1–4.2 deer/km^2.[1] As a keystone browsing herbivore, deer selectively graze on hardwood seedlings, suppressing forest regeneration and altering forest composition.[2]

The Cardelús lab established an experimental deer exclosure study in 2017, to determine how the absence of deer influences the primary production and regeneration in the forests of Hamilton, NY. We predict that tree seedling and herbaceous taxa richness and abundance will be significantly higher in exclosures compared to control sites due to reduced deer browsing pressure. Likewise, we expect a higher density of saplings (2 cm – 10 cm trees) in exclosures compared to control because of reduced browsing pressure. A feedback we predict to observe is significantly greater growth of large trees (> 20 cm) in control sites due to a release of competition from saplings in the understory driven by herbivory. We measured the growth, quantity and diversity of herbaceous and woody taxa in seedling plots at our study sites, and recorded the diameter and vitality of trees greater than 2 cm. Results from our study will be vital for influencing deer population policy, especially if our predictions are correct and we have evidence to suggest that deer-overpopulation negatively impacts forest composition.

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Research Fellow: Will Lam (2023)   **Concentration: History**

Faculty Mentor: Graham Hodges   Department(s): History; Africana and Latin American Studies

Title of Project: Runaway advertisements and Enslaved database

Project Summary:

This summer, I scanned and organized data from antebellum runaway advertisements in the *Freedom on the Move* database under the guidance of Professor Hodges. I inputted pertinent biographical data into excel spreadsheets, such as the enslaved persons' age, gender, skills, place of origin, presumed destination, etc. After 10 weeks, I had logged information from over 1,000 advertisements from all 50 US states. The information gathered and its trends will be used by Professor Hodges to write an upcoming history book.

I noticed several recurring observations and trends while analyzing the advertisements. First, many of the advertisements stated that they had imprisoned a presumed enslaved person, and requested the enslaver to contact the jail. In some of these instances, the imprisoned person had not given their name, nor informed the jailor that they were enslaved. As a researcher of these sources, this implied to me that many jailers had often targeted and jailed black individuals without any grounds. Another recurring trend that I noticed was the presumed destination of many runaways. The most common presumed destinations were states and regions that had abolished slavery. Occasionally, certain skills were assumed to play a factor in the runaway's escape and forging of a new life. For example, several individuals had been enslaved aboard steamships, and many advertisements claimed that they might seek employment as a free boat worker. Furthermore, in multilingual communities such as New Orleans, the runaway's language speaking abilities were listed to further identify them. The most common languages listed were English, French, and Spanish. Finally, advertisements often noted whether or not the enslaved person was able to read or write, and many that could were suspected of having forged a free pass to travel to other states. Some enslavers claim in the advertisements that they believed white persons had facilitated a runaway's escape, whether it be an attempt to free them, or a cynical motivation of selling them to another enslaver for financial gain.

This research opportunity has taught me the significance of primary research, and the challenges that come along with it. The advertisements contained language that reinforced the oppressive power structure of Antebellum America; many contained racist and sexist terminology. Past historical documents often contain bigoted terms, and present-day researches must handle this fact with sensitivity as to not inadvertently neglect or reinforce past prejudice. In the database, I would note the connotations of several antebellum phrases. I would reflect and note the particular inherent biases that runaway advertisements possessed in the excel spreadsheets. I look forward to using the skills and knowledge that I have acquired this summer for the Colgate London History Study Group and other future history research opportunities.

Research Fellow: Becca Landry (2024) **Concentration:** Undeclared

Faculty Mentor: Kevin Siegenthaler **Department:** Chemistry

**Title of Project:** Functional Analysis of Minor Protein Disulfide Isomerases

Project Summary:

Over one-third of the human proteome is targeted for secretion from the cell, and most of these proteins require the insertion of covalent, disulfide bonds. The introduction of disulfide bonds is catalyzed by activity of a protein disulfide isomerase (PDI). While only one PDI protein (*PDI1*) appears to be essential in eukaryotes, most organisms possess multiple, homologous, non-essential PDIs with a similar catalytic CXXC motif. To better understand the role of these minor PDI proteins, we are conducting a screen to isolate temperature sensitive *PDI1* alleles in *S. cerevisiae*. Following the isolation of these conditionally active PDIs, we intend to assess the ability of the minor PDI proteins to complement the temperature sensitive strains and suppress any growth defects.
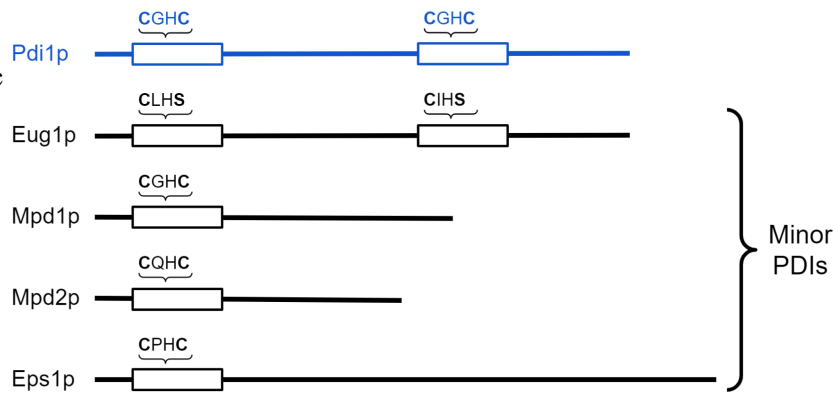
We aimed to unravel the roles of the nonessential PDI proteins in yeast and test the hypothesis that the minor PDI genes are conditionally essential and become necessary when Pdi1 activity is compromised. To this end, we employed a random mutagenesis screen to isolate temperature sensitive (TS) alleles of the S. cerevisiae *PDI1* gene. These TS alleles simulated conditions where Pdi1 activity is compromised, allowing us to test the activity of the various minor PDI homologues. Mutagenized *PDI1* alleles were screened to find mutations that exhibit a temperature sensitive phenotype. One such allele identified was the pdi1-31 strain which shows slight growth defects relative to a wild-type strain while grown at 30°C or 37°C. Simultaneously, the minor PDI genes were cloned into vectors that allowed for modulation of protein expression levels. In the future, we will test if overexpression of the minor PDI homologues suppresses the temperature sensitive phenotypes of the strains identified in our screen. This complementation data will help clarify the distinct roles of the minor PDI proteins.
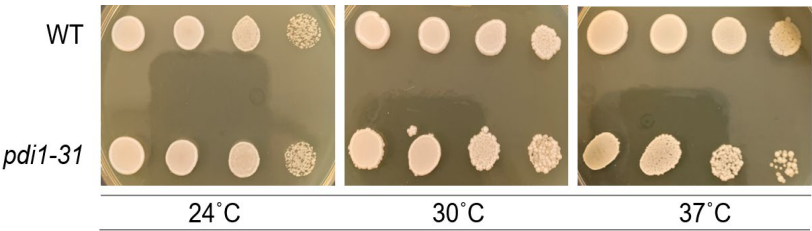
Research Fellow: YJ Lee (2022) **Concentration(s): Mathematical Economics; Middle Eastern and Islamic Studies**

Faculty Mentor: Carolina Castilla **Department: Economics**

Title of Project: Choosing when it matters: do surrogate decision-makers overcome status quo bias from overchoice?

Funding Source: SOSC Division

Project Summary:

To process large volumes of decisions daily, we come up with subconscious routines to streamline our actions based on pre-identified preferences. Nothing stops us from taking a completely different route to work, yet many stick to the same path that they always travel on even if there might be a better one around the corner. In Behavioral Economics, consciously or unconsciously choosing the same or default option instead of a possibly better alternative is called the status quo bias (SQB) and it challenges the economic principle that people act in order to maximize the benefits they receive from those actions. My research focuses on a significant cause of SQB called **overchoice**: when an individual is overwhelmed with so many choices that they elect the default instead of deliberating each available option. This summer, I designed a survey experiment that tests whether surrogate decision-makers (those who choose on behalf of others) exhibit the status quo bias from overchoice as individual decision-makers do.

*DM: Decision-Maker, *Comp: Completion

Surrogate-Easy	Individual-Easy	Surrogate-Difficult	Individual-Difficult
• Surrogate DM*	• Individual DM	• Surrogate DM	• Individual DM
• 2-4 Choices	• 2-4 Choices	• 9-11 Choices	• 9-11 Choices
Comp* Rate: 90%	**Comp* Rate:** 71%	**Comp* Rate:** 43%	**Comp* Rate:** 43%
Default Selections	***Default Selections***	***Default Selections***	***Default Selections***
Total: 60.9%	**Total:** 46.2%	**Total:** 46.5%	**Total:** 39%
Common: 59.3%	**Common:** 49.1%	**Common:** 48.6%	**Common:** 35.3%
Serious: 62.9%	**Serious:** 43.2%	**Serious:** 44.5%	**Serious:** 42.8%

Figure 1: Completion and default rates for all variations

I hypothesized that surrogate decision-makers have added pressures to make the best decision possible for their surrogates thus overcoming status quo bias from overchoice. My experiment has four treatments with the same choice-scenarios presented, only differing in number of options to choose from (2-4 vs 9-11 choices) and decision-making contexts (for surrogate or for self). The survey presents 8 questions that place participants in situations ranging from common decisions such as ice cream flavors to more serious contexts like charity. A pilot was conducted on 87 Colgate economics majors to determine average completion times and narrow down final questions from a larger pool. In addition, there were some notable *observations*: (1) unsurprisingly, the "difficult" variations, which induced overchoice, had a lower completion rate in the pilot than the "easy" variations (43% vs. 81%), but (2) the actual rate of "default" selection did not vary significantly. The latter observation could be explained by dropouts affecting selection patterns through self-selection bias. Having learned much from the pilot this summer, I will eventually launch this experiment on Amazon MTurk with a projected sample size of N=400.

Research Fellow: Grace Leightheiser (2022)   **Concentration: Environmental Studies; Molecular Biology**

Faculty Mentor: Julie Dudrick   **Department: Upstate Institute**

Title of Project: Adirondack Pollinator Project

Funding Source: Upstate Institute

Project Summary:

The Adirondack Pollinator Project is overseen by the nonprofit organization AdkAction in partnership with Paul Smith's College, Lake Placid Land Conservancy, and The Wild Center. Its aim is to address declining pollinator populations in the region by way of engaging the community through outreach, action, and education. The decrease in bees, butterflies, hummingbirds, and other pollinating species can be traced to habitat loss and fragmentation, pesticide use, disease, and climate change - increasing awareness surrounding the causes and effects of pollinator decline is a crucial step towards resolution. Because pollination is a vital ecosystem service, ongoing loss of this function would yield a cascade of negative consequences, including major impacts on food production. As is the case with many environmental conservation efforts, thoughtful inclusion of societal dynamics is particularly important when crafting a successful mitigation strategy. More specifically, understanding the ways in which people intersect with the environment and how they benefit from its well-being is paramount to effective conservation. With the Adirondack Pollinator Project, free seed packets containing a mix of native wildflowers are distributed to locals as a simple and fun way of inviting individuals to recognize how they can participate in curbing pollinator decline. Every year, roughly 10 new gardens are installed throughout the Adirondacks in areas that will see community involvement. Both the seed packets and the gardens are forms of outreach and action which open the door for interested people to learn more about the issue and find ways to help further. This also provides opportunities to dissuade pesticide use and emphasize the far-reaching impacts of climate change. The Pollinator Project exemplifies a model for engaging community members in a conservation issue and turning environmental stewardship efforts into opportunities for people to come together.
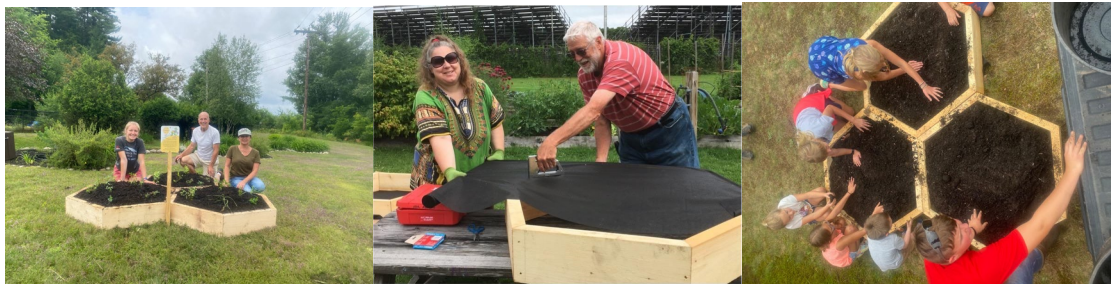
Pictured above are participants in the 2021 Pollinator Garden Assistance Program as their brand new gardens were being installed. Hands-on habitat restoration and education with the project is designed to involve people of all ages!

Research Fellow: Peter LeRoux (2021)

Faculty Mentor: Carolyn Guile

Concentration: Economics

Department(s): Art and Art History; Russian and Eurasian Studies

Title of Project: The Presence of Absence: A Study of the Memorialization of 9/11

Project Summary:

In the wake of COVID-19, the largest threat to American lives to date, the United States will commemorate the twentieth anniversary of 9/11 this fall. On September 11th, 2021, it will have been twenty years since terrorists flew passenger planes into the World Trade Center and the Pentagon, and crashed onto a field in Shanksville, Pennsylvania. On that day, amidst the deadliest attack in the country's history, the ash and rubble of the Twin Towers devastatingly claimed the lives of 2,763 innocent Americans; among them were about 400 first responders.[1] In the past year, the COVID-19 pandemic has claimed over 600,000 Americans. "In both tragedies, the eyes of the nation turned to New York, looking to see how a city brought to its knees would stagger back to recovery."[2] On September 11th, 2020, mourners gathered at the 9/11 Memorial Service in particular adherence with mask mandates and social distancing requirements. Many of these individuals equated some of the lingering effects of 9/11 with these new stresses brought on by the COVID-19 pandemic. In both cases, there exists a call to memorialize the absences brought on by each tragedy: the absence of the World Trade Center in the New York City skyline, and the absences at dinner tables across the country left by those who had been claimed by the Coronavirus.

New York City's solution to memorialize 9/11 was complex and involved a number of competing architectural designs, public opinions, competitions, lawsuits, and debates. Ultimately, after several rounds of vetting by a competition committee, the appointed architects and designers were given license to design a memorial site in accordance with their own vision. The purpose of this research is to answer the following question: "how did the architects of the National 9/11 Memorial address the needs and wants of its society, inhabitants, country, and subject matter?" This concern is particularly relevant to the aims of The Center for Freedom and Western Civilization in that it addresses the process employed to preserve a particular cultural heritage. As such, it complements the Center's endeavors to study the legacy of cultural heritage through a prominent, recent example of a new approach to memorializing.

The paper is grounded in two types of research. It will call upon scholarly articles, newspaper entries, architectural designs, photographs, and interviews to provide thoughtful insight on the World Trade Center Site Memorial Competition, its initial and final architectural designs, the voices and opinions of the New York Community, the victims immortalized by the event, and much more. It will also feature an in-depth analysis of the memorial's architecture via on-site observation. Ultimately, research finds that 9/11 represents a dichotomy between worldly lifestyles. The memorial architects encapsulated a similar sentiment in their attempts to eternally memorialize the American tragedy.

1 World Trade Center, Lower Manhattan, NYC
Photo: Peter LeRoux 06/30/2021

9/11 Memorial & Museum, Lower Manhattan, NYC
Photo: Peter LeRoux 06/30/2021

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[1]History.com Editors, "September 11 Attacks," History.com (A&E Television Networks, February 17, 2010), https://www.history.com/topics/21st-century/9-11-attacks.

[2]Marita Sturken, "Memorializing Absence," ed. Craig Calhoun, Paul Price, and Ashley Timmer, Understanding September 11, 2002, pp. 374-384.

Research Fellow: Chang Liu (2024)   **Concentration: Undeclared**

Faculty Mentor: Julie Dudrick   **Department: Upstate Institute**

Title of Project: Digitization Project for the National Abolition Hall of Fame and Museum

Funding Source: Upstate Institute

Project Summary:

This summer I had the opportunity to work with the National Abolition Hall of Fame and Museum, known as NAHOF, through the Upstate Institute Summer Field School. Located in historic Peterboro, NY, an important stop of the Underground Railroad, NAHOF is committed to antislavery and anti-racism work. In an effort to honor abolitionists and their antislavery work and in support of the second and ongoing abolition movement which seeks to put an end to racism, since 2005, NAHOF held biennial inductions of famous abolitionists to the Hall of Fame and many other meaningful programs such as Emancipation Day, Equality Day, and the Civil War Weekend. In order to reach a larger audience as well as to preserve documents, photos, and videos of past programs and events, my project this summer focused on the digitization of physical DVDs that NAHOF has stored since 2005.

Most of the DVDs that I was dealing with are related to different inductees in the Hall of Fame. My work will bring additional security to the precious contents stored on the DVDs as the videos and photos can now be stored on multiple locations, both physical and digital. In order to improve the quality of the digitized videos and make them more appealing and accessible, after the digitization process, I make edits such as smoothing the sound level by lowering some of the clapping or coughing sound, adding title slides with basic information about the video at the start of each clip, and transcribing the videos. The edited videos will eventually be placed on the NAHOF website, allowing much easier access to those informative and educational videos by a much larger audience.

This process sounds very technical, and it is so. One of my takeaways from this project is the increased familiarity with video editing software, such as Handbrake, iMovie, Otter, and Youtube, all of which can be very beneficial to my future projects. But this project is much more than that. Through watching through the videos and photos, I have gained a much better understanding of the history of abolition, become more appreciative of the progress the United States has made since the 19th century, and realize the amount of effort that every one of us needs to put in to eventually fulfill NAHOF's mission to end racism. Furthermore, through working with NAHOF and interacting with their Cabinet of Freedom, the inner workings of non-profit organizations in the US, or at least in New York State, become much clearer to me. I truly appreciate this opportunity of being an Upstate Institute Fellow, and I am looking forward to serving the local community once again in the future.

Research Fellow: Zhaoyang Liu (2023)

Faculty Mentor: Linda Tseng

Concentration: Computer Science

Department(s): Environmental Studies; Physics and Astronomy

**Title of Project:** Quantitative microbial risk assessment along coastal Los Angeles

Project Summary:

Southern California coast is an excellent spot for recreational water activities. However, potential fecal bacteria contamination poses risks to human health, commonly causing gastrointestinal illness (GI). Three primary fecal indicator bacteria (FIB), enterococcus, *E. coli*, and total coliform, are often used as indicators for fecal contamination. Thus, they are used to indicate potential presence of harmful pathogens. The research aims to evaluate the likelihood for recreational swimmers and surfers to contract GI due to potential fecal pathogens using computer modeling and assess the validity of current regulations and policies in predicting the health risk and protecting beach visitors at Santa Monica Bay beaches.

To calculate the risk of GI, I chose a distribution that fits each of the 12 unique datasets sampled under either dry weather or post-storm conditions at two different monitoring stations for the abovementioned FIBs. I first fit potential distributions in R Studio and compared the distribution shape to the data histogram. After narrowing down the selections, I chose the best fit by comparing the geometric mean of the fitted distributions to that of the datasets. And the best fit for enterococcus and *E. coli* was a lognormal distribution, and for total coliform was a gamma distribution (Table 1).

	E Coli				Enterococcus				Total Coliform			
	With Rain		Without Rain		With Rain		Without Rain		With Rain		Without Rain	
	Site 5	Site 6	Site 5	Site 6	Site 5	Site 6	Site 5	Site 6	Site 5	Site 6	Site 5	Site 6
Lognormal	🟩	⬛	🟩	🟨	🟩	🟩	🟥	🟩	🟥	🟥	🟩	🟥
Gamma	🟩	⬛	🟩	🟩	🟩	🟩	🟥	🟥	🟥	🟥	🟨	🟩
	Green: Best Fit, Yellow: Good Fit, Red: Fair Fit, Black: No Data											
	Table 1											

From the models, we randomly generate 10,000 concentrations using the inverse of the cumulative distribution function (lognorm.ppf) included in the Scipy package in Python. Then we compare the EPA or California concentration standard to evaluate potential FIB concentration exceeding the threshold. For the surfers and the swimmers, we applied the different risk models with randomly generating FIB concentrations as described previously and modeled with the ingestion dose equation $D_{oral} = I_{oral} \times C$, in which I_{oral} is the ingested seawater volume by either surfers or swimmers, and C is the seawater concentration of the bacteria (Stone et al., 2008). Lastly, we modeled the risk of GI using the exponential dose-response model (GI_prob = (1 - math.exp((D_oral $\times$ -1)/k)) $\times$ psi), in which the k and psi variables are also randomly sampled from a distribution (Hass et al., 1999). We compared the results with the EPA recommendation of 32 GI cases per 1000 people.

Fig. 1
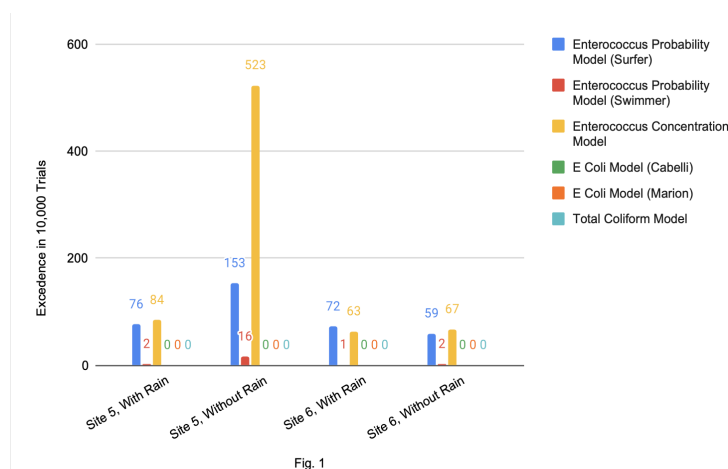
Our results show that *E. coli* and total coliform, regardless of simulating with probability or concentration, did not predict any GI risk. The enterococcus probability showed more risk of contracting GI for surfers than for the swimmers in all four occasions of different sites and different weather conditions. In contrast, enterococcus concentration showed higher exceedances than the current EPA standard (Fig. 1). If preventing any potential GI is the goal, enterococcus concentration seems to be the best at preventing GI at the Santa Monica Bay beaches. According to the enterococcus concentration, the beach area has to be shut down 523 out of 10,000 times. The result shows that the Santa Monica Bay beaches are not heavily fecal bacteria-contaminated. Thus, it shall not raise any public concerns or significantly impact the social and recreational aspects.

References:
Stone et al. (2008) J Toxicol Environ Health A, 71(24): 1603-1615.

Research Fellow: Griffin Lunn (2022)   **Concentration: Biology**

Faculty Mentor: Bineyam Taye   **Department: Biology**

Title of Project: Deworming and its impact on malnutrition among Ethiopian children

Funding Source: NASC Division

Project Summary:

Intestinal parasitic infections are known to be one of the most significant causes of morbidity and mortality, especially among low-resource areas. Poor and marginalized communities are more likely to be affected due to inadequate sanitation practices, close contact with animals, and lack of public awareness. One such disease that is largely under-recognized in several sub-Saharan countries is soil-transmitted helminthiasis (STH): an intestinal infection caused by parasitic worms. These parasites infect 1.5 billion people worldwide and have been associated with loss of iron, anemia, malabsorption, diarrhea, and dysentery. STH is additionally linked to the spread and progression of immune deficiencies, such as HIV and AIDS, thus creating a vicious cycle between infection, malnutrition, and reduced immunity. Because of this, the World Health Administration (WHO) recommends the periodic treatment of at-risk children living in endemic areas.

Mass deworming of school-aged children with anthelmintics has been recognized as an effective strategy for reducing the burden of soil-transmitted helminths. However, the consequences of this approach on childhood malnutrition are unclear. We conducted a cross-sectional survey among three primary schools in Sululta town, Ethiopia, to examine the association between students' history of deworming and the prevalence of malnutrition (i.e. stunting, being underweight, thinning). An interviewer-led survey administered to participants provided information on sociodemographic factors and deworming status, and stool samples were collected from 525 children for microscopic analysis. Independent associations of "stunting" (HAZ < -2SD), "underweight" (WAZ < -2SD), and "thinning" (BAZ < -2SD) and history of deworming were examined using logistic regression. Overall, 81.9% of children were dewormed, and a majority of participants showed some form of "stunting" (52.8%) and some form of "underweight" (59.5%). In multivariate analyses, deworming was positively and significantly associated with stunting (AOR = 2.73, 95% CI: 1.21 - 6.17, P = 0.02). Deworming was also positively associated with being underweight and negatively associated with thinning; both failed to reach statistical significance (AOR = 1.10, 95% CI: 0.31 - 3.88, P = 0.88; AOR = 0.73, 95% CI: 0.38 - 1.42, P = 0.35, respectively). These observations provide evidence of the importance of determining the most appropriate and effective interventions to reduce poor health and nutrition outcomes in Ethiopian children.

Research Fellow(s): Heidi Mach (Allegheny College)
Facundo Perez (2024)   **Concentration:** Astronomy/Physics

Faculty Mentor: Jeff Bary   **Department:** Physics and Astronomy

Title of Project: Accretion Activity on Spotted T Tauri Stars

Funding Source: Science and Math Initiative-SMI (NASC Division); Keck Northeast
Astronomy Consortium

Project Summary:

We present a multi-epoch spectroscopic study of LkCa 4, a Weak-line T Tauri Star, and DQ Tau and LkCa 15, both Classical T Tauri Star systems, finding new evidence for a correlation between the observed low amplitude photospheric variability characteristic of T Tauri Stars and the presence of large, inhomogeneously distributed cool spots on the stellar surface. Simultaneously, we examine their accretion variability through common infrared accretion indicators (Ca~II infrared triplet, the Paschen and Brackett H I lines and the He I line at 1.083 microns). Our findings suggest that the surface of LkCa 4 is mostly covered by large spots with filling factors between $\sim$ 0.6-0.9 where the minimum and maximum spot coverage coincide with the photometric maximum and minimum for the stellar light curve phased with the rotational period of the star. This provides an explanatory basis for the observed spectral type discrepancies between infrared and optically determined spectral types as well as for the low amplitude variability. Additionally, we find evidence for orbitally-modulated accretion in the DQ Tau system, with the intensity of accretion increasing towards the periastron passage of the system.

Stellar formation has become in the last decades one of the most important research fields in astronomy, in part due to its crucial role in understanding planetary formation. According to the current understanding, stars form from the collapse of a cold molecular cloud, forming in the process circumstellar disks from which the stars accrete material and grow in mass. At first, these newborn embedded protostars are impossible to observe because they are surrounded by an optically thick dust and gas envelope. Once the envelope has dissipated and we can observe them directly, they are known as T Tauri stars: low-mass stars with an age of a few million years that are still contracting down the Hayashi tracks toward the main sequence. T Tauri stars are broken into two categories: classical and weak-lined. Classical T Tauri stars (CTTS) show signs of accretion from a circumstellar disk, while weak-lined T Tauri Stars (WTTS) show no signs of accretion and are thought to be more evolved CTTS.

We present a study of several young T Tauri star systems; two single and one binary star system, searching for correlations between photometric variability with spot coverage and accretion indicators. To model the effect of starspots in our sample, we constructed a synthetic spotted star spectrum using a hotter spectral template to serve as the photosphere and a cooler spectrum to act as the spots, and then fit for filling factors and temperature. This was then repeated for every observation, yielding best fits at every rotation phase. To study accretion, equivalent line widths were measured for every observed spectra for the previously mentioned emission lines, in order to track their evolution.

Using our rich spectroscopic sample, we have been able to correlate the variations in the visual photometric brightness of LkCa 4 with changes in the spot filling factors in the infrared spectra. This result supports the idea that some young T Tauri stars are covered in large, cool spots, and is exactly what we would expect to see if this were true. This sheds some light into the spectral type mismatch between optically and spectroscopically determined spectral types, and agrees well with the current ideas within the community. We also find in DQ Tau a very clear correlation that supports pulsed accretion for the system. These interactions help us further understand how stars interact with their surroundings.

Research Fellow: Madison Markham (2024)   **Concentration:** Undeclared

Faculty Mentor: Cosmin Ilie   **Department:** Physics and Astronomy

Title of Project: Determining Dark Core Mass from the Accretion of Dark Matter Particles
in Population III Stars

Project Summary:

Despite greatly outnumbering the matter that we can see, dark matter (DM) remains elusive in physics today. Its name comes from the fact that it does not interact with light, so it appears "dark" compared to the matter that is visible. Certain particle models, such as weakly interacting massive particles (WIMPs), are popular candidates for the identity of DM, though no direct detection experiments have been able to verify the detection of DM particles. Therefore, it is important to constrain the properties of DM further than direct detection can through indirect methods.

Some promising stellar objects for studying DM are Population III (Pop III) stars; they are the first generation of stars that formed in the universe. DM is captured when a particle interacts with a baryon inside of a star, and it subsequently loses energy until it is bound gravitationally within the core of the star. Depending on the DM model used, these DM particles are either symmetric or asymmetric. If they are symmetric, they are self-annihilating and therefore will reach an equilibrium between capture, annihilation, and evaporation (if the DM particles are light enough to evaporate). If they are asymmetric, annihilations are negligent and the DM that is captured remains in star. For symmetric DM, we can calculate the number of DM particles in the star once it reaches equilibrium, and from there we can determine the total mass of the DM particles trapped in the star's core.

Other papers have described conditions necessary for low mass black holes to form from the collapse of asymmetric DM particles trapped in the cores of white dwarfs and neutron stars. The next step in this research is to investigate whether or not Pop III stars are capable of accumulating enough DM particles to trigger a dark core collapse, and whether or not this is only possible with asymmetric particle models.
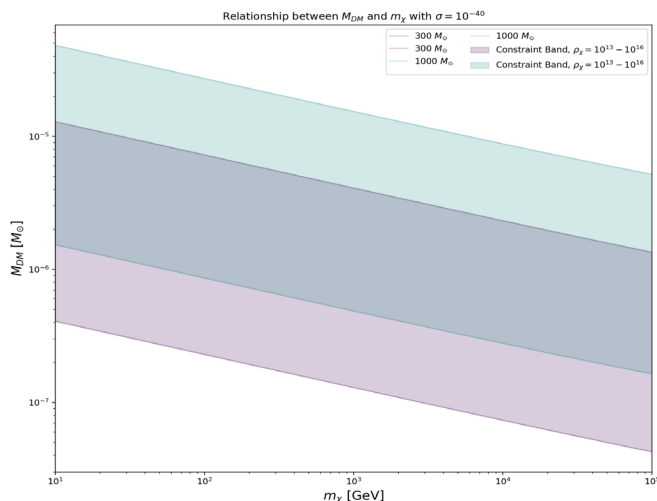
This plot displays the relationship between the total mass of DM that accumulates within a Pop III star's core and the mass of an individual DM particle. Here, particle masses within the WIMP mass range are considered, and a value of 10^{-40} cm^2 for the proton-DM cross section is used. The total mass of the DM core is determined by calculating the total number of captured DM particles once equilibrium is reached and multiplying by the mass of a single DM particle.

Research Fellow: Kate Maro (2022)   **Concentration(s): International Relations; Middle Eastern and Islamic Studies**

Faculty Mentor: Bruce Rutherford   **Department: Political Science**

Title of Project: "Security" and Military Aid: The Cases of Egypt, Colombia, and El Salvador (1945-present)

Project Summary:

US foreign assistance is a widely-studied aspect of foreign policy, though most analyses focus on the allocation of aid rather than variation over time. Specifically, in relation to US foreign military aid, existing literature is dominated by a broad security argument that positions national security objectives as consistently higher priorities than alternative explanations like democratization, human rights, economic dominance, or domestic lobbying. While a few studies have explored military aid given to specific nations, a complete analysis of how aid varies within a recipient state has not been properly explained. The goal of this paper is to determine empirically whether and how non-military priorities explain variation in foreign military aid since 1945. Analysis of the variation in military aid to Egypt, El Salvador, and Colombia at critical junctures will be used to provide alternative explanations for US foreign military aid decisions. The crux of this paper lies in a reinterpretation of how "security" interests are defined, postulating that neoliberalist economic principles may guide military aid allocation. The influence of such an open global economy is demonstrated through the cases of US military aid to Egypt, Colombia, and El Salvador.

Most of the existing literature jointly address military and economic aid, making the precise drivers or causes of their respective distributions convoluted at times. The neorealist conception of military aid allocation, however, seems to dominate the discussion. That is not to say that the field lacks alternative explanations. There is internal disagreement regarding whether, outside of traditionally defined security goals (military threats, WMDs, communism, etc…), respect for human rights leads to more foreign aid (Cingranelli and Pasquarello 1985) or has a less significant impact (Poe 1991; Lai 2003), and within the wider disagreement there are some that further differentiate between democratization and human rights (Meernik, Krueger and Poe 1998). In some analyses, economic and coercive power are cited as drivers of continued US military assistance (Blanton 2005; Meernik, Krueger and Poe 1998), whereas others point to the continued responsibility of the US to ensure international stability among poor and/or non-democratic states (Demirel-Pegg and Moskowitz 2009). However, competing explanations are generally qualified by the assumption that in times of war or instability, traditional security concerns again take precedence. It is this contention I will be addressing, using military aid data for each case study since 1945. Adjusted for inflation, this data allows for more accurate analysis of the (dis)continuation of aid. Rather than considering the variation in US foreign military aid within the context of demarcated time periods that are sharply distinct, the question of what constitutes security in a changing world may better explain aid allocation trends.

Research Fellow: Priya Martin (2024)   **Concentration: Philosophy**

Faculty Mentor: Julie Dudrick   **Department: Upstate Institute**

Title of Project: Chenango United Way, Norwich, New York

Funding Source: Upstate Institute

Project Summary:

The United Way is an international nonprofit that seeks to improve education, health, and financial stability in nearly 1,800 communities around the world. These three areas are the organization's pillars, since they are key to attaining a better life and opportunities for all. This organization supports entire communities, rather than focusing on a specific issue. The Chenango United Way serves the local community through a variety of impact initiatives, but is also a part of a global movement for change. Although I have been working remotely, this has been a wonderful experience. Even through a computer screen, I have been able to get a sense of the Chenango United Way team's passion for the work they do as well as the positive atmosphere they create.

I conducted an internal self-assessment for the United Way to expand on work begun last summer. I collected additional data and analyzed the responses in order to see how the organization has progressed over the past year. United Way Worldwide requires all local United Ways to conduct a self-assessment every three years, but the Chenango United Way is going above and beyond the requirement by conducting them more frequently. This self-assessment process allows the organization to review its effectiveness and come up with strategies for improvement in order to best serve the community. Another requirement is for United Ways to meet certain diversity, equity, and inclusion standards. This is an additional project I have been working on, in which I have been researching the equity requirements to see how they can be successfully implemented.

Through this experience, I have gained a greater understanding and appreciation of the role a nonprofit can play in the community. I have always acknowledged that nonprofits do vital work, but as I started at the Chenango United Way, my mentality of nonprofit work shifted. I had previously thought of nonprofits as fundraising organizations that locals occasionally support. However, after only a short time with the Chenango United Way, I realized that a nonprofit's relationship with the community could make it so much more. A quality I admire about the United Way is that they are involved in such a wide-range of community needs. Because of this, the role the Chenango United Way plays in the community is far reaching. I learned that they participate in a vast variety of community meetings and are involved in combating an array of issues. I find it incredible that one organization works to provide college loans to working families, build quality houses for families whose homes are unsafe, offer drug-free youth activities, combat homelessness, and so much more. I believe that this multifaceted approach combined with the amazing leadership team is why the Chenango United Way is an integral part of the community.

Research Fellow: Kristen Mast (2023)   **Concentration: Chemistry**

Faculty Mentor: Matt Hudson   **Department: Chemistry**

Title of Project: Modification of Zeolites for Improved Carbon Capture Performance

Funding Source: NASC Division

Project Summary:

Over the past hundred years, awareness has increased worldwide about the severely detrimental effects human activity has on the planet and, in particular, the buildup of greenhouse gases in the earth's atmosphere. Next to transportation, the second largest human contributor to greenhouse gas emissions is energy production. Historically, the vast majority of energy has been produced by burning fossil fuels: namely, coal, natural gas, and crude oil. Positive steps are being taken to replace these methods with clean, renewable sources, but fully eliminating fossil fuel plants will, optimistically, take at least another 30 years, and it is imperative that we develop carbon capture technology efficient enough to counteract the emissions from these plants until fully clean and renewable energy production is a reality.

Current carbon capture methods rely almost exclusively on liquid amine scrubbers which, while cheap, are also highly corrosive, incur a high-energy penalty, and provide issues with viscosity. In contrast, solid adsorbent materials show promise to be a more efficient and stable alternative, and zeolites, naturally occurring or synthetic porous aluminosilicate minerals, are a prime example. Zeolites provide many advantages such as low production cost and high stability, and they naturally capture carbon dioxide and other gases through physical adsorption. However, there is concern over the natural affinity for water vapor over carbon dioxide in zeolites. Exchanging the cations within zeolites and/or functionalizing zeolites with amines may further increase their adsorption capacity, CO_2 selectivity, and long-term stability. Different cations position themselves in different places within the zeolite framework and may affect the intermolecular interactions involved in physical adsorption. Amine functionalization introduces a capacity for chemical adsorption; different amines with different steric profiles may perform differently. We have worked to produce over 200 samples of successfully altered zeolites, using analysis of powder x-ray diffraction, infrared radiation, and total reflection x-ray fluorescence data to confirm the alterations. Future consideration will be to evaluate the carbon capture performance and cycling stability of these samples in simulated flue gas streams.

Research Fellow: Eric Matt (2022)   **Concentration(s): German; Physics**

Faculty Mentor: Ken Segall   **Department: Physics and Astronomy**

Title of Project: Superconducting Neural Circuits

Funding Source: Justus '43 and Jayne Schlichting Student Research Fund

Project Summary:

Moore's law, which states that the number of transistors in a microchip doubles every two years, has been the driving force behind the development of computers since their creation. However, as the number of transistors on these microchips have increased over the years, it is becoming increasingly difficult to scale down their size to accommodate the growing number. This has resulted in the prediction of 2025 as the termination of Moore's law where it will no longer be financially or physically possible to keep scaling down and adding transistors. This has led to a significant amount of research in alternative computing methods that veer away from the use of transistors in favor of more efficient options in terms of speed and power usage. One of the leading candidates in this research is the use of a superconducting element known as the Josephson Junction (JJ), which was the focus of my summer research projects.

Over the summer, I was working on two distinct ongoing projects: Exploring the characteristics of a fully connected neural circuit, and studying the interaction dynamics of discrete breathers and travelling vortices in a JJ ladder. These circuits were all designed and simulated in WR-spice, a circuit simulation and analysis tool. The neural circuit consists of three previously designed JJ Neurons and two JJ synapses. The neurons are mutually connected, meaning that the pulsing of one neuron impacts the pulsing of the next neuron, and when two neurons both pulse within a short period of time, the synaptic strength between them increases. Similarly, when two neurons have strong synaptic connections, but do not both pulse within the short period of time, their synaptic strengths decrease. These behaviors are akin to 'learning' and 'forgetting' in the biological brain. This research has potential future applications in neuromorphic computing and medical research.

In the context of JJs, a traveling vortex is a 2π phase flip that physically moves through the junctions within a ladder or any other junction array, while a discrete breather is a spatially localized voltage state JJ, specifically in a ladder. Vortices and discrete breathers are both nonlinear phenomena and while they had previously never been observed to interact or even exist within the same structure, theoretical work had been done showing that both were possible. I designed a novel circuit in WRspice that uses a JJ neuron to create a vortex, which then gets inserted into a JJ ladder with a prepared discrete breather. After over 450 hours of simulation time and 40,000 simulations, I demonstrated two unique cases of vortex and breather interaction. The first is a pinning event, where the traveling vortex becomes pinned at the junction immediately in front of the breather. The second is a destruction event, which involves the traveling vortex destroying the breather and continuing to travel. Both of these events matched the theoretical findings of previous work.

I am thankful for the opportunity to work in the Segall lab this summer and to be able to continue the research into my 410 project. It was a pleasure working with Will Friend, Leon Nichols, Sarah Miller, Daniel Espinosa, Wayne Wang, and of course Professor Segall over the course of the summer.

Research Fellow(s): Sam McCabe (2022)   **Concentration(s):** Economics; Computer Science
Rose Nguyen (2024)   Concentration: Undeclared

Faculty Mentor: Karen Harpp   **Department(s):** Geology; Peace and Conflict Studies

Title of Project: Virtual Galapagos: Design and Development of an Interactive Online Educational Resource for Children to Learn Science

Project Summary:

Colgate Virtual Galapagos is an interactive website designed as an online resource for children in grades 3-5 and their teachers. Students will learn about different fundamental scientific components by studying aspects of the Galapagos Islands, in a series of modules and lessons. There are two groups of students working on the project: three people on the content team and two on the programming team. In addition, there is one Colgate faculty member, one staff member, and two Colgate alumni. As a member of the programming team, our goal is to finish setting up the main menu and the introductory sequence to the module.

One of our main objectives is to create a user interface (U.I.) that is both user-friendly and visually appealing for children. This year, we focused on designing ways to engage students as they progress through the interactive learning modules. Our first major programming addition is the backpack feature, which contains a Galapagos map that tracks students' progress and a journal highlighting badges students have collected as they complete the scientific objectives centered around each island. These features are a form of gamified rewards to provide children with a sense of accomplishment and to challenge them to achieve more. Another notable addition to our U.I. is conversation between multiple characters that guide the students through each module. Instead of using audio only, as in the pilot module, we have programmed each character to pop up and "speak" through a speech bubble. This design enhances the interactive aspects of the Virtual Galapagos project, making the audio content more conversational and personal to the students.

A primary goal of our programming team was to write a coherent and easily understood source code. Because our project could not be completed within one summer, we needed to organize our programming components so that subsequent programmers could pick up where we left off and continue the project in the future. We also kept track of different atoms and molecules of the programming structure to serve as examples using the Storybook plug-in. During the summer, the programming team and content team met frequently to assess whether a content idea could be executed in terms of programming and whether there needed to be modifications on the content side so that code could be constructed effectively. Our graduate programmer addressed the programming structure revision by going through code that had been built in previous summers. He developed a more direct and coherent structure for our program and initiated the necessary steps. Rose and Sam, as junior programmers, work on the additional programming components including the backpack, log-in pages, settings page, and whiteboard template.

Colgate Virtual Galapagos is an on-going project; you can access the project by contacting Karen Harpp (kharpp@colgate.edu) for further information.

Research Fellow: Ellie McDermott (2023)   **Concentration: Religion**

Faculty Mentor: Julie Dudrick   **Department: Upstate Institute**

Title of Project: Kennedy-Willis Center on Down Syndrome at Pathfinder Village, Edmeston, New York

Funding Source: Upstate Institute

Project Summary:

Pathfinder Village is a community in Edmeston, NY where people with Down Syndrome and other intellectual and developmental disabilities (IDD) live and/or participate in day programming and activities that enrich their lives, provide practical skills, and connect them with the broader Central New York community. Every individual has their own path. Some may be learning about career skills while others may be participating in creative projects. The Kennedy-Willis Center (KWC) specifically focuses on best practices for supporting individuals with IDD, life planning for those individuals and their families, educating the broader community, and conducting disability research. Families have few resources, especially in rural areas, when it comes to disability. Pathfinder is a great resource, and scholarship opportunities are available for families who cannot afford the tuition. There are also different models of living for people with IDD that do not afford them the same autonomy and support they may find at Pathfinder. There is a long history of society viewing disability as something that needs to be fixed, but at Pathfinder, disabilities are celebrated and each individual is supported in ways that make the most sense for them and take into consideration their disabilities.

At the KWC, I worked to revive their self-advocacy group called Council Rock, which unfortunately came to a halt at the onset of the Covid-19 Pandemic. Self-advocacy, as defined by the Council Rock motto, allows individuals with disabilities to "speak up for themselves and their friends." In the disability community, the concept that disabled people know best what they want and need is important, so they should be in the spotlight when it comes to disability justice. With Council Rock, the individuals at Pathfinder can share anything troubling them or things they want to change. Self-advocacy can look different for everyone. It can mean an individual telling staff they want to change their schedule of day program activities or it could mean starting a voting initiative in their community to get more disabled people registered to vote. No matter the scope of the project, someone with IDD expressing their desires and working to make change is self-advocacy.

I helped Council Rock develop a video which shares information about disability and self-advocacy in their own words. We also planned a kickoff event for the Village to welcome back Council Rock and teach Pathfinder individuals who are not members of Council Rock what the council stands for and encourage them to join. I have always been interested in disability and this experience has given me such wonderful firsthand knowledge about it. There are resources such as courses and readings on disability that Colgate offers, but there is no better way to learn about it than working with and listening to disabled people. I feel that most Colgate students have a lack of knowledge about and exposure to disability. Because of this, I am working to create more spaces for disabled voices on campus, both for students and staff with disabilities as well as disabled visiting speakers.

Research Fellow: Christopher McElhaney (2022)   **Concentration: Peace and Conflict Studies**

Faculty Mentor: Karen Harpp   **Department(s): Geology; Peace and Conflict Studies**

Title of Project: Virtual Galapagos

Project Summary:

The Virtual Galapagos project aims to create an interactive website geared towards students in grades 3-5. The students are introduced to fundamental scientific concepts through a virtual exploration of the island chain. Students choose an animal buddy to accompany them on their virtual exploration and have a friendly Blue Footed Booby named Sula who serves as the guide. The website is broken down into several "mysteries" which are assigned to each of the major islands in the Galapagos. Within each mystery are several modules that contain clues to the island's larger mystery. Within these modules, students complete interactive activities and learn from various galapagos animal characters who act as experts in their module's respective fields. This summer, the website was restructured to make the design and user experience more interactive and child-friendly.

On the design team, we were responsible for adapting the existing content into a new script, as well as creating almost all of the graphic elements we would need to build this new version of the website. This began at the level of color and font choices and ended in creating all the visual elements we needed for the scenes and interactive features. We approached the redesign in a modular sense. We strove to create the building blocks that a future student could use to illustrate a lesson when constructing additional modules for the website. I began by focusing on baseline choices such as a color palette and a visual identity or "brand" for the project. My primary project was to develop a system to motivate students to explore scientific topics ("Messages in a Bottle, MIB) that complemented the main content by earning rewards in the form of virtual doubloons. The Virtual Galapagos website makes heavy use of immersive 360-degree videos of different points in the Galapagos. I identified objects or points of interest within the video or elsewhere on screen and inserted a message in a bottle icon. These contained pop-up windows or "messages" that would introduce a side lesson that complements the primary scientific topic on the screen. Later in the module, one of the main characters will return to test the user and reward correct responses with doubloons. We also created a villain character who can steal doubloons for wrong answers, to enhance gamification of learning. The production of the MIBs required a systematic process of research, writing, audio recording, and asset creation. I developed these interactions in parallel with ongoing script development, and then inserted them after the script was finalized.

I also worked with my team members to create all the other visual assets that were required for this module of the interactive website, including everything that would appear on screen such as pop-up windows, maps, scene decor, buttons, objects of interest, and more. This required close communication with the programmers so that we designers were clear on how the asset was being used and its appropriate format.

The creative team determined that Figma was a good program to both create visuals in as well as plot out the storyboard of the site and of the interactive elements; I used Adobe Illustrator for my asset creation. Hopefully these two tools will be accessible enough for students who continue to add content to the Virtual Galapagos in the future.

Research Fellow: Corey McLaughlin (2024)   **Concentration:** Undeclared

Faculty Mentor: Julie Dudrick   **Department:** Upstate Institute

Title of Project: Stone Quarry Hill Art Park, Cazenovia, New York

Project Summary:

The Stone Quarry Hill Art Park (SQHAP) provides exhibitions, events, and programs to educate the public about how important our environment is and how inspiring it can be for artists to live and work at the park. The park's mission is to preserve the land they have, while artists can use it to connect their work to nature and reestablish the relationship between humankind and the world we live in. The park serves the public and those who wish to find inspiration and beauty through nature and artistic expression. Simultaneously, SQHAP preserves natural land, giving many species of plants and animals a home. This year marks the 30th year that the art park has been welcoming visitors to view sculptures and appreciate the natural environment around them.

This summer, I worked with SQHAP to organize and upload data online so that the art park has all of the pieces of its history, including pamphlets, postcards and news articles in a more permanent form. After looking through local newsletters, seasonal publications from the park, photographs, exhibition pamphlets, promotional postcards and flyers, I write a summary for each year to explain what happened at the art park, what events were held there, and who was involved. My goal for the summer was to finish uploading and organizing every file from each year, starting from 1991 to 2021.

I have learned a lot about the history of the art park as I reviewed files and newspapers. I feel like I have a deeper connection to and understanding of the park. The goal of the founders of the Park was to preserve the land and connect people with art and the natural world, and they wanted to show how they both can collide and change others' perspectives of man-made and natural creations. I am considering choosing majors based around environmental studies, and SQHAP's goal to preserve their large piece of land is what made this project a great fit for me. I had countless opportunities to explore different trees, flowers, and insects that interact with the environment of the park. Some areas of the property have bedrock closer to the surface, making it difficult to use the land for building and planting, while less inclined parts have been used by local farmers for agricultural purposes. While much work has gone into maintaining the grasses and shrubbery on the property, more remains to be done to preserve plantings and ensure long-term habitats for a variety of species.

Research Fellow: Nick Mecca (2023)   **Concentration: Neuroscience**

Faculty Mentor: Jason Meyers   **Department(s): Biology; Neuroscience**

Title of Project: The Notch and Wnt signaling pathways coordinate retinal regeneration in Zebrafish, but the Notch pathway is downstream of Wnt

Project Summary:

Humans have a very limited capacity to regenerate their eyes, which means injury to the eye or blindness is usually permanent. Zebrafish display robust retinal regenerative capabilities, making them an excellent model organism for studying retinal regeneration. We observe the process of this regeneration by using an intense light to blind the fish and damage the retina. The regeneration is coordinated in part by the signaling pathways Notch and Wnt. Our research has found that Notch signaling likely functions by limiting retinal regeneration, while Wnt signaling likely activates this regeneration. We also determined that the Notch pathway takes precedence over the Wnt pathway.

The Zebrafish are blinded by this intense light because it damages their photoreceptors, the specialized cells in the retina that allow for sight. The retina begins its process of regeneration with the Müller glia (visible below), cells within the retina that enter a stem cell-like state in response to damage. After entering this state, it divides to produce a progenitor cell as well as a Müller glia cell. This progenitor cell then crawls to the location of the damaged photoreceptors and differentiates into a replacement photoreceptor cell. The Notch and Wnt signaling pathways have been known to play a role in coordinating this process of regeneration, but our research sought to further investigate this role.

To investigate Notch signaling we used drugs to inhibit the pathway, as well as genetic means to activate it. Activating Notch signaling resulted in a decrease in regenerative proliferation, while inhibiting it resulted in an increase in regenerative proliferation. This means that Notch likely regulates regeneration by limiting proliferation. We examined the Wnt pathway by using a drug to activate it. Activating Wnt greatly increased regenerative proliferation, meaning that it likely coordinates retinal regeneration by activating proliferation. In order to further study the relationship between these pathways we activated both the Notch pathway and the Wnt pathway. This resulted in decreased regenerative proliferation, meaning that the Notch pathway is likely downstream of the Wnt pathway.

Control Retina
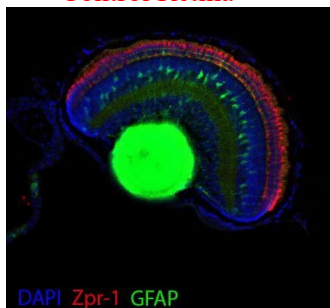
Blinded Retina

Here the retina is imaged using different fluorescent proteins, with a normal retina on the left and a blinded fish's retina on the right. The photoreceptors are highlighted in red, the Müller glia in green, and other cells in blue. The damage from blinding can be seen where the blinded retina lacks some photoreceptors.
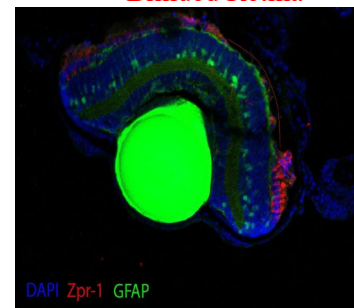
Project Summary:

This summer, I worked on Professor Sanya's project *States of discretion: Black migrating bodies, racialization, and naturalization in the United States*. As detailed in the posting, the larger project explores "how the U.S. decides on who gains documentation and how those people's careers confirm national ideologies invested in the law to become an immigrant and/or subsequent citizen."

We began the summer project by compiling a database of rejected immigration appeals cases that are published by the Administrative Appeals Office (AAO) branch of the United States Citizen and Immigration Services (USCIS). To reduce variables and focus the research question, we looked at employment-based appeals from Anglophone African countries. We analyzed language from 134 appeal decisions over the past decade. Using dates, we examined immigration policy shifts, language in public discourse, and the legacies of colonialism in the appellant's nation of origin. As part of the process, performed discourse tracing (Redden 2017) to establish patterns that show how logics inform the use of discretion of USCIS officers when deciding an applicant's legal status.

Once we created the database, we spent the remainder of this summer's research attempting to unpack how existing power imbalances between the global north and south impact individual immigration processes. Grounded in scholarship on immigration and global displacement of labor (Ngai 1999; Miraftab 2012), my research focused on the study of unequal regulation of bodies across borders and how the overlapping imperial policies determined immigration of indigenous Africans from colonized African nation-states. In analyzing the appeals decisions, we attempted to understand how national and international policies and processes impacted these appellants' attempt to emigrate to the US and how those attempts failed. In our research group meetings, we discussed and analyzed how the United States, as the global superpower, instrumentalizes and benefits from the global hierarchical division of labor predicated upon colonial histories on migrants trying to access wealthy nations' job markets. From the literature we read, it was clear that the push and pull of the economy, colonial legacies, and contemporary geopolitical concerns allowed that economically powerful nation-states exercise their power acquired via historical dispossession processes to develop skilled migrant labor without investing in the development of the labor force (Miraftab 2012). Consequently, forcing migrants to negotiate between an economically prosperous future through accepting and leveraging notions of exceptionalism, social exclusion, and disposability.

Using my background as a political science major, I am working on an essay that explores migrant labor in the democratic nation-state. I begin by accepting Giorgio Agamben's (1995) thesis that modern democratic nation-states are in a permanent state of exception and that they utilize their discretion to select "killable" subjects. By drawing on Agamben's theoretical framework of the *Homo Sacer* to conceptualize America's immigration system as a mechanism for the standardization of citizenship. In other words, establishing social and cultural traits that are in congruence with America's western, utilitarian, ableist, and capitalist way of life. Under this framework, we also find that immigration, as a social institution, sets the justification for the exclusion and exploitation of subjects that do not meet the standards of citizenship it establishes. However, rather than simply accepting Agamben's explicit exclusion and physical killing of individuals, we add elasticity to these concepts by articulating them on a structural lens. Rather than putting the "disposable" in physical camps and executing them, we theorize withdrawing their means of subsistence, their cultural dehumanization, and eventual perpetual policing as killability characteristic for a modern democratic state.

Research Fellow: Celia Meyer (2022) **Concentration:** Environmental Geology

Faculty Mentor: Paul Harnik **Department:** Geology

Title of Project: *Nucula* Life History Over Time in the Gulf of Mexico

Project Summary:

Human activities such as deforestation, fertilizer use, and wastewater management increase the concentration of nutrients in coastal marine environments. The availability of these nutrients can have a significant impact on primary productivity; the more nutrients, the greater the primary production. Primary productivity in the northern Gulf of Mexico varies geographically and has also changed over time. Primary productivity is very high near the Mississippi River, which delivers tremendous nutrients to the coastal ocean, and is lower in coastal areas like north Florida that are adjacent to smaller watersheds. Enhanced primary production could mean more food for consumers in marine food webs, potentially leading to shifts in the characteristics of marine species. My research examines how spatiotemporal variation in food supply has shaped the life histories of bivalve mollusks in marine food webs.
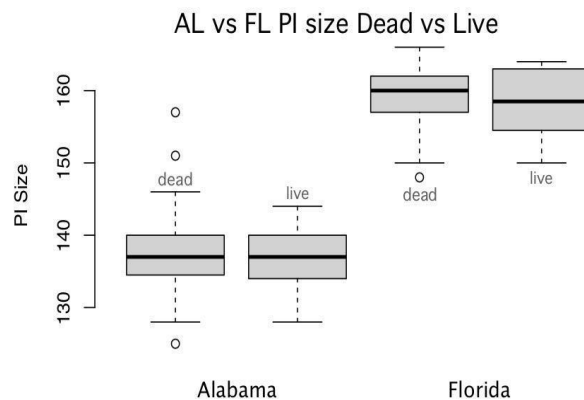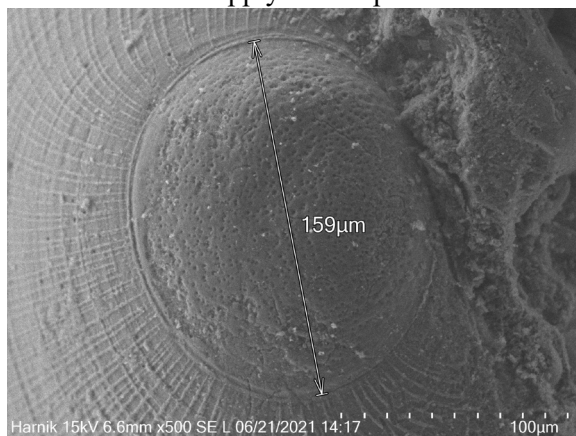
Levels of nutrients can affect survivorship within species and differences in survivorship can be observed by looking at egg size. A tradeoff exists between egg size and egg number. The larger the eggs, the fewer an individual can produce, and vice versa. In areas that are nutrient depleted, individuals that produce larger eggs tend to leave behind more offspring. Conversely, in nutrient-rich areas, survivorship increases for all egg sizes and organisms that produce more numerous, smaller eggs will leave behind more offspring. The larval shell size of marine bivalves (pictured below) is proportional to egg size and can be used to assess life history variation along primary productivity gradients. Here we assess how the size of *Nucula proxima* larval shells varies with proximity to the Mississippi River, and temporally in response to increased primary productivity over time. Live and dead specimens of *N. proxima* were collected from 15 sites off the coasts of Louisiana, Alabama, and Florida. We hypothesized that the size of *Nucula* larval shells would be larger in Florida than in areas adjacent to the Mississippi River. We also hypothesized that larval shell size would be smaller today compared to the past due to gradual increases in human activity over time. We observed a significant difference in larval shell size between regions, with smaller larval shells in Alabama and larger larval shells in Florida. In contrast, preliminary data shows no evidence that larval shell size has changed over time. Our results suggest that nutrient levels may be a primary driver of *N. proxima* life history variation in the northern Gulf, yet more work is needed to see if live-dead similarity reflects young death assemblages that postdate the onset of human activities.

Research Fellow: Colin Miller (2022) **Concentration: Biochemistry**

Faculty Mentor: Ephraim Woods **Department: Chemistry**

Title of Project: Heterogeneous oxidation kinetics of ozone-iodide interactions on the surface of aerosol particles

Funding Source: Beckman Scholars Program

Project Summary:

Ozone-iodide chemistry on the surface of aerosol particles is important because it provides a sink for atmospheric ozone and creates halogenated neutral species in marine aerosol particles. This chemistry allows for normally ionic elements to participate in gas-phase chemistry. The interaction of ozone with aqueous iodide can also accelerate reactions that form cloud condensation nuclei (CCNs). An example is that the reaction rate of ozone with monoterpenes, a reaction that transforms gas-phase species into lower vapor pressure, water-soluble molecules, is greatly increased with the addition of iodide. It is hypothesized that $IOOO^-$, a potential intermediate in the oxidation of iodide, is the species that causes the acceleration. Though the reaction between ozone and iodide in the particle phase is very important to understand, the kinetics of the reaction are difficult to measure and comprehend. The disappearance of ozone is used in many studies as a proxy for the extent of reaction, but the multifarious pathways that involve ozone obfuscate clear inferences about the reaction kinetics. Our project seeks to measure the concentration of interfacial iodide to better understand the surface compositions of aerosol particles.

Photoelectric charging enables the monitoring of the surface concentration of iodide in atmospherically relevant conditions. Using aerosolized particles from bulk solutions containing various molecules relevant to our study, laser pulses excite and ionize iodide molecules at the surface of these particles effectively; these charged aerosol particles are measured as a voltage. The less iodide concentration available for ionization leads to a decreasing signal relative to the baseline, known as photoelectric activity (Φ). Measuring the diminishing photoelectric activity of a sample as a function of different variables (ozone partial pressure and interaction time) serves as a proxy for the changing surface composition of the aerosol particles. The difference of detectability between iodide and the $IOOO^-$ intermediate demonstrates that the decreasing signal serves as the indirect observation of the $IOOO^-$ intermediate forming a substantial fraction of aerosol particle surface coverage at modest ozone pressure. The kinetic data allowed for the generation of a kinetic model that attempted to measure the rate of formation of $IOOO^-$ on the surface of aerosol molecules. Preliminary kinetic modeling yielded a rate constant for $IOOO^-$ formation of 5×10^{-13} cm^{-2} s^{-1}.

Other model organic species can be included in these bulk solutions to provide different chemical environments for the reactions to take place. For example, an aliphatic chain attached to a cationic molecule was added to a solution of potassium iodide to understand how surfactant molecules affected the rate and mechanism of $IOOO^-$ formation. The interpretation of the collected data hinges on the assumption that a steady-state concentration of iodide is achieved during the reaction, meaning that at some point, the surface composition of the measured aerosol particles does not change as a function of the interaction time with ozone.

Research Fellow: Sarah Miller (2024) **Concentration: Undeclared**

Faculty Mentor: Ramesh Adhikari **Department: Physics and Astronomy**

Title of Project: Self-Assembled Diphenylalanine Nanostructures
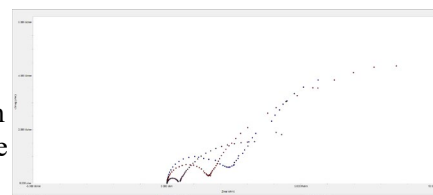
Funding Source: NASC Division

Project Summary:

Diphenylalanine (FF) is an aromatic amino acid consisting of two covalently linked phenylalanine units. Past research has shown that FF self-assembles into a variety of nanostructures that are dependent on the environment that they are assembled in. Both nanotubes and nanowires are formed through interactions between hydrogen bonding, aromatic stacking, and electrostatic interactions. In this project, we experimented with the methodology in creating FF nanostructures and looked at their properties and possible applications.
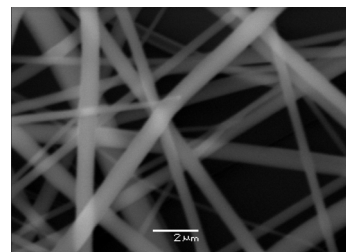
SEM images of horizontally aligned nanowires

Nyquist Plot
Blue: 0C, Red 10C, Purple:17C

My major focus at the beginning of research was testing the conductivity of FF nanowires. We varied the concentrations of FF, sonication time and annealing temperature and time to form different samples of nanostructures. By mixing the FF powder in DI water, sonicating and subsequently annealing it, we were able to create horizontally aligned nanowires. By connecting the Gamry Reference 600+ Potentiostat to the probe station, we were able to run Potentiostatic EIS tests to determine the conductance of the nanowires. These structures were nonconductive at room humidity. However, at 100% humidity, these structures were conductive. As seen in the figure to the right, increasing temperature under 100% humidity improves conductance. Because conduction only occurs in the presence of water, this indicates proton conduction in the system.

Additionally, using the horizontally aligned nanowires we created devices with memristive behavior. Memristors are two terminal resistive devices that retain memory. It is made up of two electrodes and a thin storage layer that allows for ion redistribution and changes to the conductivity of the device. While the devices had inconsistencies in their behavior, the initial data was hopeful in using FF nanowries as a candidate for memristors.

We were also able to make vertically aligned nanowires through varying methodology. One method involved using HFIP as the solvent and then proceeding with the same process as we used to make horizontally aligned nanowires. Another involved an aniline vapour process. These nanowires also proved to be nonconductive. However, we found them to be extremely hydrophobic which is a property that could be explored in research to come.

DI water on vertically aligned nanowires
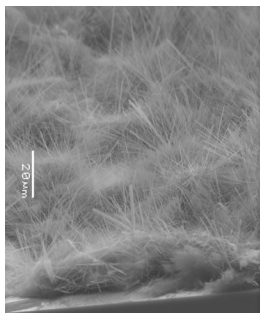
SEM images of vertically aligned nanowires

Research Fellow: Warner Neal (2022)   **Concentration: Astrogeophysics**

**Faculty Mentor: Tom Balonek**   **Department: Physics and Astronomy**

Title of Project: Long Term Optical Variability of Quasar 1308+326

Funding Source: Justus '43 and Jayne Schlichting Student Research Fund

Project Summary:

This summer was spent studying quasars, large black holes far outside of our galaxy which have rapidly spinning material around them. These particles are superheated as they move and glow as they are sent off in huge jets, causing them to be some of the brightest objects in the universe. They do not stay at a constant brightness, however, and tracking these changes in brightness can help us learn more about these objects. The main quasar we focused on this summer is known as 1308+326. It was discovered in the 1960's, and astronomers have been observing it ever since. We gathered data from every source we could find over the past 50 years and added them to our own data taken at Colgate's observatory. Once compiled, the data was plotted on a graph using Python. The values are presented in both magnitudes and flux, which help to show the overall behavior and highlight major outbursts of the quasar. It was also split based on the different color filters which different observatories use, since they let different wavelengths of light through and had to be converted to the same scale in order to accurately show variation. More work still needs to be done to better understand any periodicity of the quasar, but the work this summer has set us up to better understand the long-term behavior of this object.
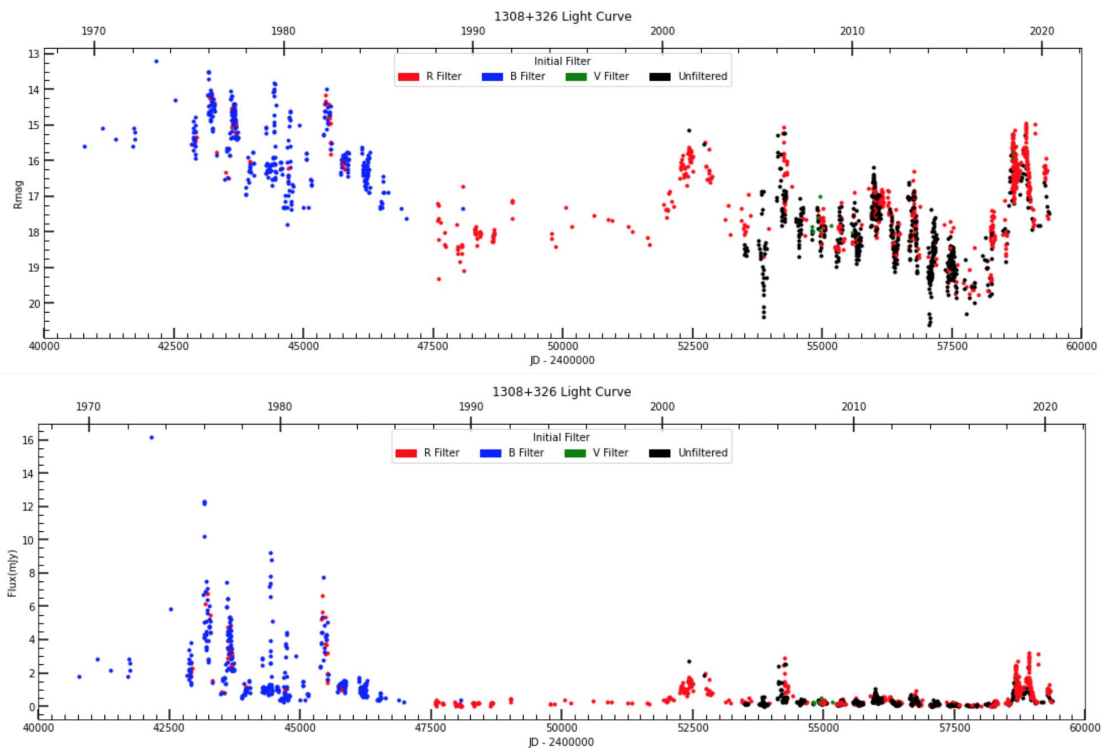
Research Fellow: Sarah Neubecker (2022)   Concentration: Spanish; International Relations

Title of Project: Internship, University for Peace humanitarian assistance program
**   (UNHCR affiliate)**

Funding Source: Lampert Institute for Civic and Global Affairs

Project Summary:

Abstract/Project Summary: My summer research project was an International Relations based internship that I completed as part of Colgate's Lampert Institute Scholars Program. This summer, I worked with a small humanitarian assistance program based at the University for Peace in Ciudad Colón, Costa Rica. Due to the nature of this UN program, I am unable to provide specific details about the work I did, in order to protect the security and sensitivity of program participants. However, I can say that my main job was creating a variety of print materials in Spanish, including 24 biweekly newsletters, for program participants. I also assisted the team with taking inventory for the UNHCR (United Nations High Commissioner for Refugees), English translation and workshop preparations. Since the program is by nature small (I worked with a team of six interns and five full-time staff), the work was very hands-on and my tasks varied from day to day. In addition to working with the program, I lived with a host family in Costa Rica, immersing myself in the Spanish language and local culture.

One recurring theme in the program I worked on is asylum seeking, migration, and refugee flows in Central America, specifically from the Northern Triangle (as defined by the UNHCR). As part of my internship, I researched and will continue researching for my senior thesis, the topic of internal migration and refugee settlement in Latin America. This internship sparked my interest in the dynamics of asylum-seeking within Latin America itself. All too often, the media and US policies focus on refugee flows from Central and South America to the United States, yet I learned very quickly that asylum seeking, refugee flows, and migration crises are almost more prevalent *within* Latin America. Costa Rica is just one example of this internal migration, as it constantly receives applications for asylum, especially with political repression and persecution on the rise in neighboring Nicaragua. This alarming trend, along with continued violence and drug trafficking in the Northern Triangle, present challenges for international institutions like the UN and individual countries with respect to how to respond with aid and intervention. As a Lampert Scholar, I will be writing a 20-page op-ed about instability in the Central American region and how this instability has affected refugee flows within Latin American and from Latin America to other countries around the world. I hope to combine my passion for Spanish and International Relations in similar work in the future, either as a Foreign Service Officer for the US Department of State or an aid worker at an international NGO.

Research Fellow: Leon Nichols (2023)   **Concentration(s): Art and Art History; Physics**

Faculty Mentor: Ken Segall   **Department: Physics and Astronomy**

Title of Project: Neuromorphic Computing with Josephson Junction Neurons Fluxon Location & Genetic Algorithm

Project Summary:

Josephson Junctions are superconducting circuit components whose behavior can be described by a second-order, non-linear differential equation. This makes them an ideal tool to explore and model complicated systems, such as neurons. They are therefore a leading candidate for quantum computing. This abstract will give background for the study of fluxon dynamics (the behavior of a quantized amount of magnetic flux) in Josephson Junctions arrays. More precisely, it will discuss fluxon location in a parallel array of Josephson Junctions, their effects on the switching currents of these functions, and how this phenomenon can be examined using a genetic algorithm code.

Josephson Junctions can then be arranged into parallel arrays of junctions, where they are physically analogous to a set of coupled, damped, and driven pendula (Fig. 1). When cooled down below T_C, current loops in the array can cause fluxons to become trapped between junctions in the array. At a certain current, I_{SW}, or thermal energy level, a fluxon will begin to move around the array and a voltage is detectable. I_{SW}, however, can vary significantly (Fig. 2). It is strongly suspected that this variation is caused by production uncertainty in the size of the junctions, akin to a particle moving over hills of different size (Fig. 1). The likelihood of this being the cause in variation has been explored using a genetic algorithm to see if this is theoretically plausible.
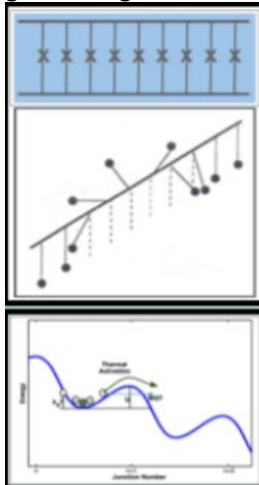
Fig. 1: shows a set of coupled, damped, and driven pendula and hill analogy.
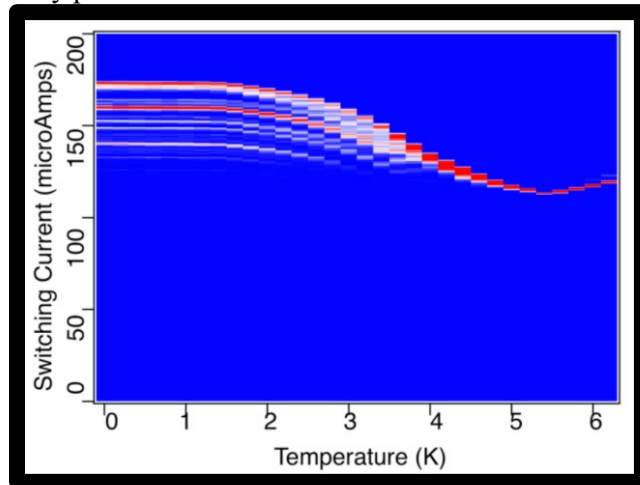

Fig. 2: Shows the variation of I_{SW} and its response to change in thermal energy.

Research Fellow: Rory O'Brien (2022)   **Concentration(s): Biology; Spanish**

Faculty Mentor: Priscilla Van Wynsberghe   **Department: Biology**

Title of Project: Understanding regulation of miRNAs by LIN-42 and KIN-20 in *C. elegans* development

Project Summary:

Caenorhabditis elegans (*C. elegans*) is a small, transparent nematode (worm) that is used to study many biological processes, such as behavior, neurobiology, and cell division. We primarily study the regulation of *C. elegans* development. Their developmental cycle is thought to be an ancestral form of the circadian clock in humans because many of the genes that regulate developmental timing in *C. elegans* are core circadian clock genes. Small RNAs called microRNAs (miRNAs) are important regulators of developmental timing that post transcriptionally inhibit gene expression. We are interested in how certain miRNAs are regulated by other proteins, specifically two called LIN-42 and KIN-20, which both have human circadian clock homologs. Understanding how these proteins - and the miRNAs they regulate - are involved in *C. elegans* development can give us important insights into how these genes might function in humans, such as in circadian cycling and disease development.

The first goal of my project was to determine the role of LIN-42 in miRNA expression in *C. elegans* embryos. LIN-42 is the homolog of the circadian regulator Period in humans, and LIN-42 levels oscillate throughout development to regulate events like molting. LIN-42 inhibits transcription of specific miRNAs such as *let-7* during later stages of development. However, the effect of LIN-42 on specific miRNAs during embryogenesis, as well as its mechanism of regulation, are unclear. I extracted RNA from wild-type (WT) and LIN-42 loss-of-function (*lin-42(n1089)*) mutant embryos and used Quantitative Reverse Transcription Polymerase Chain Reaction to analyze levels of three embryo-specific miRNAs: *mir-35*, *mir-51*, and *mir-52*. I found that *mir-35* levels were significantly higher in *lin-42(n1089)* embryos compared to WT, suggesting that LIN-42 is a negative regulator of *mir-35*. Levels of *mir-51* and *mir-52* were not significantly different between WT and mutants, however there was a large amount of error among samples. In the future, I plan to also analyze primary miRNA levels to try to determine where in the miRNA biogenesis pathway LIN-42 is acting, as well as repeat this analysis at the L1 stage of development to see how miRNA expression changes after embryogenesis is complete.

The second goal of my project was to explore the effect of KIN-20 on global miRNA expression. KIN-20 is the homolog of human Casein kinase 1 and has been shown to regulate LIN-42, but also regulate expression of the miRNA *let-7* independently of LIN-42. The mechanism of this regulation is not well understood, as well as whether KIN-20 regulates other miRNAs at different stages of development. This summer, I collected samples and extracted RNA from WT and KIN-20 loss-of-function (*kin-20(ok505)*) mutant worms at the L4 stage of development to analyze global miRNA expression using microRNA-seq (miRNA-seq). miRNA-seq is a technique that uses next generation sequencing to determine all miRNAs present in a sample and their amounts. I can then use these results to further investigate genes and pathways related to differentially expressed miRNAs in WT vs. KIN-20 mutants.

Research Fellow: Anthony Palazzola (2022)   **Concentration(s): Political Science; Economics**

Faculty Mentor: Barry Shain   **Department: Political Science**

Title of Project: Researching "Revolutionary-era American Pamphlet Literature in Context a Documentary History, 1764-1776," and "Recent Scholarship Exploring The Federalist, 1787-1788"

Project Summary:

This summer, I had the privilege of working with Professor Barry Shain and fellow Colgate student Emmanuel DiRubba. Our efforts focused around mainly two areas. First, we formatted and organized revolutionary-era pamphlets (pamphlets that are largely unknown to contemporary Americans) so as to allow Professor Shain to eventually republish these pamphlets in a future work. Second, we researched the personal biographies of each pamphlet author in order to facilitate Professor Shain in his future book to provide context for interpreting the precise arguments and motivations of the pamphlets. We also spent some time at the beginning of the project accounting for recent academic literature studying *The Federalist Papers*.

After spending hundreds of hours reading and analyzing the revolutionary-era pamphlets, we noticed that two general characteristics of revolutionary-era American society are readily apparent. First, contrary to what is often taught in most primary, secondary, and even tertiary academic institutions in America, the American revolutionary-era political elite was not in lockstep in regard to declaring independence from Great Britain. In fact, many elites held that remaining connected to Britain would be more beneficial from the perspective of protecting responsible-liberty in the colonies than declaring independence would be. And second, once again likely not in line with the conceptions that most contemporary Americans have of the revolutionary-era, the degree of toleration for minority political opinions was quite limited. Numerous pamphlets assert, for example, that certain British Loyalists had their homes burned to the ground by American Patriots and that other Loyalists were hung in effigy and tarred and feathered.

Research Fellow: Collin Parrow (2022) **Concentration: Molecular Biology**

Faculty Mentor: Priscilla Van Wynsberghe **Department: Biology**

Title of Project: Insight Into Cellular Timing KIN-20 is Required for Normal Cyclic Expression of LIN-42 Isoforms in *C. elegans*

Project Summary:

In all organisms, cells contain a functional clock. Functional cellular timekeeping is essential for activities such as sleep and wakefulness cycles, cell cycle regulation, and regulation of developmental progress. Loss of cellular timekeeping abilities results in various cellular defects. The *C. elegans* heterochronic pathway is an example of a cellular clock, and, among other things, it directly regulates temporal cell identities, including progression of larval development. The heterochronic pathway is hypothesized to be homologous to the mammalian circadian clock, with many core proteins involved in both pathways demonstrating conserved sequence homology. Elucidating a better understanding of the relationship between different circadian clock genes has potential to shed light on the molecular mechanisms by which misregulations of cellular timing arise.

lin-42 is an important transcriptional repressor of micro-RNA's essential to heterochronic pathway function. In mammals, LIN-42 homologue PERIOD expression oscillates relative to sleep/wakefulness cycles, whereas in *C. elegans*, high levels of LIN-42 oscillation correlate with larval molts. *kin-20* is a homologue of the mammalian gene(s) *ck1ε/δ*. Previous studies have observed that mutations of KIN-20 in *C. elegans* result in a defective development phenotype, and that absence of KIN-20 enhances *lin-42* mutant phenotypes. This suggests that KIN-20 may have an effect on LIN-42 function, but the specific mechanisms by which this relationship between KIN-20 and LIN-42 might exist are poorly understood.

The *lin-42* gene was modified using CRISPR/cas-9 to insert 3xFLAG tags at various points in the coding sequence of the gene (Figure 1). Western blot analysis of 3xFLAG LIN-42A and 3xFLAG LIN-42B demonstrates a cyclic expression pattern, where the highest levels of LIN-42A and LIN-42B expression occur at the same time as larval molts. *kin-20*(ok505) is a large deletion that results in loss of function of KIN-20 (Figure 1). When KIN-20 function is lost, western blot analysis of 3xFLAG LIN-42B shows that LIN-42B is no longer cyclically expressed, and that LIN-42B simply accumulates in *kin-20(ok505)* cells. These results suggest that KIN-20 is required for proper expression of LIN-42, and by extension, proper heterochronic pathway function. Further investigation is needed to understand if this effect is present in LIN-42A as well, if the relationship between KIN-20 and LIN-42 is direct, and if this relationship occurs at the transcriptional, translational, or protein stability level.

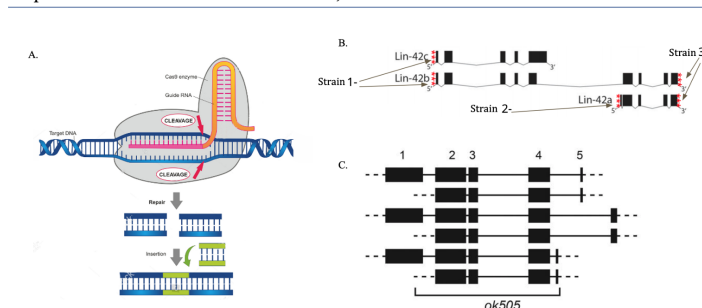Depiction of CRISPR-edited LIN-42 strains, and KIN-20 mutant allele

Figure 1 of 1. (A) CRISPR gene editing was previously used to insert 3xFLAG sequences at different sites in LIN-42 corresponding to different isoforms. (B) LIN-42 exists in three major isoforms, LIN-42A, LIN-42B & LIN-42C. 3xFLAG tags were inserted in different regions of LIN-42. Each 3xFLAG tag is illustrated by "*******" above. This was done in order to obtain stable lines of worms that can be used to detect different isoforms of LIN-42 separately. (C) Depiction of KIN-20 showing the large deletion mutation dubbed *ok505*. This mutation was used to create a strain of worms representing loss of function of KIN-20.

Research Fellow: Jillian Paulin (2023)   **Concentration: Astronomy/Physics**

Faculty Mentor: Cosmin Ilie   **Department: Physics and Astronomy**

Title of Project: Analytic Approximations of Velocity Suppression of Dark Matter Capture

Project Summary:

Dark matter remains a mystery in modern physics. While we have numerous examples of evidence that it exists, its nature is still unknown. Thus, it is important to study different dark matter detection methods. One way we can detect dark matter is by its impact on celestial bodies. Stars (and other objects) can capture dark matter by scattering off stellar nuclei until the dark matter particle's velocity falls below the stellar escape velocity. In some specific cases-- for instance, when considering Population III stars, a theoretical class of stars that would have been the earliest stars in the universe, composed entirely of hydrogen and helium-- the velocity of the star itself can be safely ignored, to a good approximation. However, when a star has a high enough velocity with respect to the surrounding dark matter halo, the rate at which dark matter capture occurs can be suppressed by a significant factor. This project addresses a way to approximate this suppression factor for use in numerical and analytic calculations, and is applicable in a wide range of circumstances, from our local Sun to the earliest stars.
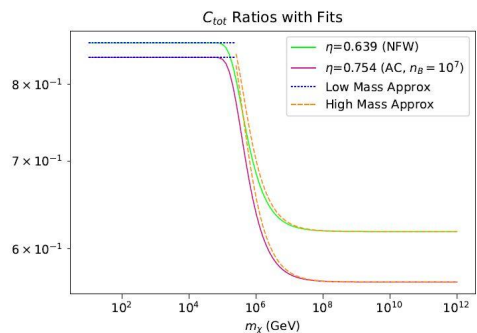
When an object is moving with respect to the dark matter halo, we can replace the traditionally-assumed Maxwell-Boltzmann distribution of dark matter with a boosted distribution. It is dependent on a parameter, η, which is dimensionless and represents the object's velocity. Analyzing the capture rate equation with this new assumption, we can find an analytic representation of the boosted capture rate. Comparing this result with the total capture rate using a Maxwell-Boltzmann distribution gives us a suppression factor, ξ_η. From there, we can make an approximation of this suppression factor in both the high-mass and low-mass regimes. The graph above shows our approximation in comparison with full numerical calculations for two different Population III stars, one which rests in a halo following a Navarro-Frenk-White profile, and the other which rests in an adiabatically contracted halo. These results may be further extended by applying this formalism to local objects such as the Sun and exoplanets, in which celestial bodies have a higher stellar velocity with respect to dark matter halos, and therefore higher suppression factors.

The graph to the right demonstrates that the bounds on the dark matter-nucelon cross section are essentially unchanged for Population III stars, proving the point mentioned above. The bounds on this cross section are shown for the same scenarios as in the first graph.
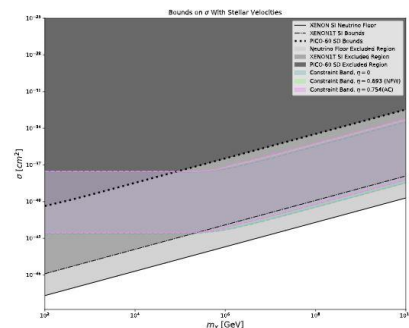
Research Fellow: Nick Poon (2022) **Concentration: Physics**

Faculty Mentor: Ramesh Adhikari **Department: Physics and Astronomy**

Title of Project: Optimizing Leaf-Based Pseudocapacitors

Project Summary:

Past research has shown that injection of poly(3,4-ethylenedioxythiophene) polystyrene sulfonate (PEDOT:PSS) into vascular channels of a Louisiana iris would create "conducting wires" when probed at two ends of the same channel. For this summer research, we experimented with using two PEDOT:PSS filled channels in parallel to each other. This configuration would be analogous to two parallel conducting plates with no conducting material connecting the two, or in other words: a capacitor. We wanted to devise leaf-based capacitors using this principle, quantify their capacitance and carry out their electrochemical characterization.

We carried out various electrochemical characterizations on the leaf-based pseudocapacitor. The cyclic voltammetry (CV) curve (Fig. 1) resulted in hysteresis curves which suggested that the RC circuit had a strong resistance component. The measurements from the Cyclic Charge Discharge (CCD) experiments (Fig. 2) was used to determine the capacitance of the leaf. With a 1 uA discharge current, we measured a leaf with an empty channel between two PEDOT:PSS injected channels to have a capacitance of approximately 300 uF. Potentiostatic Electrochemical Impedance Spectroscopy (EIS) experiments (Fig. 3) measures the real and imaginary impedance of the leaf at multiple AC frequencies which produces data that would allow us to fit models to accurately determine the physical interpretation of our leaf-based pseudo capacitor.
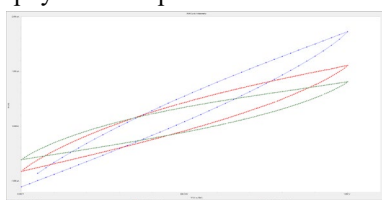

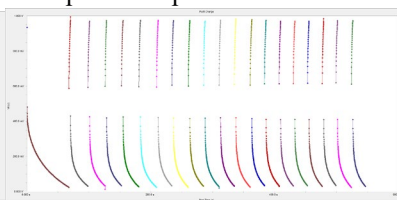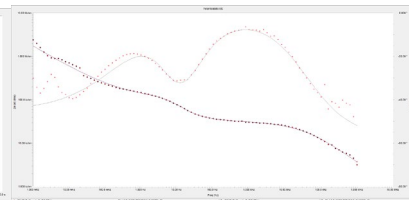*Fig 1. Cyclic Voltammetry Curve* *Fig 2. Cyclic Charge Discharge* *Fig 3. Potentiostatic EIS Bode Plot*

From the measurements that were taken over many samples, we noticed the leaf-based capacitors exhibited more-resistive behavior at low AC frequencies in the Potentiostatic EIS experiment. In other words, our leaf-based "capacitors" were not ideal capacitors because they exhibited conductive behavior at extremely low-frequencies. We speculate that there is charge transfer between ions collected at the electrode interface and the electrode itself when a current (or electric field) is applied This was identified as "current leakage". Because of the leaf's non-ideal capacitive behavior, it would be more appropriate to classify our leaf-based electrical device as a "pseudocapacitor".

One method implemented to solve this issue was to leave an empty channel between the conducting channels in an attempt to further insulate the channels. This did not fully solve the current leakage at low AC frequencies. We also attempted injecting an insulating solution, Polyvinylpyrrolidone (PVP), into the channels. Leaves with PVP injected into the central channel between two PEDOT:PSS filled channels would be analogous to inserting an insulating material between two conducting plates. The preliminary results proved to be promising, but additional samples need to be taken before any conclusion can be made. PVP was also injected along the conducting channels prior to injecting PEDOT:PSS with the goal of creating an insulated coating along the inside of the conducting channels. This did not prove successful due the PVP solution dissolving the PEDOT:PSS coating.

Lastly, we attempted to fit a model (Fig. 4) to the nyquist curve of a leaf with PEDOT:PSS injected into two channels with an empty central channel. The model (Fig. 4) contained a double layer capacitor component (left, with capacitance value of 14.24 ± 2 nF) and a pseudocapacitance component (right, with a capacitance value of 315.5 ± 30.3 nF). More work will need to be done to improve and evaluate the model of the leaf based pseudocapacitor.
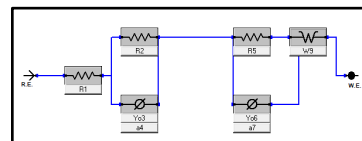

Fig 4. Leaf-Pseudocapacitor Model

Research Fellow(s): Claire Prall-Freedman (2023)   **Concentration: History**
                            Eva Wiener (2023)   **Concentration: Neuroscience**

Faculty Mentor: Jennifer Brice   **Department: English**

Title of Project: Creative Writing Fellowship

Project Summary:

For this year's Creative Writing Fellowship, Professor Jennifer Brice selected Claire Prall and Eva Wiener, who were tasked with assisting in the planning and management of multiple literary events, including the Summer Reads Program, the Porch Symposium, and the Living Writers series. The Creative Writing Fellowship is essential to the success of these events, each of which contribute to the love of literature that is so integral to the Colgate community.

For the Summer Reads Program, Professor Brice selected *American War* by Omar El Akkad. Prall and Wiener read the novel, discussed it extensively with Professor Brice, and completed research in order to make a Summer Reads website. They also contributed to the Living Writers Twitter conversation on an interactive reading of the novel, posing questions and responding to comments. A faculty discussion of *American War* also took place at the end of the scheduled reading, and Prall and Wiener helped moderate and lead a lively discussion.

Due to COVID-19, the Porch Symposium, which normally takes place in person on Colgate's campus, was completely virtual. The Symposium featured twelve authors, all of whom taught virtual master classes centered around the art of writing, and also included an open mic session on the last night of the conference. Prall and Wiener helped with administrative tasks for the event, organizing all 150 participants and ensuring they were enrolled in the master classes of their choice. They also were in charge of corresponding with participants about their workshop assignments and providing assistance and troubleshooting over the course of the three-night conference as moderators.

The main purpose of the Creative Writing Fellowship is to plan and execute a beloved Colgate tradition, the Living Writers series. Every fall, Professor Brice organizes Living Writers, in which authors come to Colgate each week to present their books and interact with the student body. Living Writers is especially focused on choosing a diverse group of authors and books that can spark productive conversations. During the semester, Professor Brice also teaches a class focusing on the chosen books. This year, ten books were selected—including two that just came out over the summer—each of which Prall and Wiener read and discussed with her in depth. These discussions were at least an hour weekly, and Prall and Wiener did close readings of the text with Professor Brice, considering aspects that could create difficulty or possibilities for the teaching of the books. They then contributed to writing copy for the website, creating author biographies, book descriptions, podcasts, and "Beyond the Book" material which included annotated reviews. Prall and Wiener not only edited podcast transcripts after they were recorded, but also selected key quotes from each to feature on the Living Writers website. Given two of the books were published so recently, they also had to take extra care to keep up with reviews and interviews that were constantly being released. In the fall, they plan to continue their work with Professor Brice, assisting with Living Writers as it unfolds.

Research Fellow: Kasar Profit (2024) **Concentration: Undeclared**

Faculty Mentor: Beth Parks **Department: Physics and Astronomy**

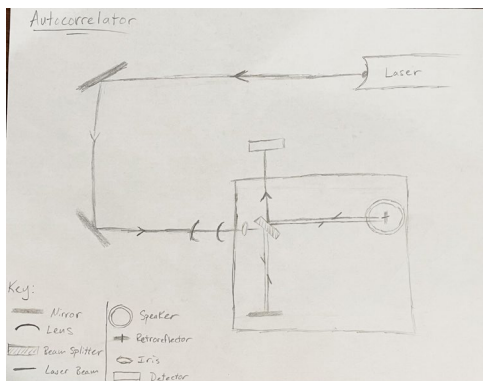**Title of Project: Ultrafast Laser Characterization**

Funding Source: NASC Division

Project Summary:

This summer I did research in ultrafast lasers and terahertz spectroscopy, working in the lab of Professor Beth Parks. The main goal for this project was to construct an autocorrelator, which is an apparatus that measures the length of laser pulses. The autocorrelator measures the length of the laser pulse by correlating one of the laser pulses with a delayed copy of itself. We get this delayed copy by splitting the laser beam using a beam splitter and having the two beams rejoin at the detector. When the two beams rejoin and overlap, it creates a signal that varies depending on how much they overlap. The light from the two beams also creates a bullseye pattern at the detector when testing the alignment of the apparatus. (as shown in image to the right). We used a lens to expand the beam and allow us to see the pattern better. This allowed us to measure the length of the pulse.
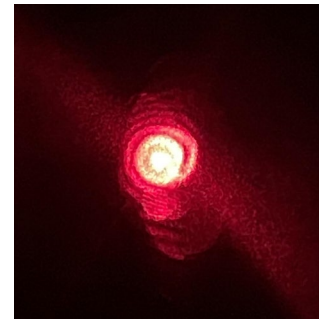
The laser in the lab is a pulsed laser and has laser pulses of about 100 femtoseconds long, which is too short to measure with any electronic device, so we needed the autocorrelator for this reason. In fact, for some sense of scale, 1 femtosecond is to 1 second what 1 second is to 32 million years. The autocorrelator setup requires two mirrors, a beam splitter and a detector. It is set up so that one of the mirrors can move back and forth slightly. The slight back and forth movement of the mirror causes a delay between the two beams and allows us to observe the two beams sweep past one another. We attached one of the mirrors (known as a retroreflector) to a speaker and the vibration of this speaker will cause the slight back and forth movement of that mirror automatically (see diagram to the left). The whole reason for constructing the autocorrelator to measure the length of the laser pulses is to help with assessing the properties of the laser beam in the lab. This is also known as characterizing the laser. Characterizing the laser is important because it helps with keeping track of the laser should anything come up. Making sure the laser is working within its specifications is important when conducting an experiment, and characterizing the pulse length helps us know the what limits the laser should be operating in, so if it is not functioning properly, we would know for the experiment and take make a note of it, or try to resolve the problem before continuing.

Research Fellow: Jeiko Pujols (2023)   **Concentration: Physics**

Faculty Mentor: Ramesh Adhikari   **Department: Physics and Astronomy**

Title of Project: Mechanical Properties of Tyrosine Nanofibers

Funding Source: Science and Math Initiative-SMI (NASC Division)

Project Summary:

Tyrosine is an aromatic amino acid that self-assembles into nanofibers when mixed in deionized (DI) water. Tyrosine nanofibers are a potential building block for environmentally friendly devices and measurement of the stiffness of these structures such as Young's modulus provides insight into their practicality. During my summer research project, I utilized the atomic force microscope (AFM) to determine the Young's modulus of tyrosine nanofibers.

During the early stages of my research process I worked on preparing samples in which fibers could be probed individually. When the fiber solution was deposited on a substrate and left to dry at room temperature the fibers clumped together which was not suitable for accurate modulus measurements. To achieve separated fibers on a substrate I experimented with different tyrosine solution concentrations and techniques such as heating and spin coating. One of the sample preparation methods I found appropriate for my purposes was spinning a concentration of 99.5 µg/mL Tyrosine in DI water solution for 30 to 60 seconds in the digital vortex mixer for fibers self-assembly and then spin coating the fiber solution on a mica substrate at 200 rpm for 90 seconds. The spin coated fiber solution was left to dry at room temperature.

To measure Young's modulus the AFM's "Mechanical Properties" mode was used with a cantilever of 200 N/m spring constant. Specific probing locations on the nanofibers were selected with the "Point and Shoot" feature of the AFM which would tap the locations and produce force curves through cantilever deflection feedback. In the *Nanoscope Analysis* application of the AFM forces curves were analyzed with the Hertzian model to determine Young's modulus and reports of the modulus were extracted using the "Auto-program" feature of *Nanoscope Analysis.* The data was then graphed with a custom Python code.

As shown by figure 1 it was found that if the fibers are not broken during probing, reliable approximations of a fiber's modulus can be obtained with few measurements due to the data's consistency. Figure 2 shows that the modulus of the fibers can range between approximately 10 to 40 GPa.
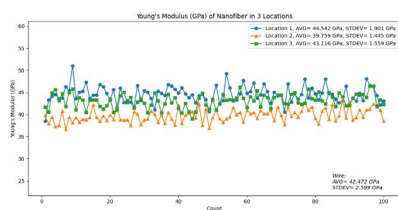

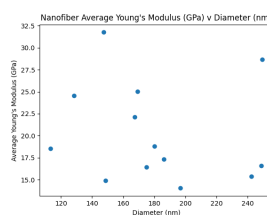**Figure 1.** Graph of 100 modulus measurements in 3 locations along a nanofiber.

Figure 2. Plot of average Young's modulus and diameter for 13

Research Fellow: Olivia Quartz (2022)   **Concentration: Geology**

Faculty Mentor: Amy Leventer   **Department: Geology**

**Title of Project: Examining *Fragilariopsis kerguelensis* rectangularity in East Antarctica
                      as a proxy for reconstructing paleoclimate**

Funding Source: Norma Vergo Prize

Project Summary:

The extent of our knowledge surrounding current and future global warming is heavily reliant on the reconstruction of past climate systems. We do not have access to direct temperature measurements prior to human existence, so in order to effectively learn about how glacial cycles and climate sensitivity have evolved, indirect data can be collected from fossilized pollen, tree rings, and a variety of other proxies. My research project this summer is evaluating a specific microfossil's shape as a new proxy for reconstructing paleotemperatures. *Fragilariopsis kerguelensis* is a diatom species native to Antarctic waters. When examining these fossils under a microscope, two distinct morphotypes become apparent. Both are bilaterally symmetric, but the first is more pointed at its ends while the other is more rounded and elliptical. The differences can be defined by measuring rectangularity; the *F. kerguelensis* with more rounded ends demonstrate high rectangularity, while the lanceolate variety show low rectangularity. Initial studies show that highly rectangular *kerguelensis* are only present in waters colder than 1*C, and therefore samples with a higher percentage of high-rectangularity *F. kerguelensis* indicate cooler temperatures and vice versa. The exact relationship between rectangularity and sea surface temperatures (SST) is unknown--partially because not enough studies have been conducted on the relationship, and partially because the localized studies that have been conducted do not apply universally to all locations where *F. kerguelensis* are found.

My specific project examines diatoms in surface sediment samples from several sites along the Sabrina Coast in East Antarctica. For each of the sites, diatom slides were prepared from the collected samples. I then manually photographed roughly 150 specimens per microscope slide before uploading them to a measuring software. SHERPA (SHapE, Recognition, Processing, and Analysis) acts as a tool for measuring rectangularity by matching the uploaded diatom images to pre-existing *F. kerguelensis* templates. The exported morphological data is then graphed, and based on the percentage of specimens with high-rectangularity, a SST is derived. It is evident that there is some correlation between percent rectangularity and paleotemperature, but the formula itself may have to be adjusted in order to calibrate these temperatures by geographic region. To gain a further understanding of the accuracy of the temperature measurements, I will use the same microscopy and SHERPA processes to analyze one core on the Sabrina shelf at multiple depths. By comparing these temperature results to preexisting TEX86 data, a highly accurate paleothermometer, the accuracy of the SHERPA-derived SST estimates will become more apparent. At the conclusion of this assessment, this project will provide further insight into whether or not *F. kerguelensis* shape analysis is a viable, beneficial proxy for reconstructing paleoclimate.

Research Fellow: Charlie Quill (2023)   **Concentration: Geology**

Faculty Mentor: Karen Harpp   **Department(s): Geology; Peace and Conflict Studies**

Title of Project: Virtual Galapagos Design and Development of an Interactive Online Educational Resource for Children to Learn Science

Funding Source: NASC Division

Project Summary:

This summer, my research project was centered around the production and development of an interactive website for children to learn about how subjects like geology, biology, and oceanography can be learned by children studying them in the context of the Galapagos islands. I contributed to the website construction as a member of our creative team, designing and producing many visual assets necessary to enhance the educational experience and engagement of the users. Additionally, I worked to write and edit scripts for segments of the website. After 10 weeks working closely with designers, programmers, and faculty, we were able to produce material for a module of the Virtual Galapagos website. Though there is still work to be done before a final product is complete and available to the public, this summer was important for the visual production of the Virtual Galapagos website, as well as the advancement of its identity as an educational resource.

I designed a variety of digital assets, including backgrounds, icons/logos, interactive items, buttons, and more. One aspect of the website that was developed during the summer was a game currency, designed to motivate users to pay close attention throughout each module and ultimately retain more of the learned content. To integrate this concept into the game, I designed a currency, which we chose to call a "doubloon," and created icons that represent the increase in wealth that a user can accumulate as they work through scientific concepts in the website modules. Another asset I worked on was the background of the "buddy select screen," in which the user chooses a partner to accompany them on their journey throughout the Galapagos islands. The difficulty in the production of this asset was finding a balance between creating an attractive, visually appealing image while also accurately representing the marine life in the Galapagos.
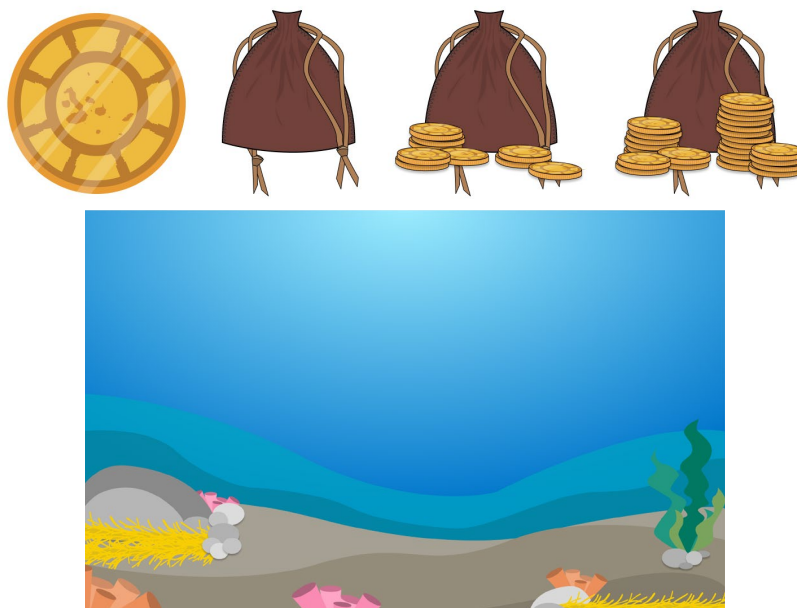
Research Fellow: Allen Quizon (2023)   **Concentration: Computer Science**

Faculty Mentor: Ahmet Ay   **Department(s): Biology; Mathematics**

Title of Project: Analysis of Core Gene Networks Controlling Zebrafish Segment Determination

Funding Source: NASC Division

Project Summary:

The zebrafish segmentation clock network uses spatial fold change in the FGF signal output to control positional information for somite segmentation (Simsek and Ozbudak, 2018). It is hypothesized that a non-cell autonomous gene regulatory network controls SFC. This summer, we used mathematical modeling to find and analyze SFC-generating biological networks.
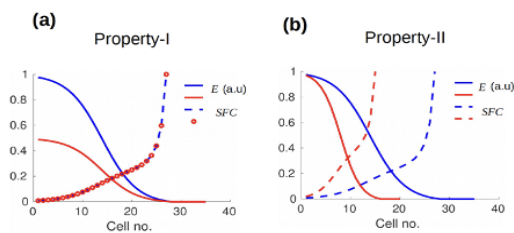

Figure 1. Mutant conditions. (a) Wildtype FGF signaling molecule concentration is represented as a solid blue line. The dotted blue line represents the SFC graph for Mut0. The solid and red dotted line represents the case where the FGF signaling is halved (Mut1) and its corresponding SFC curve. (b) The solid red line represents the case when the FGF signaling is shifted to the left (Mut2). The red dotted line represents the corresponding SFC curve, which is also shifted to the left.

Using MATLAB, we generated all possible one, two and three gene networks in a one-dimensional 32 cell tissue (Cotterell and Sharpe, 2010). The strength of gene interactions, degradation rates, sigmoid function variables, and a morphogen scaling factor affect network dynamics. We developed two model versions: cell-autonomous and non-cell autonomous. In the non-cell autonomous case, each cell communicates with its neighbor. We simulated each network for over fifty thousand parameter sets, and compared their fitness so the SFC curve under three genetic backgrounds (wild type, Mut1, Mut2). We found that the simplest biological network that can fit to the experimental data had 5 edges, which was the same network for cell and non-cell autonomous.
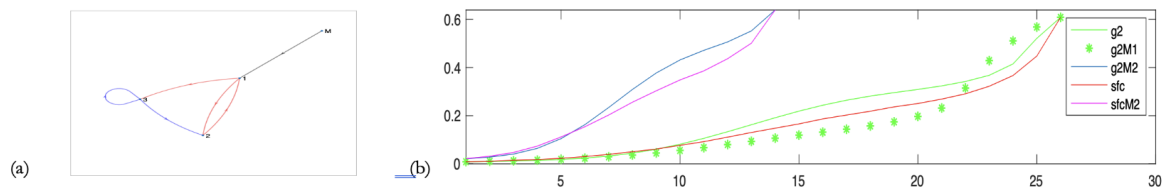

Figure 2. The simplest network, and its fitness to the data. (a) Network with three genes and five edges (excluding the morphogen) that fit SFC curve in all genetic backgrounds. The red edges represent repression, blue edges represent activation, and the gray edge represents morphogen input to gene 1. (b) Three gene five-edges network shows a good fitness to the expected SFC curves.

In summary, the SFC curve cannot be generated in biological networks with one, two, or three genes with less than four edges. Contrary to expectations, cell-autonomous networks can mimic non-autonomous networks' biological behavior. Extensive testing will confirm our findings.

1.   Cotterell J, Sharpe J. An atlas of gene regulatory networks reveals multiple three-gene mechanisms for interpreting morphogen gradients. *Mol Syst Biol.* 2010;6:425.

2.   Simsek MF, Özbudak EM. Spatial Fold Change of FGF Signaling Encodes Positional Information for Segmental Determination in Zebrafish. Cell Rep. 2018;24(1):66-78.e8.

Research Fellow: Jeffrey Ran (2022)   **Concentration: Neuroscience**

Faculty Mentor: Wan-chun Liu   **Department: Psychological and Brain Sciences**

Title of Project: Protocol Development of DCX Immunohistochemistry on *Taeniopygia guttata*

Funding Source: NASC Division

Project Summary:

Adult neurogenesis is characterized by the inclusion of new neurons in the adult brain. Songbird species, such as *Taeniopygia guttata* or commonly known as zebra finch, are often used as model species to study neurogenesis. Neural migration protein doublecortin (DCX) is a protein expressed by neuronal precursor cells and immature neurons. With the inclusion of DCX antibodies in this laboratory, a new protocol for DCX immunohistochemistry was developed from previous studies. This study developed techniques and procedures for perfusion and immunohistochemistry for juvenile and adult zebra finches of both genders. The procedure was performed on free-floating and mounted brain sections. This study found that monoclonal mouse anti-DCX can react with the anti-mouse secondary antibody to yield expression of neurogenesis in the zebra finch brain. In accordance with our hypothesis, free-floating wash steps were more effective in the quantification of DCX expression in juvenile and adult zebra finch brains. As expected, DCX expression was greater in juveniles when compared to adults. This study produced the first successful protocol for DCX staining in juvenile, adult, male, and female zebra finches in this laboratory. Further, bromodeoxyuridine (BrdU) staining was also performed to compare measurements of neurogenesis with the new DCX protocol. This research program produced procedures to effectively quantify neurogenesis in the zebra finch brain. The resulting protocol and laboratory setup will allow future researchers to effectively perform DCX staining procedures in upcoming semesters.
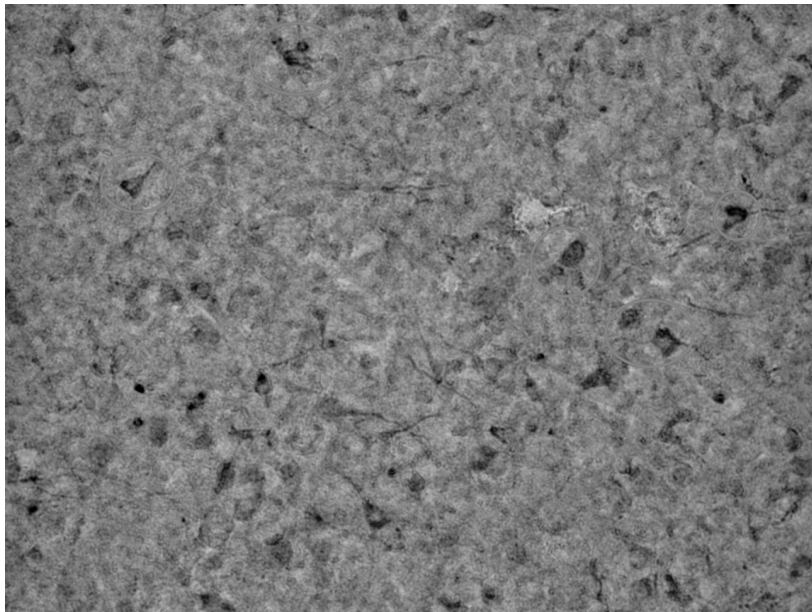
Figure 1. Expression of the resulting DCX labelled neurons through immunohistochemistry in a female juvenile zebra finch (20x magnification).

Research Fellow: Kevin Reim (2022)   **Concentration(s):** Philosophy; Economics

Faculty Mentor: David Dudrick   **Department:** Philosophy

Title of Project: *The Gulag Archipelago:* Truth in a Nation of Lies

Project Summary:

The Soviet Union existed for three-quarters of a century and killed millions with its hard labor prison: The Gulag. Alexander Solzhenitsyn wrote *The Gulag Archipelago* to expose *what* the Gulag system was, *how* the Soviet people let it happen, and most importantly, how to *escape* from the fatal flaws of the Soviet Ideology. All three of these insights can be contained with a single quote from the book:

> "If only it were all so simple! If only there were evil people somewhere insidiously committing evil deeds, and it were necessary only to separate them from the rest of us and destroy them. But the line dividing good and evil cuts through the heart of every human being. And who is willing to destroy a piece of his own heart?" (Gulag 75).

The purpose of this project is to interpret the Gulag Archipelago using this quote in order to fully understand what went wrong with the Soviet Experiment.

The Soviet Union had a unique prison system called the Gulag. These were prison camps far away from any civilization that forced their inhabitants to work hard labor. These camps were filled with deaths every possible way: disease, starvation, the cold, even the guards or the prisoners themselves. Millions of people were arrested and millions of people died in these prisons.

How and why did this happen? Solzhenitsyn connects anecdotes from different survivors to demonstrate that the Soviet Union was not under the craze of a cult of personality but rather, followed Marx to the letter. He demonstrates that the death and starvation of the Soviet Union are the direct consequence of Marxism as well as how every person in the Soviet Union lied every day in order to stay alive. Every person in the Soviet Union gave up their freedom in order to avoid the burden of individual responsibility, which led to the oppression and deaths of millions.

Solzhenitsyn transcends merely being a historian to being a philosopher when he describes the danger of ideology, defined as that which gives evil-doing its long-sought justification. Ideology moves the line dividing good and evil *away from* the human heart. Thus, Solzhenitsyn figures out that all the most murderous regimes of the world – Soviets, Maoist Chinese, Nazis, North Koreans, Spanish Inquisitors, Colonialists – all move the line dividing good and evil onto other people. It is this movement which allows for murder on massive scales to occur. The only way out of ideology is to accept the reality of man's existential freedom, and therefore accept responsibility for the evil in their life.

Research Fellow: Alyssa Kryzelle Reyes (2022)   **Concentration(s): Peace and Conflict Studies; Asian Studies**

Faculty Mentor: Megan Abbas   **Department: Religion**

Title of Project: Seats at the Table: The Criticality of Women's Involvement in Nation-building in Bangsamoro

Project Summary:

The Bangsamoro peace process is praised for its gender sensitivity. Given the region's vulnerability to cycles of poverty and violence, these advances in gender development are a considerable feat. However, it is only recently that women and gender development were institutionalized into the process. This research examines the integration and institutionalization of women, their protections, and empowerment in the Bangsamoro peace process. This research explores: (1) the history and failed attempts at answering the Moro Problem, (2) women as stakeholders in negotiations, and (4) the making of the peace process. Through extensive literature review and analysis of articles, social media content, reports, peace agreements, and legislations from 1976 to 2021, I found the inclusion of women to be a gradual development in the peace process driven by the evolution of the Philippine political landscape, whose democratic foundation always included women. Beyond the influence of national politics, the focus of the peace process shifted from conflict-ending to developing peace which created more room for women to be part of the process.

Given the evolution of the Bangsamoro Peace Process, I identified three distinct phases of gender-based development. The first phase began with women as initiators in 1976-1993 with Imelda Marcos and Corazon Aquino that produced important frameworks like the Tripoli Agreement and the 1987 Constitution. The second phase was the implementation stage. Despite these frameworks, the peace process diverged into two tracks between 1996 and 2010 resulting in failures and successes as two separatist groups championed the Moro cause. This protracted stage of implementation revealed structural and institutional failures due to factors beyond the control of the peace process. As a result of dissatisfaction and opportunity, civil society and grassroots organizations propelled female leaders that took charge of peace and gender-sensitive developments. The third phase was the institutionalization in 2011 to 2021 where women became part of the process as experts of the conflict and advocates about gender-sensitive effects. The culmination resulted in the Comprehensive Agreement on the Bangsamoro providing more gender-sensitive development programs, protections, and empowerment of women in Bangsamoro.

Research Fellow: Matt Sampson (2023)   **Concentration: Mathematical Economics**

Faculty Mentor: Rebecca Metzler   **Department: Physics and Astronomy**

Title of Project: Biominerals: Exploring Composition, Structure, and Function

Project Summary:

During the Summer, I explored biomineralization in mollusks with my project focusing on pigmentation in Neritidae snails. I was searching for differences in the different layers and pigments of the nerite snail shell. Figure 1 shows how a typical nerite snail shell appears under the microscope. There are three visibly distinct layers, with the pigmentation occurring in the exterior layer.

One of the techniques that I used to explore nerite shells was microindentation. To analyze the indents that we make in the shell, we measure the diagonal lengths of the indents. This allows us to obtain a hardness value. The data that I collected on the hardness of different pigments was varied and contradictory. However, I found that the interior shell layer was significantly harder than the middle and exterior layers, and the middle layer was significantly harder than the exterior layer. I also used infrared spectroscopy to identify the calcium carbonate polymorphs within the nerite shells (figure 2), with the interior of the shell being aragonite and the exterior of the shell being calcite. Finally, I used Energy Dispersive X-Ray Spectroscopy (EDS) on the scanning electron microscope (SEM) to determine differences in the elemental composition of different pigments.
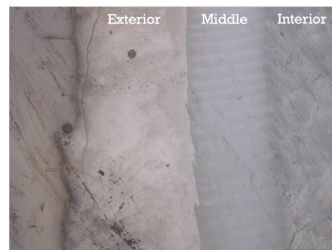

Figure 1. Changing the polarization of the light from the microscope enables one to see three distinct layers in the Nerite shell.
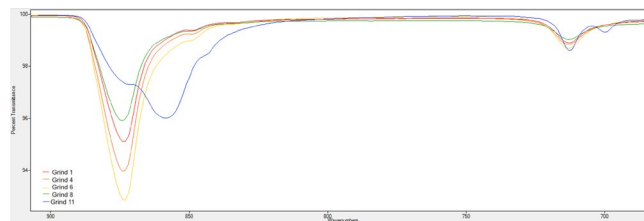

Figure 2. Infrared spectroscopy revealed that aragonite is present in the interior of the shell, and calcite is present in the exterior of the shell. Aragonite (blue) has a double peak near 700 wavenumbers. Calcite does not. This "filing curve" was obtained by filing all the way through the shell and taking spectra of the shell fragments after each file.

Research Fellow: Rachel Schaaf (2022) **Concentration(s): Mathematics; Chemistry**

Faculty Mentor: Rick Geier **Department: Chemistry**

Title of Project: Investigation of the Synthesis of an Alkyl Substituted Porphyrin and N-Confused Porphyrin

Funding Source: Miller-Cochran Fund

Project Summary:

Porphyrins are heterocyclic organic macrocycles with biological and non-biological relevance. N-confused porphyrins (NCPs) are isomers of porphyrin with an inverted pyrrole ring. While aryl substituted NCPs have been previously isolated, alkyl substituted N-confused porphyrins have yet to be reported in the literature. This summer, we focused on the syntheses of tetrapentylporphyrin and N-confused tetrapentyl porphyrin.
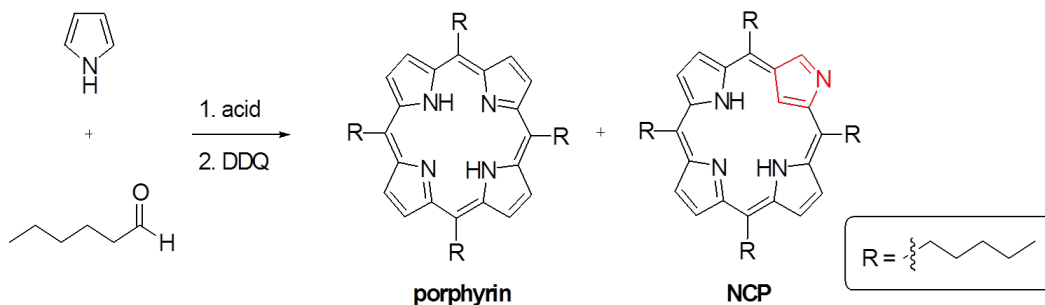
Previous students in our group investigated a small number of reaction conditions, one of which produced the NCP in modest yield. These students isolated a small quantity of the NCP. Previous students also prepared the tetrapentylporphyrin. These samples were used to begin examining the use of TLC to determine the yield of the porphyrin and NCP in reaction mixtures.

Using the condition identified by the previous students, we isolated and purified a further quantity of NCP, and confirmed its identity through UV-vis, ^{1}H-NMR, and mass spectrometry. Purification steps were refined as we were concerned there may be loss of NCP during this process. The isolated sample was then used to develop an HPLC method to monitor yield of the porphyrin and NCP to allow for comparison of the TLC method that was also under development by another student. HPLC conditions were refined to ensure sufficient separation, reasonable retention times, and good peak shape for the compounds. The detector response was then calibrated over a range of porphyrin and NCP concentrations. The HPLC method was used to monitor porphyrin and NCP yields in the analytical-scale reactions.

Analytical-scale reactions were conducted to explore the effect of acid, acid concentration, and reaction time on the yields of porphyrin and NCP. We found that most of the acids gave similar, low yields for the NCP with one acid producing a higher yield.

Research Fellow(s): Hunter Schaumloffel (2023)   **Concentration:** Biochemistry
                   Nilesh Shah (2024)   **Concentration:** Undeclared
                   Esther Wu (2023)   **Concentration(s):** Biochemistry; Neuroscience

Faculty Mentor: Jacob Goldberg   **Department:** Chemistry

Title of Project: New Chemical Tools to Study Biological Systems

Project Summary:

The goal of our research is to design small-molecule chemical probes to study biological systems. During this summer, efforts were directed to the synthesis and purification of a variety of short peptides, which are a series of amino acids bonded to each other, that will be used to explore three areas of chemical biology: (1) the development of new methods for modifying cysteine residues in proteins; (2) the implementation of enzymatic protein labeling strategies; and (3) the advent of new fluorinated amino acid for studying the role of hydrogen bonding interactions in protein folding. These tools will allow us and others to explore protein biochemistry and better understand the nature of protein folding and aggregation, processes that play important roles in many neurodegenerative pathologies such as Alzheimer's disease and Parkinson's disease.

To synthesize these peptides, we used resin beads as solid supports to anchor growing peptide chains. Protected amino acids were iteratively coupled and deprotected to extend the chain, as shown schematically in Figure 1. Subsequent purification by high performance liquid chromatography gave the desired peptides. In this way, we were able to create peptides of various lengths and could incorporate noncanonical amino acids--those not found in nature--into peptides and ultimately proteins. These tools provide desirable spectroscopic, reactive, and functional properties that are not otherwise available from the set of canonical amino acids and allow new opportunities to interrogate biomacromolecules.
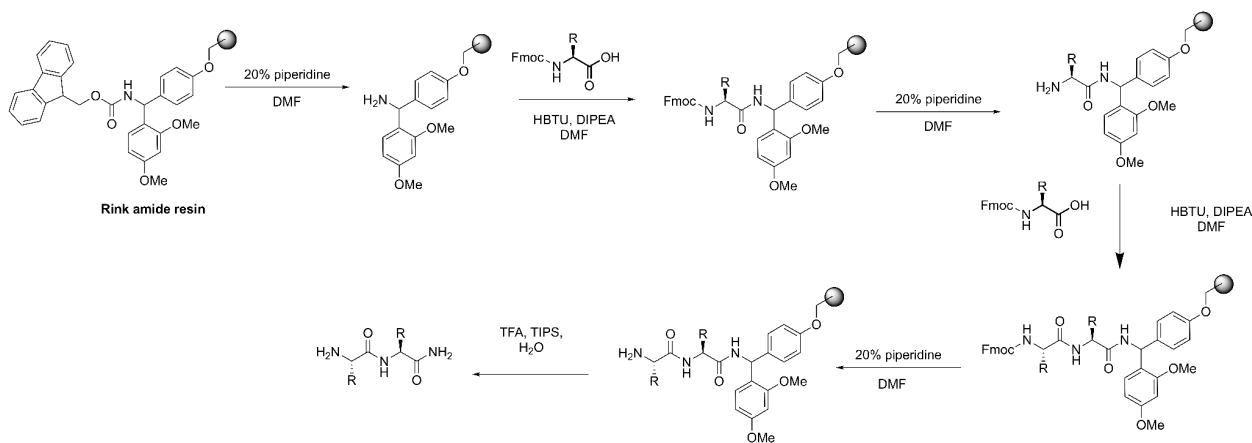

Figure 1. A generic scheme for peptide synthesis.

Research Fellow: Emily Schwartz (2021)   **Concentration: Environmental Studies**

Faculty Mentor: Julie Dudrick   **Department: Upstate Institute**

Title of Project: Road Salt Reduction Research with AdkAction

Funding Source: Upstate Institute

Project Summary:

AdkAction seeks to promote vibrant communities, address unmet needs of local residents, and maintain the wild character of the Adirondacks. With 6 million acres of public and privately managed land, over 100 towns and villages, and a year-round population of approximately 132,000 people, organizations such as the AdkAction play an important role in protecting the environment and communities in the present and the future. Since 2010, AdkAction has been studying the use of road salt as an effective tool for winter maintenance, while educating and advocating for its use reduction. Yet, within the last few decades, salt usage has become alarmingly high. Within the Adirondacks, approximately 190,000 tons of road salt are applied each winter season on state, county, and municipal roads. To help quantify the impacts of this usage, AdkAction helped sponsor a report conducted by Paul Smith's Adirondack Watershed Institute in 2019 that found that 64% of wells (out of 500) exceeded the federally recommended limit for sodium. These sodium levels not only threaten the viability and health of freshwater ecosystems, surpass animals' salt tolerance, and deteriorate infrastructure, but it also poses harmful effects to humans including high cholesterol and increased risk of stroke.

This summer, I developed a white paper that analyzed road salt public outreach campaigns within the United States and Canada. Following this research, I provided recommendations and suggestions derived from each public outreach campaign that I believe will best suit the communities within the Park. This project was on a small scale, having only analyzed 9 public outreach campaigns; however, the breakdown of each campaign will allow AdkAction to maximize their time, labor, and success. Looking into the future, I would suggest a statistical analysis into the actual success of these cases and a dissemination of this information when gathering with each working group.

As a recent graduate of Colgate with a degree in Environmental Studies, Geology, and Geography, this summer has allowed me to explore different topics within my area of study
that I had not yet encountered. Whether it be road salt, food security, or composting, I have gained valuable information from this internship that I will use throughout my future career in conservation.

Research Fellow: Amelia Seasholtz (2023)   **Concentration: Biochemistry**

Faculty Mentor: Rick Geier   **Department: Chemistry**

Title of Project: Investigation of a One-Flask Synthesis of Calixphyrins

Funding Source: NASC Division

Project Summary:

Calixphyrins are porphyrinoids with hybrid structures relative to porphyrin (all sp^2 meso positions) and calix[4]pyrrole (all sp^3). The combination of sp^2- and sp^3-hybridized meso positions impacts macrocycle properties such as metal ion binding, spectroscopy, and stability. The synthesis of calixphyrins is generally more difficult due to their lower symmetry.
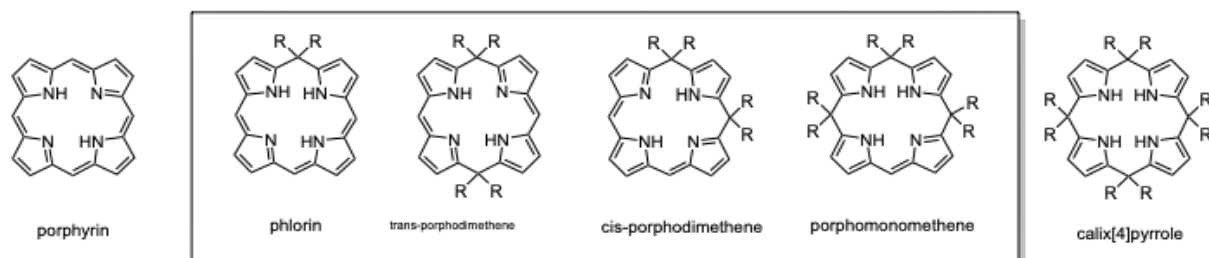
Previously, our group investigated the one-flask reaction of pyrrole with pentafluorobenzaldehyde and acetone that afforded a phlorin in good yield. These results encouraged a broader study of reaction conditions to determine whether the product distribution could be shifted to other calixphyrins. Preliminary studies identified a reaction condition that afforded the trans-porphodimethene, cis-porphodimethene (contaminated with phlorin), and porphomonomethene in relatively good yields.

This summer, we repeated the one-flask reaction with the goal of isolating pure cis-porphodimethene. Column chromatography was employed and good separation was observed between the products. The calix[4]phyrin products were then characterized by UV-Vis, ^{1}H-NMR, and LD-MS. The cis-porphodimethene in good purity was obtained (12% yield, 240 mg). Additionally, we prepared and characterized calix[4]pyrrole from the reaction of pyrrole with acetone (50% yield, 536 mg). Last, we completed the initial development of an HPLC method and obtained suitable separation between the complex mixture of porphyrinoids. This HPLC method will allow us to monitor the distribution of products as we systematically investigate reaction parameters in future analytical-scale experiments.
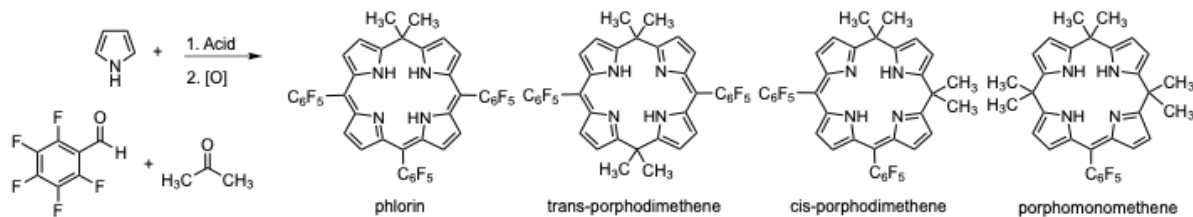
Research Fellow: Sophie Shaffer (2022)   **Concentration: Psychological Science**

Faculty Mentor: Meg Gardner   **Department: Educational Studies**

Title of Project: **Understanding the role of critical educators in the transformation of schools for justice**

Funding Source: SOSC Division

Project Summary:

The purpose of this research initially started as an assessment of Colgate's Teacher Preparation Program (TPP) and to find gaps in the program and ways to support alumni from the program. Colgate's Teacher Preparation mission is outlined to "educate a small number of excellent teachers" as well as strive to teach students to center the child despite a nationwide trend of homogenizing education. My research specifically pointed to ask: *Is Colgate's TPP creating critical educators that their mission statement attempts to create?*

To assess the research question, I held a focus group consisting of program alumni that are currently teaching as my main data collection. I also had an interview from an alumnus who never went into teaching as supplemental data and add to vary perspectives. four questions in total and probing. The interview lasted around 30 minutes.

When I coded my responses from my focus group the themes of critical pedagogy, social justice, student centered learning, and internal mindset began to emerge. As an organization of themes the overarching idea of critical pedagogy was highlighted as my starting point. To many of the current teachers, they reflected on the importance of introducing social justice topics and critical pedagogy in the classroom but revealed that in practice it can be more difficult to implement. For example, one teacher cited their difficulty in explicit social justice lessons given that their discipline is math and that is a particularly hard discipline to integrate social justice. Another teacher was committed to finding additional narratives to incorporate into their history class, however, finding less white washed textbooks was continually challenging and draining. Although difficult at times, these teachers all were committed to student centered learning practices in their classrooms. By focusing on the needs of the student, teachers are disrupting the standard model of schooling and replacing the idea of being "all knowing" and allowing themselves to learn from their students.

Throughout the focus group there was a universal commitment to putting students first and disrupting the conventional ideas of teaching. This is the root mission of the Teacher Preparation Program and there is a clear commitment to implementing this mission in their personal teaching practices.

Research Fellow: Elizabeth Shaw (2022)   **Concentration: Anthropology**

Faculty Mentor: Julie Dudrick   **Department: Upstate Institute**

Title of Project: Vaccine Confidence among Refugees in Utica

Project Summary:

Despite excellent performance during clinical trials, many in the U.S. still regard the available COVID-19 vaccines with skepticism. This research project worked with The Center, a refugee resettlement agency in Utica, to identify sources of concern about the vaccine among the populations that they serve. The research began with an exploration of current literature investigating the nature of vaccine hesitancy and strategies for increasing vaccine confidence. There seems to be a consensus that it is very difficult for external forces to change someone's mind about the safety and efficacy of a vaccine. Many sources also highlighted the importance of trusted sources of information, such as a family doctor. The Center employs community navigators, who act as liaisons between each ethnic group of refugees and the services that the Center provides. These individuals are members of the community that they represent, and are often chosen because they are trusted and respected in their respective communities. For this reason, community navigators were a very important source of information for this project. The Center had organized many efforts to vaccinate their clientele, and these messages were often pushed out by community navigators. When others refused, they recorded why. These data revealed that the vaccine hesitancy among the refugee communities in Utica comes from a variety of factors. Many were concerned about the health risks related to allergies and blood clots, others were concerned about the side effects of the vaccine, and others were concerned about fertility and prenatal health. In order to best address these concerns, a list of responses was compiled to be shared out by community navigators. The pamphlet does not actively disagree with any fears, or "myth-bust," but instead intends to approach the conversation as an open dialogue.

Elizabeth Shaw (standing center) volunteers at a vaccine sign up organized by
The Center's community navigators.

Project Summary:

Although I was originally tasked with writing a research paper on "Aristotle, Nietzsche, and the Nature of Truth," I quickly realized that the question 'what is truth' could not be adequately considered through a mere comparative lens. Too long have Western minds sought a linear or singular path to a higher being: Plato's Forms and the Abrahamic God. This is also to say that the West traces its origins to Greek and Abrahamic thought. Next, but without abandoning those prior 'truths,' they turned to the concept of the 'self' because, in the absence of that God, the present or now becomes valued. So, western thinkers sought perfection or 'God' in the 'self' (Silverman 1984). In hindsight, this paper becomes an attempt to reevaluate these 'centers' and, in turn, illustrate the world as it *actually* is.

Captivated by Friedrich Nietzsche's "style of philosophic writing which remains intensely skeptical of all claims to truth," I look to his critique of representation and 'Will to Value' as a theoretical foundation for this paper (Norris 2002, 56). I found his noncompliance with the "presumption that a system as such has a special claim to truth" to be of significance (Kaufmann 30, 1992). His antagonism towards the notion that the sensible sign provides transparent access to intelligible abstraction is indicative of a 'taking on' of institutions or, to be precise, the philosophical and religious orthodoxies of his day. This calls for a reevaluation of particular systems of 'truth' or 'knowledge.' Quite accordingly, he illustrates this deconstructive stance through the identification of 'Will to Value' in Christianity, Western philosophy and its presuppositions, and the abortive actuality of nihilists.

Because his writings actually predate the arrival of 'possible worlds' semantics and existentialism in western thought, the first section of this paper includes a contemporization of his earlier critique of metaphysics and onto-theology. Interestingly enough, I found this very process of contemporization to be suggestive of a new existentialist empiricism: a renewed focus on the sensible over that of the abstract. It is a revisitation and contemporary revision of Nietzsche's 'Will to Truth' that I term the 'realization of a nothing.' Since I fancy the metaphoric, the reader encounters four representations of 'Will to Value' so as to further our understanding of his aforementioned will, the 'Will to Truth' and, in turn, my contemporary revision as the 'realization of a nothing.'

Although Friedrich Nietzsche's critique of representation and 'Will to Value' is instrumental in guiding us towards this new existentialist empiricism, I vehemently disagree with his posthumous understanding of the ideal subject of modernity. His 'ubermensch' or 'transhuman' suggests that man can entirely do away with their received way or tradition of knowing and doing after identifying his or her own 'Will to Value'; Nietzsche "preaches liberation, originality, reinvention, and self-creation" to his readers in a post-moral setting (West 2017, 16). And yet, despite his deconstructivist mentality being a positive divergence from 'producers of knowledge,' this is entirely a misconception of the human subject. It is not a matter of choice that one still "cling[s] to "good" and "evil['s]" leftovers after the 'realization of a nothing' (Nietzsche 1982, 313). Hence, Nietzsche wrongly advocates for a kind of post-moralist religion that deifies a Cartesian understanding of the human subject as individual. Whether he became convinced by Wagner "that greatness and genuine creation were still possible" or merely sought to Darwinize his 'Will to Truth,' he falls victim to the very 'Will to Value' he sought to critique in the aforementioned orthodoxies or institutions (Kaufmann 1992, 30).

Hence, the second realization, being the 'realization of the body,' is a realignment of Nietzsche's deconstructive approach with actuality and redefinition of the ideal subject of modernity! It is a fusion of semiotic and psychoanalytic theory that combats this Cartesian understanding of the subject and that of 'conscious thinking.' While his thought embodies the radical material and perceptual transformations attending industrial modernity, Nietzsche is merely a stepping stone towards the real subject of modernity. It is Jacques Lacan who "adds the dimension of language to Freud's discovery of the unconscious" that I find particularly useful in both resisting this misunderstanding of the human subject and developing an *actual* understanding of such (Kornbluh 2018, 42). As a means to flatten this misunderstanding, the deceptive logic of the unconscious and the subject is soon revealed!

Moreover, upon arriving at this second realization, the reader soon discovers that the two realizations coupled together grant us access to a temporary state of what I term the 'trans.' The wielding of the 'trans' is symbolic of *actual* self-awareness: the ability to embrace this new existential empiricism whilst also acknowledging the 'self' as a subject. If one continues to enter and, in effect, develop this temporary but accessible state of the 'trans,' one's very notion of *living* or *being* soon becomes drastically altered by it!

Research Fellow: Emma Silverman (2023)   **Concentration(s): Spanish; International Relations**

Faculty Mentor: Julie Dudrick   **Department: Upstate Institute**

Title of Project: The Center, Utica, New York

Funding Source: Upstate Institute

Project Summary:

Formerly known as the Mohawk Valley Resource Center for Refugees, The Center aims to support refugees and immigrants in their arrival and adjustment to Utica and the Mohawk Valley as well as foster a welcoming environment for immigrants. The Center places refugees in housing and takes care of many of their day-to-day needs in the first couple of months after arrival. In addition, The Center supports refugees long past their first few months in New York by offering services such as Covid-19 vaccination clinics, interpretation and translation services, cultural and workforce development workshops, driving and language classes, legal consultation events, and employment opportunities.

Before my experience with The Center, I was unaware of the large refugee population in Utica. The impressive cultural diversity of the city presents itself in the dozens of immigrant-owned restaurants and businesses. With so many ethnic groups living in one place, often with limited English skills, The Center's language services serve an essential need—the ability to communicate across cultures. The Center publishes almost all of its materials and resources in at least 10 languages, and sometimes up to 20. Its translation and interpretation services offer about 50 languages. These linguistic services give The Center credibility and foster trust with Utica's immigrant communities that allow it to offer other services like vaccine clinics. Also, the Center employs and works closely with leaders of various ethnic communities in Utica, increasing the level of collaboration between The Center and the people it serves.

My work for The Center focused on social media and marketing needs, and on promoting a virtual event called [A Walk in Their Words](). For the event, participants would walk or run individually while listening to audio recordings of refugees helped by The Center and partner agencies. We also had an in-person kickoff event for the walk with a Covid-19 vaccination clinic, a Chobani yogurt truck, and a bicycle giveaway. Increasing awareness of this event and pushing registration was one of the most important contributions I made to The Center this summer because I had the opportunity to increase support for their mission in upstate NY and beyond—we received registrations from at least 15 US states. In turn, increasing support for The Center means increasing support for refugees and immigrants in their unique struggles.

As an International Relations and Spanish double major, my work this summer gave me the chance to see how international issues of immigration play out in local communities. I learned about how local organizations work directly with individuals and groups who have been affected by persecution, war, and other crises. In this way, my experience with The Center served as a reminder that the topics we often discuss in an academic setting affect real people deserving of respect and support.

Research Fellow: Ayush Sinha (2022)   **Concentration(s): Economics; Mathematics**

Faculty Mentor: Michael Connolly   **Department: Economics**

Title of Project: Loan Termination of Fannie Mae Multifamily Mortgages Going Underwater

Funding Source: SOSC Division

Project Summary:

Abstract: Using a sample of 14182 Fannie Mae multifamily mortgages issued from 2009 to 2020 in coastal states within 50 miles to the coast, we estimated the effect of being exposed to sea level rise of up to 6 feet on loan termination. With controls for loan, property, and geographical factors, we ran a proportional hazards model to answer this question. We show that loans on exposed properties are less likely to be paid off fully than unexposed loans. More specifically, such loans are less likely to be prepaid.

We wanted to find out whether Fannie Mae multifamily mortgages exposed to sea level rise terminate at a different rate than unexposed properties. This question was inspired by (Pennington-Cross Smith 2020)[1] that looks at loan characteristics that determine early loan termination of small Fannie loans, (Gustafson et al 2018)[2] that estimates the effect of SLR exposure on the property prices, and (Issler 2020)[3] that uses a proportional hazard model to estimate prepayment/default risk due to energy inefficiency.

Our sample of loans is from Fannie Mae's publicly available DUS disclose and loan performance data sets and sea level rise data is from NOAA. We also used data from FRED, EIA, and GreenStreet CPPI. Only 5 loans in our sample defaulted so we could not analyze loan defaults and focused on prepayment and full payment instead. Both the summary statistics and our proportional hazards estimation results suggest that there is a lower prepayment rate to exposed properties.

This result can't be related to the property going water, as the worst case scenario by the IPCC "only" projects a 1-3 feet rise in sea level by 2100[4]. Instead, it is possible that Fannie Mae is acquiring mortgages in areas exposed to sea level rise with loan characteristics that discourage loan prepayment as compared to unexposed areas, through differing loan characteristics. Apart from earning more interest, it is currently unclear what Fannie Mae gains from this. We need to investigate this further, with a more robust identification strategy.

	Full Payment	Full Payment	Prepayment	Prepayment
SLR exposure(<= 6 feet)	−0.499***	−0.333***	−0.542***	−0.351***
	(0.087)	(0.082)	(0.091)	(0.085)
Time till balloon payment	0.040**	0.251***	0.054***	0.281***
	(0.003)	(0.009)	(0.003)	(0.009)
LTV	−0.024	−0.107***	0.005	−0.070**
	(0.022)	(0.029)	(0.021)	(0.027)
LTV at Issuance	1.161***	1.291***	1.314***	1.536***
	(0.127)	(0.141)	(0.133)	(0.148)
Coupon Gap	−0.305***	−0.485***	−0.299***	−0.494***
	(0.019)	(0.021)	(0.020)	(0.022)
log(UPB at Issuance)	0.014	−0.093***	0.030*	−0.089***
	(0.017)	(0.018)	(0.018)	(0.018)
Refinance	−0.266***	−0.137***	−0.270***	−0.115***
	(0.039)	(0.040)	(0.040)	(0.042)
Underwritten DSCR	0.043***	0.075***	0.031***	0.060***
	(0.011)	(0.013)	(0.010)	(0.013)
Original Term	−0.078***	−0.282***	−0.088***	−0.309***
	(0.003)	(0.008)	(0.003)	(0.009)
Property build year dummy	Y	Y	Y	Y
Total Property Units	0.0003***	0.0003***	0.0003***	0.0003***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Elevation	−0.0004**	0.0004	−0.0005**	0.0004*
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Distance to Coast	0.001	−0.003*	0.001	−0.004**
	(0.001)	(0.002)	(0.001)	(0.002)
Property State dummy	N	Y	N	Y
Origination year dummy	N	Y	N	Y
Observations	784,661	784,661	784,661	784,661
R^2	0.004	0.006	0.003	0.006
Max. Possible R^2	0.084	0.084	0.079	0.079
Log Likelihood	−32,840.240	−31,930.690	−31,119.700	−30,156.990
Note:				*p<0.1; **p<0.05; ***p<0.01

	0 Mean	Min	Max	1 Mean	Min	Max	2 Mean	Min	Max	Total Mean	Min	Max
Exposed to SLR(<=6ft)	0.06 (0.24)	0.00	1.00	0.05 (0.21)	0.00	1.00	0.40 (0.55)	0.00	1.00	0.06 (0.24)	0.00	1.00
Miles to Coast	12.31 (13.34)	0.00	49.98	11.43 (12.65)	0.01	49.99	14.20 (17.14)	0.48	42.46	12.04 (13.14)	0.00	49.99
Elevation	56.61 (82.22)	-2.35	1,176.92	62.95 (88.05)	-2.56	904.15	7.76 (5.40)	2.87	15.01	58.53 (84.09)	-2.56	1,176.92
LTV at Issuance	0.01 (0.00)	0.00	0.01	0.01 (0.00)	0.00	0.01	0.01 (0.00)	0.01	0.01	0.01 (0.00)	0.00	0.01
Original DSCR	1.91 (1.43)	1.00	40.66	2.17 (2.52)	0.96	61.56	1.85 (0.70)	1.15	2.69	1.99 (1.84)	0.96	61.56
Log(Original UPB)	15.84 (1.24)	11.62	20.03	15.44 (1.20)	11.76	19.11	15.54 (0.94)	14.36	16.39	15.72 (1.24)	11.62	20.03
Final Observed Loan Age	44.14 (33.64)	3.00	146.00	81.24 (30.96)	3.00	137.00	63.20 (37.90)	46.00	131.00	55.51 (37.03)	3.00	146.00
Total Units	148.68 (160.77)	5.00	5,881.00	149.20 (180.71)	5.00	5,881.00	155.60 (62.64)	86.00	203.00	148.84 (167.10)	5.00	5,881.00
Observations	9,832			4,345			5			14182		

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[2] Pennington-Cross, Anthony, and Brent C Smith. "Early Termination of Small Loans in the Multifamily Mortgage Market." Real Estate Economics, vol. 48, no. 4, 2017, pp. 1198–1233., doi:10.1111/1540-6229.12194.

[3] Issler, Paulo, and Paul Mathew. "Multi-Family Mortgage Default Risk Associated with Energy Inefficiency: Fannie Mae Securitized Loans." Building Technology and Urban Systems Division, 3 Nov. 2020, buildings.lbl.gov/sites/default/files/project/documents/Multifamily%20Mortgage%20Default%20and%20Energy%20Efficiency%202020-11-03.pdf

[4] "Choices Made Now Are Critical for the Future of Our Ocean and Cryosphere." IPCC, 25 Sept. 2019, www.ipcc.ch/2019/09/25/srocc-press-release/.

Research Fellow: John Slater (2022)   **Concentration: Astronomy/Physics**

Faculty Mentor: Thomas Balonek   **Department: Physics and Astronomy**

Title of Project: Periodicity of Quasar 1308+326

Project Summary:

In the summer of 2019, Colgate's Foggy Bottom Observatory began to regularly observe the quasar 1308+326 regularly after noticing it flaring brighter than it had been in half-a-decade or more. At FBO, we collect data via a 16-inch telescope that we connect a CCD imaging device to in order to obtain digital images. For most clear nights, we have been collecting data as much as possible. Quasars are supermassive black holes in the center of galaxies that expel jets out of either side of the object. This occurs from an interaction between heated materials in the disk and its strong magnetic field.

As we began to collect data two summers ago on this newly flaring object, we came across a paper that proposed a 16.9 year period from Britzen et al. from 2017. However, this team conducts its research in the radio wavelengths and FBO conducts research in the optical R wavelengths. Last summer for FBO research, our focus shifted to reducing our own data after collecting much of it in 2019. We completed this, setting our sights on a periodicity analysis. FBO has data from 2001-2004 that shows another outburst that supports the Britzen claim, although in optical R.

Using Python, two analyses have been conducted thus far, Lomb-Scargle and Structure Function. Both take note of how the data is unequally distributed, an important distinction that does not allow us to use some traditional analyses like autocorrelation. The Lomb-Scargle analysis uses a Fourier transform to find the frequency of repeated data. The structure function takes the difference between each optical R magnitude measurement from each of the following and plots the difference versus the difference in time from each measurement. For the Lomb-Scargle plot, two peaks appear. However, the next peak is where we want to focus. Although not as strong as the previous, this one shows a period of around 22 years, encapsulating all three of the main outbursts. While this does not line up completely with what we expected, it is still an important result to note. For the structure function, the important parts of the graph show themselves in the dips, where the difference in magnitudes are smaller comparatively. A large dip around 7500-8000 days corresponds to around 20-21 years, a result closer to what we expected. In the future, there is still much work to be done. This work will be continued in the fall as my thesis work.
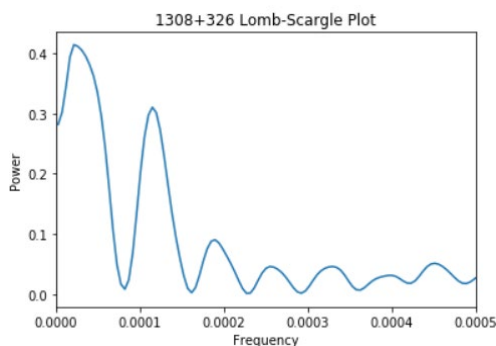
Research Fellow: Gabrielle Sorresso (2022)   Concentration(s): Environmental Studies; Economics

Faculty Mentor: Isla Globus-Harris   Department: Economics

Title of Project: Wind Energy and Changing Incentives for Reserve Power in Texas

Funding Source: SOSC Division

Project Summary:

The expansion of wind power into electricity markets is a crucial part of reducing carbon emissions and combating global climate change. However, the large-scale addition of wind energy to electricity grids brings a unique set of challenges. Wind power provides energy only when the wind is blowing and we have not yet developed the resources to effectively store and regulate it. As more wind turbines are added, there is a greater range of wind energy that can be on a grid at any given time. Therefore, as the number of wind turbines on a grid grows, so does the extent of forecasting errors. Currently, electricity grids in the United States are working to incentivize the generation of reserve power that can complement rapid increases in wind power. This type of generation is flexible because it can quickly come on or off a grid to balance supply and demand forces in the event that forecasting for wind power is incorrect or unpredictable weather conditions arise. Because increasing wind power leads to higher volatility and less accurate forecasting of energy production, flexible types of generation will have a more important role in electricity markets moving forward. Evaluating the success of reserve power markets is crucial to ensuring that more renewable energy can be sustainably added to a grid over time. Without this type of power to support the expansion of wind energy, grids may face decreases in reliability and higher instances in which supply cannot meet demand.

My research evaluates the effect of wind energy on the Electric Reliability Council of Texas (ERCOT) market for reserve power. Although I look at the Texas market specifically, these results are largely generalizable to other electricity grids across the United States. I study how forecasted wind energy generation and volatility affects the offerings and price of reserve power in this market. My research started with a comprehensive literature review and researching previous work on this topic. I then compiled a data set of over 87,000 observations in STATA, an econometric analysis software. I collected the bulk of my data from ERCOT and then used STATA code to build additional variables to analyze the market. After constructing my dataset, I conducted an extensive econometric analysis in STATA.

I find that in the current market system, increased wind generation and wind volatility disincentivize generators to supply reserve power, despite sometimes raising the price of this power. My results highlight the potential issues with the current system for reserve power. In the long run, this system will not incentivize the necessary increase in capacity of reserve power needed to support the expansion of further wind generation. To be compatible with the long run needs of the grid system, this market should incentivize generators to create reserve power specifically when it is needed most (when there are the most amount of forecasting errors expected). This sends the signal to market participants to build out their capacity for reserve power as wind generation increases in the longer term - which is exactly what will be needed to combat the volatility of wind forecasting and maintain a balance of supply and demand on the grid. Without proper incentives in this market, capacity for reserve power will not increase over time, potentially leaving ERCOT without the capability to meet the needs of its consumers during fluctuations in wind power.

Research Fellow: Sam Sporn (2022)   **Concentration: Political Science**

Faculty Mentor: Juan Fernando Ibarra Del Cueto   **Department: Political Science**

Title of Project: When Next Steps Become Transparent: Open Government Partnership

Funding Source: Lampert Institute for Civic and Global Affairs

Project Summary:

This summer, I interned for the Open Government Partnership, a multilateral initiative started in 2011 by the Obama administration that aims to cement commitments between governments and their constituents promoting open governance, strengthening networks for inclusion, and mitigating corruption while empowering the population. I examined multi stakeholder forums and throughout my work I noted the more and less successful elements of these spaces for dialogue. I was able to make conclusions and therefore suggest ways for OGP to better address multi stakeholder organizations taking into account the variety of contexts presented by each country and their own structures of governance. This will aid OGP in assessing requirements for member countries and also in their approach to mediating the implementation of open governance within different settings. Similarly, my findings should give insight to potential improvements in communications with the organization's points of contact in each country and how to best utilize these individuals in order to build strong relationships and foster meaningful discussions about their membership.

Key to the implementation of OGP is the incorporation or creation of what they call "multi stakeholder forums", or "a structured environment designed to maximize participation and cooperation between government and civil society by bringing relevant partners into the discussion and ensuring that all voices are heard".[1] The emphasis on multi-stakeholder dialogue is an extension of OGP's work to bridge the gap between government and civil society. I conclude that differences in country contexts necessitate different approaches to inclusive dialogue between civil society and government. For example, in the case of Norway, the country has already-established links between stakeholders that would otherwise serve to productively implement OGP goals and commitments. Therefore, this context renders it less important to create or restructure a multi stakeholder forum. I compare this to the situation in cases like Costa Rica, where OGP guidance on multi stakeholder dialogue is crucial to the inclusion of civil society representatives within spaces of governance. I organized a matrix to map comparisons in multi stakeholder fora and data.

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[1]https://www.opengovpartnership.org/multistakeholder-forums/

Research Fellow: Jeri Stoller (2022)   **Concentration(s): Environmental Geology; English**

Faculty Mentor: Paul Harnik   **Department: Geology**

Title of Project: Geographic Variation in Shell Preservation Across the Northern Gulf of Mexico

Project Summary:

Historical samples of mollusk shells (death assemblages) are increasingly used to infer the state of coastal ecosystems before the onset of certain human activities. However, a variety of processes, such as weathering and erosion, affect the shells of organisms after they die, which could result in biased estimates of past conditions. Environmental differences could lead to differences in shell preservation,

Figure 1. A subsample of shells from Florida. The bivalves show various kinds of taphonomic degradation, including encrustation, bioerosion, and loss of luster.

thereby complicating comparisons of death assemblages along environmental gradients. In the northern Gulf of Mexico, environmental variation is strongly shaped by the influence of rivers. Coastal regions that are adjacent to large watersheds, such as the Mississippi River, experience elevated sediment, nutrient, and freshwater loads in comparison with regions, such as the Florida Panhandle, that are adjacent to much smaller watersheds. Consequently, variation in biodiversity across the northern Gulf could reflect preservation differences. To assess geographic and environmental variation in shell preservation, we collected live and dead bivalve mollusks from sediment samples at 15 sites, from three regions (Louisiana, Alabama, and Florida). For each site, we gathered a random subsample of at least 100 dead bivalve shells and scored each fragment according to eight variables (articulation, fragmentation, edge modification, encrustation, internal and external luster, bioerosion, and thickness). In general, most shells were disarticulated, fragmentary, and eroded and/or pitted. In order to examine the similarities between different sites, we performed a principal components analysis. While the condition of shell fragments at individual sites can vary greatly, we observed no clear geographic separation among sites. Edge modification, luster, and fragmentation contributed the most to preservation differences among sites. Because regional changes in environment across the northern Gulf do not have consistent preservation differences, geographic variation in the bivalve death assemblages likely reflects genuine biological differences, not preservation biases. This information will be critical when using death assemblages to generate biological baselines for the northern Gulf.

Research Fellow: Ian Swain (2022)   **Concentration: Classics**

Faculty Mentor: Geoffrey Benson   **Department: Classics**

Title of Project: The Lyric Translator: A Perspective Through Sappho 31

Project Summary:

Because of the great language diversity of the world, translation has the important role in our society of widening access to important texts. But by no means is translation a simple or even mechanical process. Especially in a literary genre such as lyric poetry, where sound, language, emotion, and meaning all work together in profound ways, how a translator chooses to use the freedoms of language is integral to the effectiveness of their translation. This project studies lyric translators such as the Roman poet Catullus, Sir Philip Sidney, and William Carlos Williams through the much admired 31st fragment of Sappho (c. 600 BC), perhaps the most famous lyricist of Ancient Greece, and tries to show that good translations of Sappho 31 can reimagine its power by representing the original's structure, situation, dialect, and voice.

I consider various readings of Sappho 31 with attention to its text, author, images, language, and organization, with a view to what features of the poem are "translatable." Catullus's translation of Sappho 31 in his 51st poem provides a reimagining of the Sapphic situation in her own meter and further distinguishes itself with its *otium* stanza (51.13-16), which Horace plays on in *Odes* 2.16. Textual reconstruction from contemporary classical scholars is another form of translation intended to rebuild Sappho's voice from the empty page. Sir Philip Sidney's impressive sixteenth century interpretation of Sappho 31 in the eclogues of his pastoral romance *Arcadia* show his interest in representing within narrative the performative situation of Sappho and Greek lyric more broadly; William Carlos Williams's translation of Sappho 31 considers questions of linguistic identity in representing poetic voice by translating Sappho into his "American idiom"; and the experimental homophonic translations of Catullus by Celia and Louis Zukofsky make a fascinating example of representing voice through imitating sound.
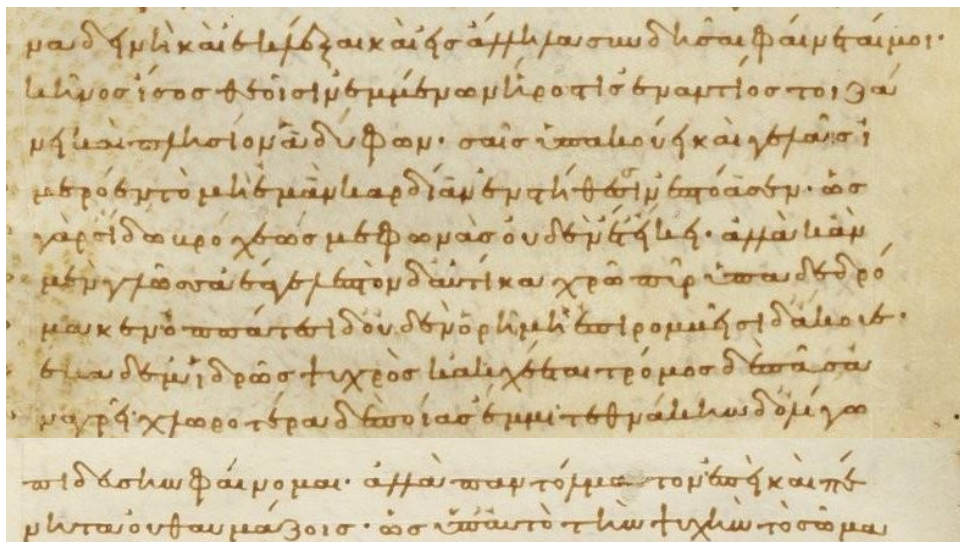

Image: text of Sappho 31 quoted in the 1st century AD critical work περὶ ὕψους *[On the Sublime] attributed to Longinus, in a 10th century manuscript (Parisinus graecus 2036) housed in the Bibliothèque nationale de France.*

Research Fellow: Rebecca Sweigart (2023)   **Concentration: Art and Art History**

Faculty Mentor: Julie Dudrick   **Department: Upstate Institute**

Title of Project: Hudson Headwaters Health Network

Funding Source: Upstate Institute

Project Summary:

The Hudson Headwaters Health Network (HHHN) is a healthcare organization that aims to provide healthcare and access to that care to underserved communities in the Adirondack and Glens Falls regions. Continuously expanding, they currently have 21 health centers covering over 7,200 square miles. This summer, I assisted them in celebrating their 40th anniversary by making videos that describe their mission statement, origins, the recruitment process, and how they hope the next 40 years will look.

When I first started my Summer project, I was able to learn a lot about the background of HHHN and what they do for their community. Coming from a rural community myself where some people do not have access to proper care, I was beyond thrilled to learn that HHHN is assisting everyone they possibly can, even if they don't have health insurance. People from all over come to HHHN for primary care, specialized care, and sometimes even emergency care. Although they don't specifically do emergency care, they still make sure that the patient gets the care they need, even if they have to be driven to a local hospital. No matter what, the communities surrounding the HHHN health centers know that they have a place they can go to when they need help.

My project had me review videos and interviews of their current staff and retirees. Watching these videos really helped me understand just how close knit this organization was, and how much they cared for their patients. The videos I completed for them will be in a digital exhibition for future providers and recruits to see, and I genuinely hope that they fall in love with HHHN's mission as much as I have.

I am currently a rising junior at Colgate, and recently declared an Art and Art History major and Film and Media Studies minor. This summer project has been beyond helpful in letting me explore a more professional side of FMST. Although I have done FMST research in the past and taken courses, this internship feels very beneficial in allowing me to actually apply my studies and help out an organization convey all of the careful work they have done. I wanted to be a Field School Fellow this Summer because I had heard about it from my major and minor advisors and was excited to jump into an opportunity that would not only be extremely educational, but also help out the communities around Colgate. As my first time as a Summer Upstate Institute Fellow comes to an end, I am blown away by the amount of experience I was able to gain, the connections I was able to build, and the phenomenal health care center that I was able to learn more about.

Research Fellow: Drew Tompkins (2023)   **Concentration: Political Science**

Faculty Mentor: Julie Dudrick   **Department: Upstate Institute**

Title of Project: Arts at the Palace

Funding Source: Upstate Institute

Project Summary:

Arts at the Palace is a local nonprofit organization dedicated to "presenting, developing and expanding the reach of the arts within the Central New York region," currently located at the Palace Theater in downtown Hamilton. It hosts performances, classes, and activities in the areas of music, dance, and theater for the greater Hamilton community. As one of the few arts organizations in the area, their programs help to provide both children and adults the ability to engage with stimulating arts pieces and arts education. The organization spends most of its time planning future events like bringing bands to Hamilton and renting the space to Colgate organizations, on top of constantly competing for grant funding.

Like many other arts organizations, Arts at the Palace has struggled with the COVID-19 pandemic. Moving from full time entertainment to remote-based learning and now transitioning back to entertainment has been a tumultuous path. However, through this journey the organization has learned much about its place within the community and how it may establish a larger presence. The Palace Theater itself has served many purposes throughout its lifetime, but Arts at the Palace hopes to generate a steady stream of unique regional musicians and enrichment through its classes and mainstay programs-- such as their annual gala or Jazz at Noon. The performances, classes, and activities will reinforce the small arts community of Hamilton and surrounding areas.

I was tasked with "Reopening Arts at the Palace" from its year-long COVID slumber. I assisted first with understanding current NYS COVID-19 guidelines and planning for their implementation in stages. As COVID restrictions were modified, our plan was altered to fit the updated regulations, and eventually the Palace was able to begin planning larger events. We were able to plan a fall music series and apply for grant funding from the New York Council on the Arts, which begins in September and features a number of professional regional musicians. We were also able to apply for 2022 funding that will hopefully continue to provide live music, theater, and dance performances for the community.

As a political science major, this experience has provided me with lots of information in the nonprofit and legal sphere. The project has enabled me to write grants, assist with general administrative activities, and interact with numerous legal restrictions including safety codes, health restrictions, and accessibility standards. I've learned a lot about community engagement and how to properly run a nonprofit organization--which is why I applied to be a Field School Fellow in the first place. I applied hoping to develop my research skills in a real world setting and to explore a future career in nonprofit or adjacent legal work, and succeeded in obtaining such engagements. Additionally, I hope that my work here can benefit the greater community in developing Arts at the Palace's prominence in Hamilton, as well as within the Colgate community.

Research Fellow: Tedi Totojani (2023)   **Concentration: Mathematical Economics**

Faculty Mentor: Yang Song   **Department: Economics**

Title of Project: Graduating in a Recession and Job Satisfaction

Funding Source: SOSC Division

Project Summary:

1. Summary & Results

It is well documented in the literature of labor economics that students who graduate during economic recessions carry a higher likelihood of being unemployed, a higher likelihood of dropping out of the labor force, and lower salaries both in the short- and long-run. This paper expands on the existing research to consider the effects of recessions on measures of job and salary satisfaction. We find that the unemployment rate at graduation is negatively correlated with salary satisfaction at the 95% confidence level, and with job satisfaction at the 99% confidence level. When testing the results by gender and race, the negative effect on salary satisfaction remains significant only for females, whites, and Hispanics, while the effect on job satisfaction remains significant only for females, Asians, and African Americans.

2. Data

We use six waves of the National Survey of College Graduates (NSCG) between 2003 and 2019. For the explanatory variables, we make use of the technical duration of US recessions as determined by National Bureau of Economic Research (NBER) to construct an indicator of whether the respondent graduated in a recession, as well as data on unemployment rates from the US Bureau of Labor Statistics to create various measures of labor market conditions around graduation.

3. Empirical Methods

For our main analysis, we regress self-reported salary satisfaction and job satisfaction on the average unemployment rate within six months after graduation, controlling for demographic characteristics, potential years of experience, survey year, current location, college major and minor, parental education, US citizenship status, and disability status. The results remain similar when we use the average unemployment rates of alternative periods around graduation (e.g. three months before and after) as the main explanatory factor. In a separate specification, we use a dummy variable for graduating in a recession as the main explanatory variable, and the coefficients of our variable of interest are plotted in the graph below.

Effects of Graduating into a Recession on — Salary Satisfaction / Job Satisfaction
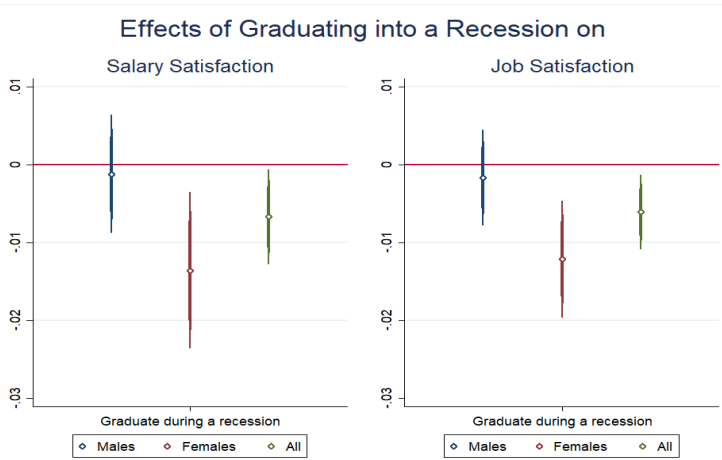
Notes: The graph plots the regression coefficients of a dummy variable for graduating in a recession as the main explanatory variable, each from a separate regression. The negative signs imply that respondents who have graduated in a recession are less likely to be satisfied with their job or salary, controlling for the various factors mentioned above. We also see that this effect is more pronounced for females.

Research Fellow: Ashley Tourtelot (2022)   **Concentration: History**

Faculty Mentor: Julie Dudrick   **Department: Upstate Institute**

Title of Project: Railroad at the Oneida County History Center

Funding Source: Upstate Institute

Project Summary:

Over the summer, I was privileged to work with the staff and volunteers at the Oneida County History Centers. I knew and believed before my internship started that the History Center would be the perfect place to spend ten weeks. As it turned out, OCHC became more than an internship and the place where I grew both personally and academically. At the Center, I had the opportunity to choose and build, from the wide variety of artifacts stored in the archive, an exhibit on the Underground Railroad that OCHC showcased in early August to all members of the community. My work was made possible with the faith and help of Patrick Reynolds, the Center's Public Programs Director, and Rebecca McClain, the Executive Director. With their help, I accomplished a huge project that brought to life a vibrant exhibit, a virtual self-guided tour, and a subject we could incorporate into New York State's K-12 social studies curriculum guidelines.

I chose to focus on how the Underground Railroad emerged in Central New York by telling how the abolition movement came into Utica, and how Utica and Central New York evolved from a farm town settlement into an urban safe space for fugitive slaves -all in less than a half a century. The exhibit highlights broad developments such as the Second Great Awakening and the Industrial Revolution to connect changes and continuities in the 19th century with local history that people within this area can identify and understand. Much of my work this summer brought me into contact with a variety of people in the area including the founders of the Oneida County Freedom Trail Commission. The commission has spent a significant amount of time collecting researching African American history in this area, which I found extremely useful in my project. Moreover, I was lucky enough to collaborate with the Oneida County Freedom Trail Commission to create a walking tour of some of Utica's Underground Railroad stops on Clio. The tour is available to anyone interested and can be found with this link: https://www.theclio.com/tour/2012. The goal of this tour was to engage with people who perhaps cannot come into the center or would rather engage with history in other ways, and hopefully, the tour draws more people to my exhibit.

My work this summer sought to bring to life a historical development that brought together people from various backgrounds who, despite their differences, put central New York in the middle of a movement that emancipated enslaved groups. I think it is essential for all people to have their stories told when showcasing a bit of what Central New York offers as this region is so rich in national and local history. I am glad that I have had the chance to educate people from a variety of ages and backgrounds in a way that also transformed the gallery at the Oneida County History Center as it was a fulfilling opportunity that many do not get to see or do.

Research Fellow: Alexa Trubiano (2023) **Concentration: Environmental Geology**

Faculty Mentor: William Peck **Department: Geology**

Title of Project: Carbon Sequestration Potential of Iron Slag in New York

Funding Source: Doug Rankin '53 Endowment-Geology Research

Project Summary:

Franklin Iron Works in Franklin Springs and the Knob Brook furnace near Ironville are both localities in New York State where iron was produced during the 19th century and where waste slag can be found. Iron slag is a non-metallic industrial waste product created during the refinement of iron ore into pig iron in blast furnaces. In the furnace, lime, magnesia, silica, and alumina separate from the iron and combine together in a silicate melt, which can differ in composition based upon the temperature at which it was formed in the blast furnace. Due to the minerals that make up slag, calcium silicates make up the predominant composition of the waste product. When exposed to carbon dioxide, the calcium silicates can weather and create calcite. The presence of a calcite rind on the slag suggests that the process of carbon sequestration is occurring. Carbon sequestration is when minerals capture and store carbon dioxide from the atmosphere in a solid form. Carbon dioxide is a greenhouse gas that contributes to global climate change, so investigating processes that remove it from the atmosphere is of great importance. In this research project, I sought to examine slag as a source of carbon sequestration and the likelihood of it being used as a carbon sink in order to make modern iron production carbon neutral.

I collected samples from both the Franklin Iron Works and Knob Brook furnace localities. After bringing the samples back to Colgate, I cut and polished each sample in order to create mounts for the scanning electron microscope (SEM). The mounts were coated in a thin layer of carbon to aid in imaging on the SEM. I was able to determine the elements present in various mounts using the SEM X-ray energy spectra. I then crushed about 5 grams of the samples into a powder using a ball mill grinder in order to make slides for the X-ray diffractometer (XRD), which measures the d-spacings of the different minerals in each powder. I was able to determine the mineralogy of each slag sample using data from both the SEM and XRD. This was necessary in order to confirm the presence of calcite in the samples. After confirming the mineralogy of the samples, I conducted an isotope analysis on the remainder of the powdered samples. The samples were dissolved in acid and evolved gas was cryogenically purified using a pentane-liquid nitrogen mixture. The resulting carbon dioxide was analyzed for its isotope ratios and calcite abundance using a mass spectrometer. I analyzed the primary (interior) calcite as well as the secondary (exterior rind) calcite of the samples.

The data led to some conclusive results as well as results that indicate a need for further research. Using the SEM and XRD I was able to determine the mineral composition of each sample. The samples from the Franklin Iron Works locality are dominated by a mineral called akermanite, while the Knob Brook furnace samples, which are in general more glass-rich, have abundant clinopyroxene (diopside-augite). I was able to determine the presence of calcite in samples from both localities and using SEM imaging was able to find not only secondary exterior calcite, but primary interior calcite in some of the samples. After conducting an isotopic analysis, I concluded that secondary calcite in slag is volumetrically minor in comparison to primary calcite (X vs X%), which suggests that carbon sequestration is not occurring at a substantial rate. Weathering of primary calcite may instead introduce carbon dioxide into the atmosphere. It is also important to note that the isotope ratios of the primary and secondary were distinct. More research is needed to conclude how much carbon dioxide is being released into the atmosphere via slag weathering and if it poses a threat to the environment.

Research Fellow: Jack Underhill (2022)   **Concentration(s): Molecular Biology; Philosophy**

Faculty Mentor: Rebecca Metzler   **Department: Physics and Astronomy**

**Title of Project: Exploring Structure and Composition of Mineralized Adhesive and
                                    Shell Layers in *Etheria elliptica***

Funding Source: National Science Foundation Grant

Project Summary:

Etheria elliptica is a species of freshwater oyster found throughout Africa and Madagascar. They play an important ecological role, partly due to the formation of large oyster beds as individual organisms adhere together, and they also support local fishery economies. In addition, they have potential to be used as paleoclimate archives to develop models of past climates due to the way that environmental factors are interred into their shell composition. Despite this, little is known about the adhesive that the organisms produce during settlement, nor has there been a systematic review of the shell structure. A combination of x-ray photoemission electron microscopy (X-PEEM), scanning electron microscopy (SEM), and microhardness testing was used to develop an understanding of the adhesive and shell's properties. The shell has three kinds of layers: prismatic, nacreous, and growth layers. It was determined that all three of these layers, as well as the adhesive, are mineralized with a variety of calcium carbonate called aragonite.
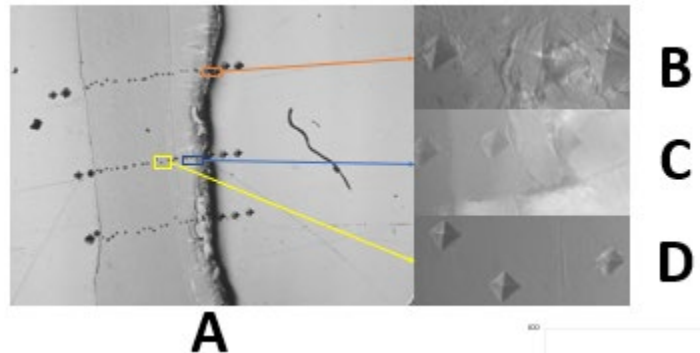

Figure 1: Microindentation is used to obtain hardness values through a cross section of shell (A). Images B-D show magnified indents from the adhesive, prism, and nacre, respectively. While microindents were analyzed for a set of samples, a representative image is shown. There is a significant difference in hardness between the three layers, even though there is some overlap of error bars (p-value = 1.3×10^{-32}) (E).

X-PEEM data was used to gather information about the chemical composition and crystal orientation of a cross section of the organism. A synchrotron provides broad spectrum radiation with adjustable polarization so that a polarization-dependent imaging contrast (PIC) map can be created. This revealed that the aragonite making up the adhesive is nanoparticulate of varied orientation and density, while the aragonite in the shell layers is more uniform in both orientation and density. The prismatic layers form crystals that are perpendicular to the nacreous layer, which is made of stacked aragonite tablets. Preliminary analysis of SEM imagery showed that they increase in thickness approaching each growth layer. They then sharply decrease in thickness moving away from the growth layer before gradually increasing toward the next.

During microindentation a diamond tip is loaded onto the sample with a force of 0.098 Newtons, and the diagonals of the resulting indent are measured and converted to a hardness value. It was determined that the adhesive, prism, and nacre are significantly different in hardness (p value = 1.3×10^{-32}). The adhesive was the softest layer, followed by the nacre, with the prismatic regions being the hardest. Preliminary results indicate that the nacre becomes softer moving towards the interior of the shell. Contrarily, the adhesive seems to increase in hardness moving inward toward the prismatic region.

Research Fellow: Evie Unger-Harquail (2022)   **Concentration: Geology**

Faculty Mentor: Amy Leventer   **Department: Geology**

Title of Project: Antarctic Climate Proxies

**Funding Source: Doug Rankin '53 Endowment-Appalachian Research**

Project Summary:

This summer, I am on campus conducting research with the geology department with the guidance of Amy Leventer. My research is in paleoclimatology, the study of past climate change and its influencing factors, knowledge which then helps scientists understand and predict modern climate change and forcings. Specifically, I am analyzing thousands of samples of the diatom species *Fragilariopsis kerguelensis,* a single-celled algae with a shell composed of silica, that is well preserved in the ocean sediments around Antarctica. found in Antarctic sea ice.

In the past decade, researchers have proposed that *F. kerguelensis* changes shape in response to fluctuating temperatures, suggesting that it might make a high-quality proxy for paleotemperatures. We are using SHERPA, a shape analytics software, to gather data that depicts a correlation between the shape of *F. kerguelensis* at varying depths, the relative abundance of the species in the fossil record, and paleotemperature. Previous literature has used the measurement of high or low rectangularity to infer paleotemperatures, which we are now applying back through time.

The *F. kerguelensis* I am studying were collected during a 2014 cruise aboard the research vessel, the *Nathaniel B. Palmer,* using a jumbo piston corer. The core is about 9 meters in length and sampled at approximately every 10 cm, yielding over 90 samples total. These sediment samples were then prepared as slides, viewed under a microscope at 1000x magnification, and digitally captured before being uploaded to SHERPA. After compiling data sets, we run them through code that yields graphs depicting average rectangularity and an approximate temperature. Radiocarbon dating will be used to get ages for our samples. Once the dates are calculated, we will be able to correlate our paleotemperatures with their places in history. Because the bottom of our core captured the very end of the last ice age and the subsequent warming cycle experienced by the planet, it will give us insights into the climatic and environmental conditions associated with modern-day global change.

This research is incredibly rewarding because I am part of its development from start to finish. I get to see my samples go from bags of dirt to slides to Excel spreadsheets. I'm planning to continue this research for the rest of my senior year, culminating in my honors thesis. My research builds off of a thesis written by Rachel Meyne, class of 2021, and publications by Kloster et al., 2014 & 2018, and Glemser et al., 2019. I have also been fortunate enough to have the assistance of graduate student Joe Ruggiero of Northern Illinois State University. Many thanks to Professor Leventer for her guidance and to my lab partners Olivia Quartz and Jane Carskaddan.
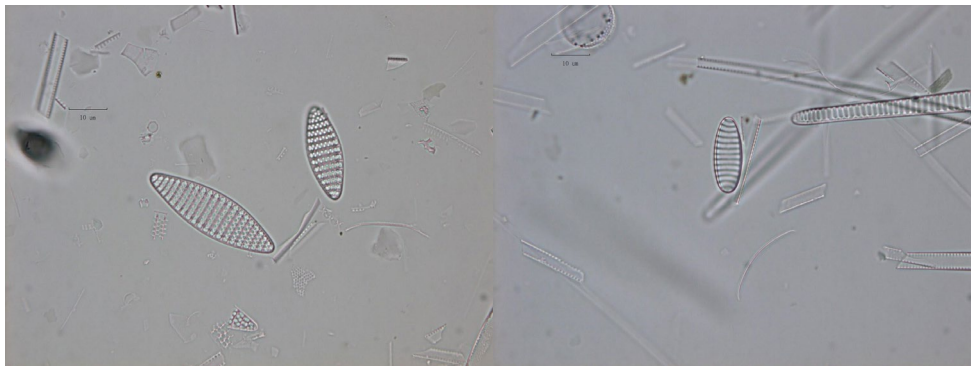
Research Fellow(s): Cecilia Vu (2022)
Cat Wang (2023)

Concentration: Environmental Biology
Concentration: Environmental Studies

Faculty Mentor: Linda Tseng

Department(s): Environmental Studies; Physics and Astronomy

Title of Project: The Adsorption of Atenolol onto Micro-Polystyrene

Project Summary:

Microplastics are generally classified as plastics between the sizes of 1 μm and 5 mm and are widely found throughout natural environments. Because of their small size, marine animals are extremely susceptible to the accidental ingestion of them. This can be deadly if accumulated because plastics are often treated with chemical additives to attain certain properties. In addition, different plastics have been known to absorb different chemicals onto their surface causing additional detriment to the animals that ingest them. Microplastics have been found to be extremely difficult to simply remove them from the environment due to their durability and ability to continually break down into smaller pieces. Micro-polystrene is one of the most commonly found microplastics found in the environment due to it being one of the most commonly manufactured and utilized plastics in the market.

This research was conducted in order to observe how much of a particular CEC (Concerning Emerging Contaminant) may be adsorbed and retained onto micro-polystyrene beads. The chemical chosen to observe was atenolol as it is a common pharmaceutical often used to treat high blood pressure, and as such, is also a common chemical found in wastewater. The experiment conducted simulated how micro-polystyrene would behave in the open aquatic environment that has been exposed to atenolol at a concentration of 5.7 ppm. Sampling of ~1.00 grams of micro-polystyrene beads in atenolol solution was done in triplicates in a time span of the following in hours: 0, 1, 2, 3, 6, 12, and 24. Each triplicate was then filtered through a solid phase extraction (SPE) cartridge, sonicated, eluted, concentrated and filled with internal standard, then analyzed with gas chromatography-mass spectrometry for chemical composition analysis.
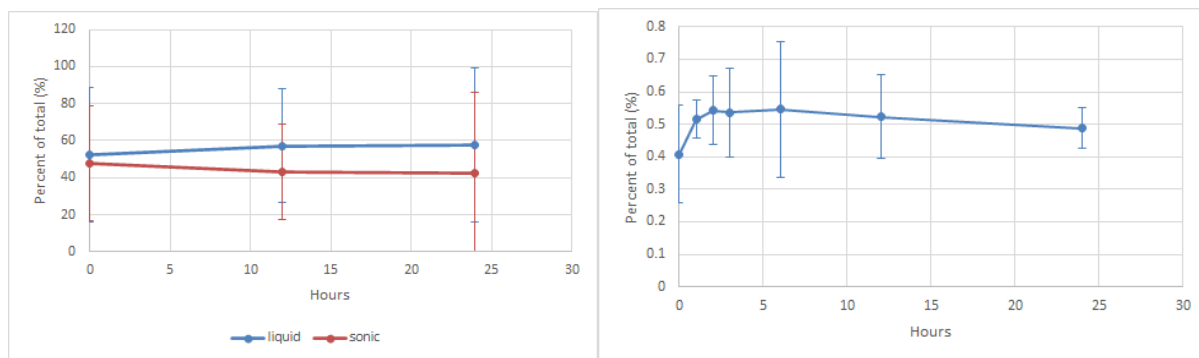
The graph on the left shows the controls while the graph on the right shows the sonicated samples with the controls. The graph on the left shows between 40% and 60% of the total atenolol was remained on the glass bottle (red). The graph on the right shows that a similar amount of atenolol transferred onto micro-polystyrene. This indicates that about half of the atenolol was adsorbed by the glass in the absence of micro-polystyrene, and about the same amount of atenolol transferred onto micro-polystyrene. This is evidence that micro-polystyrene can adsorb atenolol, but the result for the control also cautions proper design for adsorption experiments with controls is important to check if chemicals actually transfer onto plastics or elsewhere during the experiment.

Research Fellow: Wayne Wang (2023) **Concentration: Physics**

Faculty Mentor: Ken Segall **Department: Physics and Astronomy**

Title of Project: Cryogenic Memory Using Josephson Junction Neurons

Project Summary:

The development of Artificial intelligence and Machine Learning spurs an increasing demand for computational power. Unfortunately, the development in traditional silicon computing is significantly lagging behind the demand. It becomes an urgent task to find an alternative way of computation. A promising alternative is superconducting neuromorphic supercomputers, where the computer is cooled to near absolute zero (-459.67 ºF) and contains artificial neurons rather than transistors. This type of computation promises high energy efficiency, faster operating frequency, and greater computational power in general. Scientists and engineers have built many logic components for computers in this category, but we are still searching for a reliable, scalable, and energy-efficient memory. Therefore, my research project intends to find such memories using artificial neurons.

This summer, we came up with several systems that gave us hope for eventually achieving our goal. And one of the systems and its output is illustrated below.
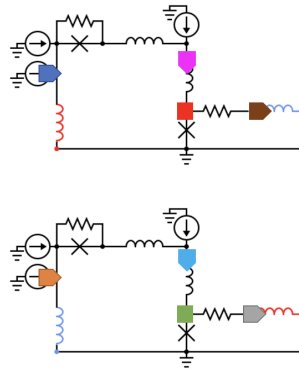

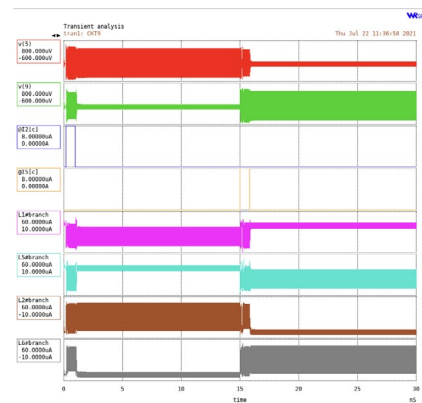Figure 1: Circuit image of the RS flip flop

Figure 2: Output of circuit.

If you have taken Electronics, you can tell that the top two voltages act like an RS flip flop, which is actually the centerpiece of a memory. These outputs should always be the opposite of each other, and a memory should demonstrate hysteretic behaviors (memorizing its original state after the pulse is off). So far, the main challenge for us is the timing issue; that is, the time we turn on the pulse matter, and we cannot get the system to flip its states reliably enough. The usual success rate is about (78%). To make the system scalable, we have to limit the number of junctions we use in the system to fit more memories in a chip in the future.

Research Fellow: Martin Welych-Flanagan (2022)   **Concentration: Geology**

Faculty Mentor: Amy Leventer   **Department: Geology**

Title of Project: Devonian Paleoclimate

Funding Source: Hackett-Rathmell 1968 Memorial Fund

Project Summary:

During the Middle Devonian, the Appalachian basin was covered in a shallow, epicontinental sea that deposited an apparently continuous and high resolution column of sediment that became the Hamilton Formation. These strata preserve cyclic changes in facies, interpreted as sea level cyclicity, the origin of which has been debated. Recent evidence of corollary cycles globally at this time point towards a eustatic origin, while previous paleoclimate interpretations, based on stable oxygen isotopes, have suggested a climate too warm for large continental glaciers. The use of clumped oxygen isotope analysis on calcite formed at this time would provide a direct measure of seawater composition, which is expected to change along with any glacioeustatic cycles. However, due to the sensitivity of the clumped isotope paleothermometer, it is crucial to use samples that have not been diagenetically altered between their formation and the present. This study aimed to assess the degree of alteration experienced by biogenic calcite in the form of brachiopod shells collected from several cycles in the Hamilton Group to determine the suitability of clumped isotope analysis. *Spinocyrtia granulosa* were collected from 5 layers representing 5 third-order cycles of the Ludlowville formation from 3 sites in the Cayuga Lake region. Brachiopod fossils were mounted and analyzed using cross-polarized light microscopy, Secondary Electron Imaging (SEI), and Electron Backscatter Diffraction (EBSD). Each of these techniques have a respective increase in resolution, and this ability to determine alteration.

Every sample analyzed was observed to have alteration of some form to the degree that clumped isotope analysis was rendered inappropriate. Under optical microscopy, alteration appeared as recrystallization into inorganic rhombohedral calcite (IRC), visible on many of samples, and amalgamation of adjacent crystals, which is difficult to distinguish from adjacent crystals happening to have similar orientations, but was unable to be ruled out in every sample analyzed. SEI allows much higher resolution of unpolished samples, and can clearly identify amalgamation, distortion, and recrystallization into IRC. Every sample observed had amalgamation in some spots, and most had instances of IRC. EBSD confirmed these results.

Every sample analyzed from several locations in the region had observable alteration, resulting in reordering of the internal bonds and therefore destruction of the clumped isotope signature. Processes that lead to alteration, such as groundwater infiltration and deep burial, are likely to be regional in nature, suggesting that very few if any brachiopods in the region from this time period are likely to preserve a clumped isotope signature.

Research Fellow: Duncan Wieland (2022)   **Concentration: Philosophy**

Faculty Mentor: David Dudrick   **Department: Philosophy**

Title of Project: The Metaphysics and the Practical Issues of Identity Politics

Project Summary:

Metaphysics is not something we often have to consider in our day-to-day lives, nor do we often have to parse through the commitments of our moral claims and their broader implications. Why should we? Wondering whether or not it matters if God exists or if there should be a definitive human nature does not help us with our more immediate concerns. Most of us have reliable intuitions to differentiate between good and bad, what we should and shouldn't do, and what is socially acceptable and what isn't; we can make our way through life without having ever considered metaphysics and still come out alright. Except that is not the case. Metaphysics is essential to our immediate beliefs and is necessary for rationalizing our intuitions. Without realizing a metaphysical framework, we can feel lost, unsure of what we want from life, confused—and we are never really sure *why* we believe what we believe, besides that it feels right for us.

Where we have previously looked to God, or even commerce and citizenship, today we must look inward to define ourselves; what we value, what is good for us, and what gives us dignity. This is the "identity" that presupposes identity politics. Rather than looking outward and deciding who we should be, we are encouraged to *discover* what subjectively matters and who we want to be. And when we choose to subscribe to a manner of living, there remains a niggling doubt because other ways of living are just as well as our own.

Charles Taylor and Carl Trueman provide a compelling modern account of what constitutes identity and how it came to be. Our modern conception of self has intellectual roots that began over 200 years ago with the Romantics, specifically Jean-Jacques Rousseau. From there, the influence of Marx, Nietzche, and Christianity becomes relevant in how we think about ourselves, our morality, and what it means to live a good life. In addition, Marx and Nietzche influenced the historical narrative of identity politics, a perennial cycle of oppression that serves to keep the elite in power. From Christianity, identity politics adopts the idea of transgressors and innocence.

We live in an age of individualism, which is by no means new. But today, we are more divided than ever without a common goal or good to unite us. Identity politics seeks to bind particular identities on axes like sexual orientation, gender, and race under the banner of advocacy. Identity groups are supposed to share a common experience of oppression, but the identity politics approach is heavy-handed, with ideologies corresponding to each axis imposed on the individuals belonging to them. Those who do not share the opinions of identity politics of their particular identity are dismissed.

Authors like Mark Lilla, Joshua Mitchell, and Francis Fukuyama believe that a return to liberal competence and national identity is imperative to the success of our nation. Ultimately, this paper attempts to show that the metaphysics of identity politics is insufficient and undesirable politically. It is polarizing and misleading for the individual as well as the nation.

Research Fellow: Keiona Williams (2024)   **Concentration: Undeclared**

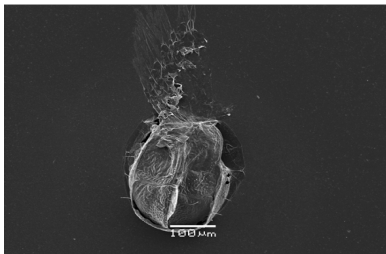**Faculty Mentor: Rebecca Metzler**   **Department: Physics and Astronomy**

Title of Project: Barnacle exoskeleton formation in differing temperatures

Funding Source: National Science Foundation Grant

Project Summary:

Barnacles are known to be pesky little creatures for boaters and ship captains. They attach themselves to the hulls of ships, causing them to drag and burn more fuel as they move through the water. This is known as biofouling. Boaters, ship captains and scientists alike have been working to find antifouling methods but, with rising sea temperatures, there is a possibility the increasing heat will fix the problem. Barnacles, such as the Balanus Amphitrite used for this study, do best in warm and temperate water and are found worldwide. As temperatures rise however, the fate of barnacles hangs in the balance of whether they can survive in these affected environments. In this study, we hope to see a response from the barnacle species Balanus Amphitrite, to conclude if rising sea temperatures will affect barnacle growth and crystalline formation of their shells.

In the first round of experiments, it was found that for all temperature conditions (27.1°C (control), 29.1°C, and 31.1°C) that more cyprids settled and metamorphosed into barnacles in the 3rd tray (reason unknown). It was also found that fewer barnacles formed in the 27.1°C condition than in the 29.1°C and 31.1°C.

The barnacles formed at 31.1°C however, appear to be weaker than those formed at 27.1°C and 29.1°C (photo of a barnacle grown in 31.1°C to the left).

As temperatures rise, barnacle exoskeleton formation will suffer changes in crystalline structure. Further research may include examining the hardness of the barnacles grown in all three temperature conditions to confirm if crystalline orientation differs within the barnacles.
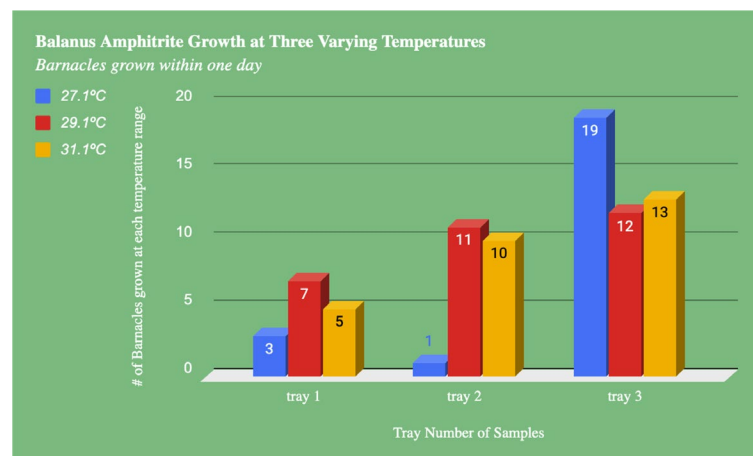
Research Fellow: Morgan Wynkoop (2021)   **Concentration(s): Spanish; Molecular Biology**

Faculty Mentor: Ana Jimenez   **Department: Biology**

Title of Project: Oxidative Stress in Feral Dogs from the Bosawas Biosphere Reserve in Nicaragua

Funding Source: Beckman Scholars Program

Project Summary:

Reactive oxygen species (ROS) include molecules such as superoxide and hydrogen peroxide and can have a negative impact on the physiology of organisms. ROS in the cell can be generated as byproducts of normal metabolism in the mitochondria or in response to certain pathogens. Although certain levels of ROS are required for normal cellular processes like cell signaling, high levels of ROS can cause damage and play a role in disease. Organisms can manage ROS production through antioxidants including enzymes such as catalase or superoxide dismutase or molecules such as vitamins C and E. Total antioxidant capacity (TAC) can be measured spectrophotometrically in order to understand an organism's ability to respond to ROS. If ROS production is not properly controlled, then oxidative stress can result in damage to important molecules in the cell including lipid peroxidation. An increased understanding of oxidative stress is important because oxidative stress has been suggested to have a role in aging and the development of diseases including cancer.

We received blood plasma samples collected from feral dogs living in the Bosawas Biosphere Reserve in Nicaragua. The dogs living in the Bosawas Biosphere Reserve differ from domesticated dogs living in countries like the United States because these dogs do not receive regular veterinary care, are not purebred, and are not regularly spayed or neutered. The dogs were also found to commonly have been exposed to many tick-borne pathogens, parasitic infections, canine distemper virus, and canine parvovirus, but none of the dogs tested positive for heartworm disease. An understanding of the disease history of the dogs is important because pathogens can have an impact on oxidative stress. We measured TAC and derivatives of reactive oxidative metabolites (dROMs) as a measure of lipid damage in order to better understand the dogs' ability to manage oxidative stress. Cellular damage that results from oxidative stress may play a role in aging, so understanding oxidative stress in both purebred domestic dogs and the dogs from the Bosawas Biosphere Reserve may highlight differences in the aging patterns of these dogs. Our results are awaiting data addressing characteristics of the Bosawas Biosphere Reserve dogs from the team from whom we received the samples. After this information is obtained, we will analyze our results in order to find patterns between TAC and dROMs concentrations with respect to characteristics such as body size and age.

Research Fellow: Nancy Xu (2024)   **Concentration:** Undeclared

Faculty Mentor: Jing Wang   **Department:** East Asian Languages and Literatures

Title of Project: The Needham Questioning: An Integrative Philosophy of Knowledge

Project Summary:

This summer I conducted research on a project titled "The Needham Questioning: An Integrative Philosophy of Knowledge" with professor Jing Wang from the Department of East Asian Languages and Literatures. We met either on zoom or in the library every week to discuss my daily work and the research I did on the topics of causation in Western epistemology and philosophy of science, and Chinese Daoism. As her research assistant, my tasks include compiling bibliography and reading notes, scanning books for future references, transcribing other scholars' talks regarding Daoism and Chinese medicine, and discussing my notes from these tasks with the professor.

From taking reading notes, I enhanced my philosophy learning by focusing on Western philosophers including Aristotle, Kant, Hegel and Schopenhauer. I specifically looked at the roles of causality/cause/causation in their thoughts. In western philosophy, causation is usually a simple backward relationship between things. Although some scholars criticize this definition, they cannot find the exact relationship among different things. In Daoism, people believe that everything is connected with the sky and the earth. Relationships between each other are very complicated. From what I observe between philosophy from two cultures, western philosophy tends to speculate the exact cause or reason of a specific thing but Chinese philosophy concentrates the whole universe.

The Needham Question (Why modern science arose in Europe, not China?) is itself a biased question since modern science is defined by Europe and it [supposedly] arose in Europe but it does not mean it did not appear in China. After Europe discovered the so-called modern science, they started to colonize and establish their western centralization. From reading the viewpoints of those scholars, their reasons for why modern science does not appear in China tend to criticize that there is no pure science in China. Pure science is a concept defined by Western scholars. From analyzing their perspectives, I found out that Western centrism is a very severe issue in the academic world.

To sum up, this research is very rewarding. I not only learned research skills, enriched my philosophy knowledge but also some fundamental skills in the working field. As my first actual job, I practiced my communication skills and especially the transition from a student to a researcher in a working environment. This research experience reaffirmed my passion to research on academic injustice. In the future, I hope to learn more of both Chinese and Western philosophies to be more rounded in my scholarship.

Research Fellow: Yang Yang (2023)   **Concentration(s): Educational Studies; Asian Studies**

Faculty Mentor: Julie Dudrick   **Department: Upstate Institute**

Title of Project: Earlville Opera House

Funding Source: Upstate Institute

Project Summary:

The Earlville Opera House is one of the few Victorian-style theaters left in the United States. Built in 1892, it has served as the focal point for rural community activities and arts education. In the late nineteenth century and early twentieth century, the opera house hosted live performances, such as vaudeville acts, three-penny opera, and traveling medicine shows. From the early decades of the 20th century to the 1950s, the opera house was converted to a movie theater, featuring silent movies and Hollywood's newest releases. The widespread popularity of cars and televisions forced the theater to close its door. It was not until 1971 when Joey Skaggs, an artist from New York City, purchased the building and sold it to the Earlville Opera House, Inc. for the benefit of the community. Since then, the Opera House has operated as a volunteer-based, not-for-profit organization with a dual mission: to provide the highest quality arts, cultural and entertainment events to our rural constituency; and to renovate and rehabilitate the Opera House's historic theater. The Opera House is also the site of the Decentralization Program (DEC) for artists and organizations in Broome, Chenango and Otsego County. The goal of DEC program is to distribute state arts support to populations outside of New York City and the Opera House re-grant the fundings which comes from taxpayer money to further benefit and diversify the art education and community arts in the Southern Tiers.

This summer I researched artists and not-for-profit organizations in Central New York and Southern Tier regions, and organized archive newspaper clips and documents for EOH's upcoming 50th anniversary. For this event, I compiled a comprehensive list of past board members, made scrapbooks for the past three years, and more. The archive section of the Opera House is mostly preserved in the form of paper newspaper and printed brochures. I am in charge of organizing past documents and scanning them into digital files so then it can be easily accessed through the cloud. I also assisted the Opera House at DEC outreach. Because of the new appointment from the New York State, the Opera House is especially interested in serving the community to the fullest extent.

As an Educational Studies Major, working with the Opera House enhances my understanding of how education can take place outside of the traditional classrooms. From past experiences, arts education is often overlooked and deemed less important than main subjects. The Earlville Opera House showcases the lively musicianship and craftsmanship in a rural community, even in the midst of the pandemic. This internship taught me that even though the contemporary education system might not prioritize art education, there are unlimited opportunities for both kids and adults to immerse themselves in the world of arts and music outside of schools. Additionally, the DEC program reminds me of the importance of supporting a group of people in a geographically, racially, and economically diverse area.

Research Fellow: Tony Yap (2022)   **Concentration:** Astrogeophysics

Faculty Mentor: Jonathan Levine   **Department:** Physics and Astronomy

Title of Project: Coincidence Counting of Atoms for Spaceflight Rb-Sr Geochronology

Project Summary:

Our team is developing a novel atom-counting instrument capable of spaceflight and in-situ Rb-Sr geochronology of planetary specimens, especially on the Moon and Mars. In other words, we are designing and assembling a machine to date extraterrestrial rocks using the isotopes of Rubidium and Strontium.

Since ^{87}Rb decays into ^{87}Sr at a known rate, determination of their relative abundance within a sample enables an estimate of its age. Having been sputtered from the sample, these atoms travel down a beam intersected by lasers tuned to resonantly excite either Rb or Sr. The resonating atoms fluoresce as they cross the laser beam in ~3500ns, with each expected to emit a burst of hundreds of photons within that window of time. Such bursts are detected as multiple flashes, termed *multiplets*, in temporal coincidence. This work focuses on optimizing their detection in two computational projects: (1) Modeling the angular distribution and polarization of Sr fluorescence, given the polarization of incoming laser light, and (2) writing an algorithm for identifying bursts of photons against a background of stray light.

The former was accomplished through the use of angular momentum conservation and quantum state rotations, with which we expressed the excited state of the Sr atom along an arbitrary quantization axis. We found that the probability of emission was zero along the axis in which the incoming light is polarized, but maximum in the plane perpendicular to it. Modifications to the instrument accounting for this result has led to >50% improvement in signal [Refer to Figures (i) and (ii)]. While a "brute-force" algorithm may identify all multiplets within a dataset in a matter of days, my algorithm achieves this in ~5 seconds by subsampling the data in 3500ns windows. It additionally evaluates the observed multiplet abundances against predictions by Poisson statistics—a proxy for noise—to discern photon bursts from the background. Further research is required to aid our ongoing quest to enhance the instrument's signal-to-noise ratio.

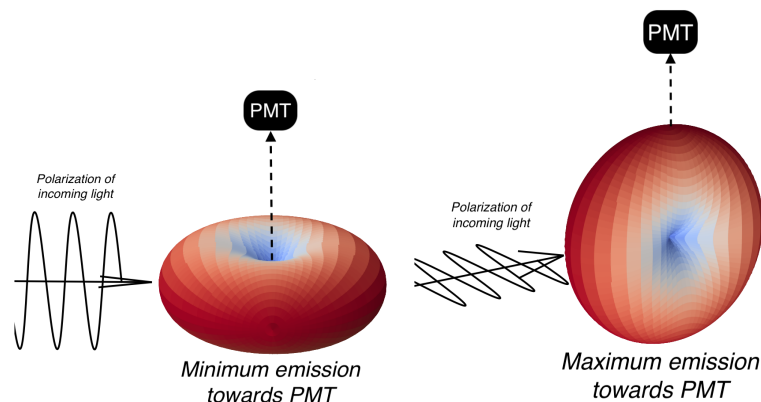**Figure (i):** The previous configuration of incoming light polarization and the photomultiplier (PMT), resulting in minimum direct detection of bursts. In these models, elevation of a point from the atom's center is scaled by the probability density of emitting through that point, producing the observed "donuts."

Figure (ii): The new configuration, resulting in maximum direct detection of bursts.

Research Fellow: Zoe You (2022)　　　　　　　　**Concentration: Physics; Chinese**

Faculty Mentor: Kiko Galvez　　　　　　　　**Department: Physics and Astronomy**

Title of Project: Photon Imaging and Quantum State Tomography

Funding Source: Volgenau Wiley Endowed Research Fellowship

Project Summary:

Quantum entanglement is regarded as one of the most important concepts of quantum mechanics - it is considered a phenomenon that can be found in quantum mechanical systems but not in classical systems. Quantum particles are described as "entangled" when the particles cannot be considered independent but are correlated to each other. For example, if we can detect or measure one particle of an entangled pair, then information about the other can be inferred without directly measuring the other pair. Using this principle, we studied new imaging techniques that can be applied to various fields (medicine, remote sensing, etc.) that require imaging with minimal physical contact (for example with extremely delicate samples or for samples of various sizes that cannot be placed in front of a camera).

This summer, we focused on two projects that uses entangled photons - 1) imaging objects without actually placing the object in front of the camera but by detecting the other entangled photon that interacts with the object, and 2) exploring (and potentially diagnosing) various tissues through quantum state tomography by sending polarization-entangled photons through the tissues. For the first project, before using fully entangled photons we used normal down-converted photon pairs to test and check the different paths the photons are travelling, with the imaging object placed in front of the camera. Once all the components were aligned, we were able to obtain images of several objects including thin strings, a small Colgate logo, and a slice of mouse brain. After that we moved on to using entangled photons, which we are currently working on to obtain the ghost image.
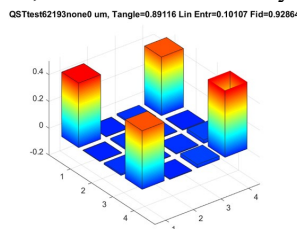

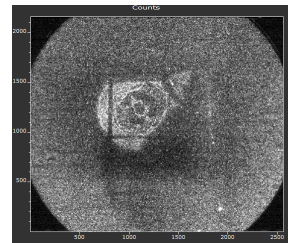Fig 1. Quantum State Tomography of an entangled HH +VV state　　Fig 2. Image of a slice mouse brain

With the second project, we sent entangled photons through polystyrene microbeads and graphed quantum state tomographies as the decoherence of the photon pairs changed depending on the dilution ratio and particle size. From the laser source the photon pairs were sent in maximally entangled states, but as one photon passed through the microbead sample the states changed into more mixed-like states. Depending on the intensity of decorence, the tangle (degree of entanglement) and linear entropy (degree of mixture) curves followed the path of Werner states.

Other than using different samples to produce entangled and mixed states, we also used filter pairs of various bandwidths. The tomography results showed that the wider the bandwidth the lower the tangle with higher linear entropy values. The overall trend of different band pass filters also followed the Werner curve. For our next step, we plan to use microtubules (tubulin polymers of cytoskeletons) to explore the decoherence of entangled photons as they pass through the tissues.
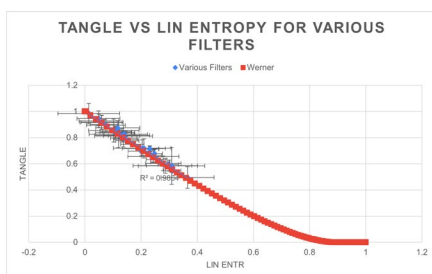

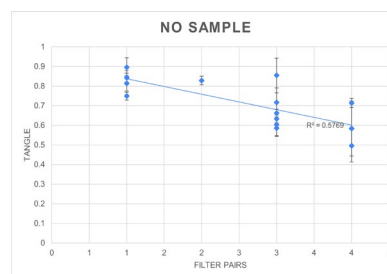Fig 3. Tangle vs Linear Entropy curve of photon states　　　　Fig 4. Tangle vs Linear Entropy curve of photon states
using different filter pairs and samples　　　　　　　　using different filter pairs but no sample

Research Fellow: Emma Zeng (2023)   **Concentration(s):** Biochemistry; Mathematics

Faculty Mentor: Abdel Isakovic   **Department:** Physics and Astronomy

Title of Project: Limitation of Fowler-Nordheim Electron Field Emission Model at Nanoscale

Funding Source: Justus '43 and Jayne Schlichting Student Research Fund

Project Summary:

I have been working on two projects during the summer. The second one will be continued next semester.

Title 1: Limitation of Fowler-Nordheim Electron Field Emission Model at Nanoscale
Fowler-Nordheim (FN) plots of the form ln (J/E2) versus 1/E have been used for the past decade to analyze field electron emission data. Several other models exist, yet due to historical reasons, it has become common to use FN plots [1]. An increase in experimental data as well as some recent mathematical developments in field electron emission theory have made the FN model less valid than it was, especially at the nanoscale. We present a compilation of nanowires field electron emission experimental data published up-to-date, as well as experimental results of fabricated Ni3Si2 nanowires, and argue that the FN model presents several limitations in analyzing field emission current-voltage data when applied at the nanoscale.

Project Summary:
The unique nanoscale properties and broad range of electrical, mechanical, and chemical applications make nanowires the focus of several recent studies. Nanodevices are complicated combinations of individual wires. The different properties of individual nanowires rend their theoretical modeling and experimental characterization a difficult task.

Field electron emission (FE) has been an object of long-time studies and is still an active nanomaterials and nanostructures research area because of its great commercial interest in electronic devices such as field electron microscope, field electron spectroscopy, and microwave generation. The Fowler-Nordheim model studies the dependence of the current density (J) on the applied electric field (E), the work function (φ) and the field enhancement factor (β)

In summary, Fowler-Nordheim Theory works well for 3D bulls but it has limitation for nanowires. Tip shape of nanowires(β) has been discussed in literature, but it fails to offer consistency. There is some evidence that the work function F will not be consistent for nanowires of the same material There have been different approaches like ML, CL or MG plots, but these too have piece-wise validity at best. Lastly, a new measure S/V was proposed to rederive FN equation for 1D and 2D model.

Title 2: Similarity Scoring Matrix Of Amino Acid Based On X-ray Coefficients
Amino acid similarity matrix is constructed to analyze physicochemical properties among amino acids to characterize protein-sequences and predict protein folding and function. Current versions which are used in bioinformatic are based on mutational model of evolution (PAM) and actual substitution rates (BLOSUM). Advances in nanotechnology and nanoscale biophysics make for accessible studies of amino acids with new tools, such as X-rays, mesoscopic transport etc. In this research, we propose and deduce new types of similarity matrices based on X-ray coefficients (atom form factor, mass absorption, mass attenuation) under different energy and conductance under different voltage. What we see in our results is that besides cysteine and methionine, the similarity rate between other amino acids mostly reaches 90 and the four X-ray property matrices have very low correlation coefficient (almost 0) with isoelectric point and BLOSUM, but they have pretty high coefficient between each other (around 0.9).

Research Fellow: Angela Zheng (2023)

Concentration(s): Educational Studies; Philosophy and Religion

Faculty Mentor: Meg Gardner

Department: Educational Studies

Title of Project: Globally Competent Teaching Curriculum Development

Project Summary:

This summer, I conducted research with Professor Meg Gardner of the Educational Studies department. The study focused on the curriculum development of "Globally Competent Teaching" – a pedagogy aiming to enhance K-12 students' and pre-service teachers' global perspectives.

Admittedly, the idea of preparing students to face global challenges is not new. If one looks up the New York State K-12 Social Studies Framework revised in 2014, one of the learning themes is called Global Connections and Exchange. InTASC Model Core Teaching Standards, standards to develop future teachers published in 2013, also mentioned the importance of connecting local and global issues when educating students. However, Professor Gardner told me that the current education was not doing good in meeting these standards.

The divorce between education standards and practices caught my interest – is there any way teachings could meet these standards; what global-perspective-enhancing teaching practices are like? This is where my research started.

The beginning of my research was dominated by a great number of literature reviews under the advice of Professor Gardner. It is in this process that I developed the pedagogy based on my research and decided the name of the pedagogy: "Globally Competent Teaching." In the next stage of the research, I developed a curriculum for high school students in mathematics classes. The curriculum employed ideas from Globally Competent Teaching to show the audiences how teachers could teach a high school mathematics class in a globally competent way.

I found the following three critical components of "Globally Competent Teaching" throughout my research. First, the educational goal of teachers is getting students ready to *view things from multiple perspectives* and *connect concepts across disciplines*. Second, in terms of teaching practices, teachers could use virtual exchange platforms such as iEARN.com effectively to achieve globally competent teaching goals. Finally, when teachers want to assess students' global competency, they can use rubrics according to their understanding of Globally Competent Teaching or use the established assessment tools by educators: Global Perspective Inventory (GPI).

The research with Professor Gardner has profoundly impacted my understanding of future education. It makes me realize that education itself is continually evolving. We live as global citizens in an increasingly interconnected world -- the pandemic has magnified this fact. Receiving globally competent education, therefore, is becoming more and more significant.

Research Fellow: Jessica Zhong (2022)   **Concentration: Chemistry**

Faculty Mentor: Ernie Nolen   **Department: Chemistry**

Title of Project: Synthetic effort towards C-linked GalNAc-Ser/Thr analogs as metabolically stable Tn antigen mimic

Project Summary:

Tn antigen, expressed by many types of tumors, is a cell-surface carbohydrate that elicits an antibody response. Our research goal is to synthesize the Tn antigen mimic for studies aimed at the understanding of key factors in immuno-recognition with potential for cancer vaccine development. The mimic is structurally similar to Tn antigen and is metabolically more stable.
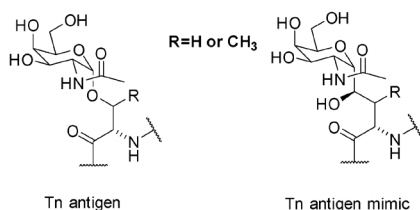
Previously, we carried out a synthetic scheme that was analogous to the synthesis of the Tn antigen mimic in terms of experimenting with the stereocontrol of the chiral center at the C-linkage (scheme 1). The reactions yielded two separable diastereomeric isoxazolines **2** and **3** in a 7:1 ratio. Thus, we proved that having a methyl *cis* to the galactose ring, which was symbolic of a Z-alkene, helped to orient the alkene of **1** *exo* to the ring so that the N-oxyl radical approached from the *si*-face. This eventually led to the desired configuration of **4**.
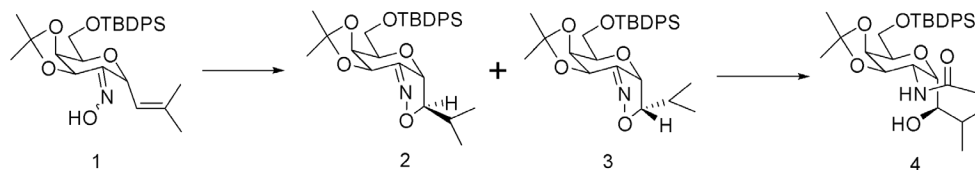
Scheme SEQ Figure * ARABIC 1. Stereoselective synthesis of C-linked -GalNAc-1'-hydroxyisobutane.

To apply the model studies, we carried out the synthesis of α-C-alkynyl glycoside **7** from the corresponding alkyne **5** and α-1,2-anhydrosugar **6** as shown in Scheme 1.[2,3] After a few false starts, we managed to obtain compound **7** at a very low yield. The reaction was stereoselective due to zinc chloride (a Lewis acid), which complexes to the epoxide for the ring opening followed by intramolecular attack of the alkynyl nucleophile exclusively from the α-face. In the future, we plan to improve the synthetic method of the C-alkynyl glycosidation followed by reduction using the Lindlar catalyst to give the desired Z alkene **8**. As we have proved in the model study, the Z isomer will eventually lead to Tn antigen mimic in the correct configuration.
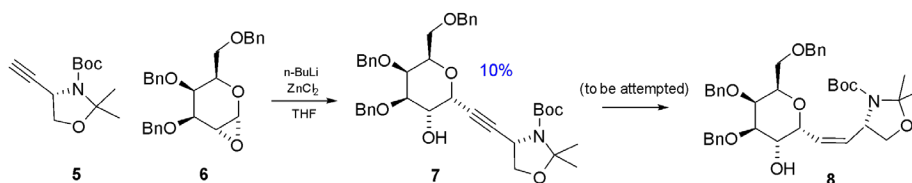
Scheme 2. Synthesis of the -C-alkynyl glycoside and its reduction to the Z alkene (to be attempted).

Research Fellow: Jane Zugarek (2022)   **Concentration(s): Neuroscience; Geography**

Faculty Mentor: Julie Dudrick   **Department: Upstate Institute**

Title of Project: Numbers and Needs in Cornhill

Funding Source: Upstate Institute

Project Summary:

This summer, I held a role in a higher education consortium that researched in partnership with the Community Foundation of Herkimer & Oneida Counties. Throughout this experience offered by the Upstate Institute Summer Field School, I worked with individuals from the Community Foundation, Hamilton College, SUNY Polytechnic Institute, and Utica Public Library to better understand the City of Utica and its Cornhill neighborhood. The Community Foundation is a community-based social impact investor whose mission is to engage, invest, and lead the populations of Herkimer and Oneida County as they target various areas of social development such as workforce development and neighborhood revitalization. Under its neighborhood revitalization initiative, the Community Foundation has been pursuing the development of multiple "impact centers" or reimagined community centers that provide space for nonprofit partners and social agencies to serve families in high-need areas, such as the Cornhill neighborhood. My research centered around finding and organizing existing data pertinent to a prospective impact center in Cornhill, and relaying what data is missing with other members of the consortium such that we can begin to collect new data that will serve as an indicator of the impact center's footprint. Additionally, I used GIS software to map data that assessed need and vulnerability in the Cornhill area and created a living data catalog to track the influence of the impact center.

The Community Foundation's current impact center project focuses on the Cornhill neighborhood of Utica, New York. Cornhill is Utica's second-most populated section with a large population of African Americans, but it is also a poorer, more disenfranchised part of the city. Thus, there is a need for new businesses, healthcare resources, and the promotion of land ownership which is why the Community Foundation and higher education consortium has been working to conduct a needs assessment of the area. My work will help inform the Community Foundation's understanding of what needs exist in the Cornhill area--both quantitatively and visually with maps--and how the impact center and nonprofit partners can best serve the Cornhill population. The map below depicts healthcare resources and their 10-minute walking time area in relation to Cornhill. This ArcGIS Online map helps visualize the accessibility of health resources for Cornhill residents and how the impact center (black start) will help serve the area. Expectantly, the data and maps may be incorporated into the Community Foundation's grant proposals in the future and, in the long-term, the data catalog will serve as a point of reference for the involved organizations to understand the impact center's contributions to the community.
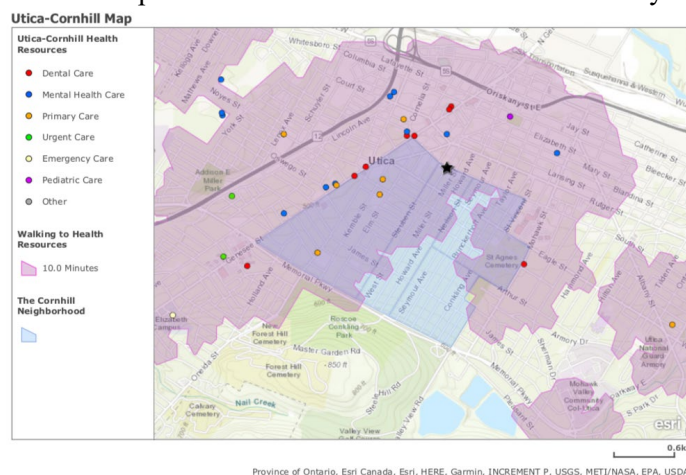
Statistics

Please note the total number of participating students is the number of student projects. Students working on two different projects with different faculty are counted twice. Students with double-majors are counted twice in the Distribution of Students by Concentration table.

In addition, the total number of participating faculty is the number of faculty supervising student research projects. Faculty holding joint appointments are listed by the department/program which most closely matches the subject of the research project supervised (source of funding consulted for interdisciplinary projects). Faculty in different departments jointly supervising one student research project are both counted in the Distribution of Students by Faculty Division and Department table.

Total number of participating students: 235

Distribution of Students by Concentration (students with double majors are included twice)

Anthropology	4
Applied Math	9
Art and Art History	5
Arts and Humanities	1
Asian Studies	2
Astrogeophysics	2
Astronomy/Physics	7
Biochemistry	11
Biology	12
Chemistry	8
Chinese	1
Classical Studies	1
Classics	1
Computer Science	15
Economics	11
Educational Studies	6
English	5
Environmental Biology	3
Environmental Economics	1
Environmental Geography	4
Environmental Geology	4
Environmental Studies	8
Film and Media Studies	1
French	1
Geography	4
Geology	16
German	1
History	9
International Relations	5
Mathematical Economics	5
Mathematics	7
Middle Eastern and Islamic Studies	4
Molecular Biology	16
Natural Sciences	3
Neuroscience	20
Peace and Conflict Studies	6
Philosophy	6
Philosophy and Religion	1
Physical Science	1
Physics	15
Political Science	10
Psychological Science	7
Religion	2
Russian and Eurasian Studies	3
Sociology	4
Spanish	5
Theater	2
Undeclared	26
Women's Studies	2

Arts and Humanities	**32**
Art and Art History	5
Arts and Humanities	1
Chinese	1
Classical Studies	1
Classics	1
English	5
French	1
German	1
Philosophy	6
Philosophy and Religion	1
Religion	2
Spanish	5
Theater	2
Natural Sciences and Mathematics	**154**
Applied Math	9
Astrogeophysics	2
Astronomy/Physics	7
Biochemistry	11
Biology	12
Chemistry	8
Computer Science	15
Geology	16
Mathematical Economics	5
Mathematics	7
Molecular Biology	16
Natural Sciences	3
Neuroscience	20
Physical Science	1
Physics	15
Psychological Science	7
Social Sciences	**53**
Anthropology	4
Economics	11
Educational Studies	6
Geography	4
History	9
International Relations	5
Political Science	10
Sociology	4
University Studies	**38**
Asian Studies	2
Environmental Biology	3
Environmental Economics	1
Environmental Geography	4
Environmental Geology	4
Environmental Studies	8
Film and Media Studies	1
Middle Eastern and Islamic Studies	4
Peace and Conflict Studies	6
Russian and Eurasian Studies	3
Women's Studies	2
Undeclared	**26**

Distribution of Students by Faculty Division and Department:

(Number is greater than total number of participating students due to jointly supervised projects)

Arts and Humanities	**13**
Art and Art History	2
Classics	2
East Asian Languages and Literatures	1
English	2
Philosophy	2
Religion	2
Theater	2
Natural Sciences and Mathematics	**147**
Biology	31
Chemistry	25
Computer Science	4
Geology	30
Mathematics	5
Neuroscience	4
Physics and Astronomy	33
Psychological and Brain Sciences	15
Social Sciences	**36**
Economics	8
Educational Studies	7
Geography	4
History	3
Political Science	10
Sociology and Anthropology	4
University Studies	**3**
Environmental Studies	3
Other	**53**
Center for Freedom and Western Civilization	12
Lampert Institute for Civic and Global Affairs	8
Upstate Institute	33

Distribution of Students by Funding Source

Internal	**159**
Center for Freedom and Western Civilization	12
Division of the Arts and Humanities	6
Division of Natural Sciences and Mathematics	73
Division of Social Sciences	24
Division of University Studies	3
Lampert Institute for Civic and Global Affairs	8
Upstate Institute	33
Endowed	**61**
Alexander V. Wasson Fund to Support American History	2
Bob Linsley/James McLelland Fund	2
Doug Rankin '53 Endowment-Appalachian Research	2
Doug Rankin '53 Endowment-Geology Research	3
Hackett-Rathmell 1968 Memorial Fund	1
Herman T.R. Aude Mathematical Fund	1
Holden Endowment Fund	1
James M. Taylor Mathematical Fund	2
J. Curtiss Taylor '54 Endowed Student Research Fund	3
Jonathan H. Kistler Memorial Curricular Innovation Fund	2
Justus '43 and Jayne Schlichting Student Research Fund	13
Michael J. Wolk '60 Heart Foundation	8
Miller-Cochran Fund	2
Norma Vergo Prize	3
Oberheim Memorial Fund	2
Picker Interdisciplinary Science Institute	1
Volgenau Wiley Endowed Research Fellowship	8
Walter Broughton '63 Research Fund	2
Warren Anderson Fund	3
External	**29**
Beckman Scholar Program	3
Keck Northeast Astronomy Consortium	1
NASA Mars Data Analysis Program	2
NASA New York Space Grant	2
National Institutes of Health (NIH) Area Grant	4
National Science Foundation Grant	16
Summer Undergraduate Research Fund (SURF)	1

Total Number of Participating Faculty: 84

Distribution of Faculty by Division and Department:

Arts and Humanities	**10**
Art and Art History	1
Classics	2
East Asian Languages and Literatures	1
English	1
Philosophy	1
Religion	2
Theater	2
Natural Sciences and Mathematics	**49**
Biology	9
Chemistry	11
Computer Science	1
Geology	7
Mathematics	3
Neuroscience	1
Physics and Astronomy	11
Psychological and Brain Sciences	6
Social Sciences	**23**
Economics	6
Educational Studies	3
Geography	3
History	2
Political Science	6
Sociology and Anthropology	3
University Studies	**1**
Environmental Studies	1
Other	**14**
Center for Freedom and Western Civilization	9
Lampert Institute for Civic and Global Affairs	4
Upstate Institute	1

Distribution of Faculty by Funding Source

(Faculty with more than one funding source are counted multiple times)

Internal	**71**
Center for Freedom and Western Civilization	9
Division of the Arts and Humanities	5
Division of Natural Sciences and Mathematics	37
Division of Social Sciences	14
Division of University Studies	1
Lampert Institute for Civic and Global Affairs	4
Upstate Institute	1
Endowed	**47**
Alexander V. Wasson Fund to Support American History	1
Bob Linsley/James McLelland Fund	2
Doug Rankin '53 Endowment-Appalachian Research	2
Doug Rankin '53 Endowment-Geology Research	2
Hackett-Rathmell 1968 Memorial Fund	1
Herman T.R. Aude Mathematical Fund	1
Holden Endowment Fund	1
James M. Taylor Mathematical Fund	1
J. Curtiss Taylor '54 Endowed Student Research Fund	3
Jonathan H. Kistler Memorial Curricular Innovation Fund	1
Justus '43 and Jayne Schlichting Student Research Fund	9
Michael J. Wolk '60 Heart Foundation	5
Miller-Cochran Fund	2
Norma Vergo Prize	2
Oberheim Memorial Fund	2
Picker Interdisciplinary Science Institute	1
Volgenau Wiley Endowed Research Fellowship	6
Walter Broughton '63 Research Fund	2
Warren Anderson Fund	3
External	**18**
Beckman Scholar Program	3
Keck Northeast Astronomy Consortium	1
NASA Mars Data Analysis Program	1
NASA New York Space Grant	1
National Institutes of Health (NIH) Area Grant	2
National Science Foundation Grant	9
Summer Undergraduate Research Fund (SURF)	1