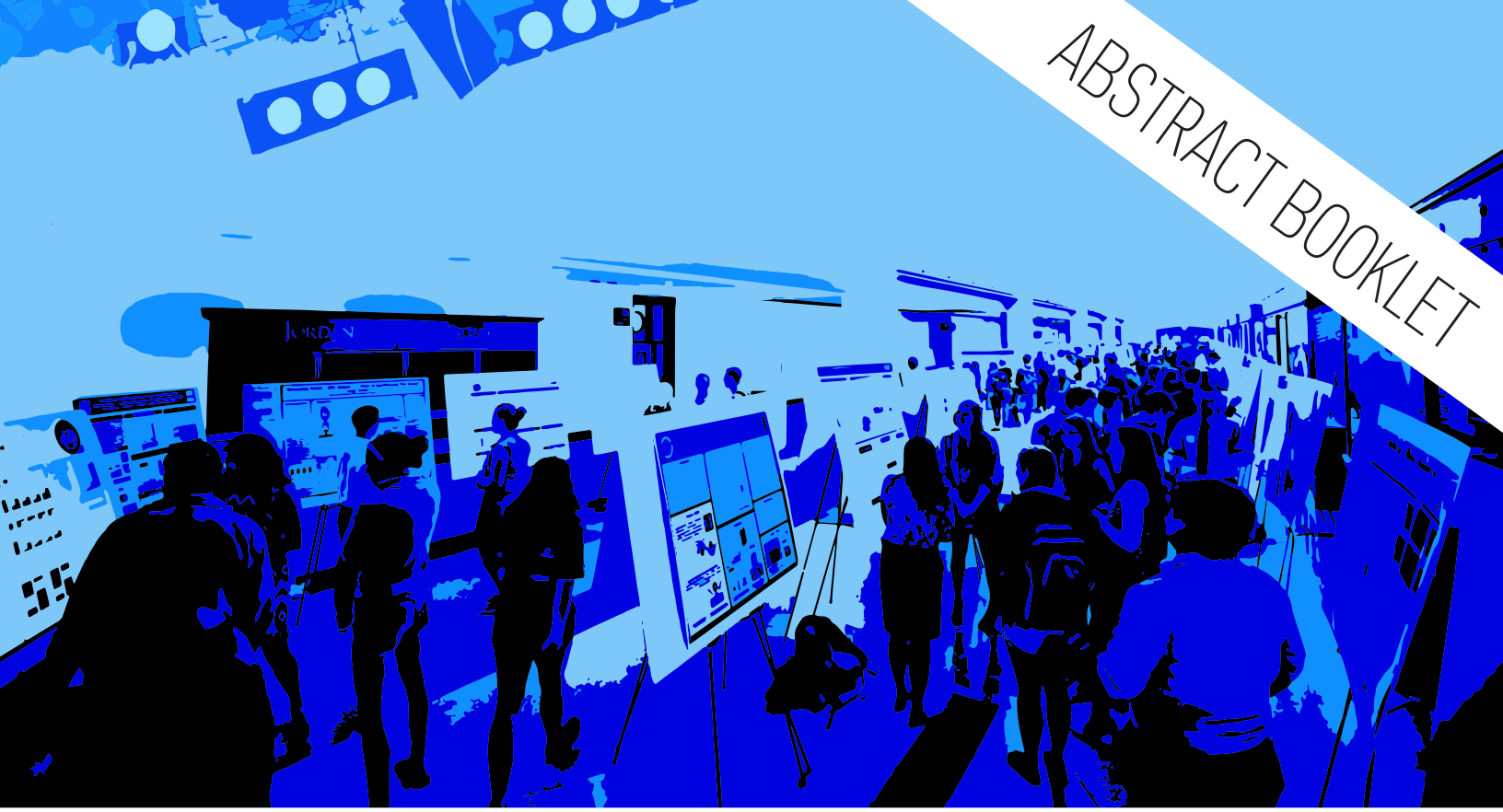

ABSTRACT BOOKLET

COS JAM 2024

COLLEGE OF SCIENCE JOINT ANNUAL MEETING

THURSDAY MAY 2 · 1-4:30PM · JORDAN HALL GALLERIA

1:00-2:00	POSTER SESSION I (ODD NUMBERS)
2:00-3:30	CONCURRENT ORAL PRESENTATIONS
3:30-4:30	POSTER SESSION II (EVEN NUMBERS)

UNIVERSITY OF NOTRE DAME | SCIENCE

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COS JAM Schedule

Thursday, May 2, 2024 Jordan Hall of Science

1:00 pm - 2:00 pm Poster Session 1 (Odd numbered poster presentation)

2:00 pm - 3:30 pm Concurrent Oral Presentation Session

3:30 pm - 4:30 pm Poster Sessions 2 (Even numbered poster presentation)

Refreshments will be provided during poster sessions.

Concurrent Oral Session 1:

Jordan 101
Moderator: Dr. Steven Wietstock, Teaching Professor
Department of Chemistry and Biochemistry

2:00-2:15 Amanda Waelde
Optimization of Tryp-N™ for Pyroglutamic Acid Avoidance

2:15-2:30 Marissa Panethiere
5-ALA ester prodrug for enhanced photodynamic inactivation of cancer cells

2:30-2:45 Aidan Meuninck
Purification and Characterization of Monoclonal Human Plasminogen Antibodies

2:45-3:00 Aisling Kruger
Elucidating the Role of Iroquois Transcription Factor 4a in Kidney Development

3:00-3:15 Julia Florek
Expression and Regulation of Human Endogenous Retrovirus K (HERV-K) in Ovarian Cancer

3:15-3:30 Rebecca Kubick
Epigenetic Modifiers Improve Temozolomide Efficacy in Combination Therapy on Human Glioblastoma Cells

Concurrent Oral Session 2:

Jordan 105
Moderator: Dr. Daniele Miranda, Research Assistant Professor
Department of Biological Sciences

2:00-2:15 Evan Peters
Using the waxworm Galleria mellonella to assess virulence of the environmental yeast Cryptococcus neoformans

2:15-2:30 Erik Curtis
Leaf Litter Inputs and Their Biofilms Influence Size-Specific eDNA Removal Rates in Streams

2:30-2:45 Corbin Hite
Effects of an Invasive Plant (Elodea canadensis) on Sockeye Salmon and Ecosystem Structure in an Alaska Lake

2:45-3:00 Dorrian Cohen
The Last of Fung(Us): Evaluating the Antifungal Activity And Superlative Mechanism of Action of a Synthetic Enterocin Peptide Library

3:00-3:15 Brooke Rodriguez
Added Value of Biomeme Franklin® Real-Time PCR Thermocycler in Pathogen Surveillance

3:13-3:30 Peter Martin
A Meta-Analysis of Per- and Polyfluoroalkyl Substances (PFAS) in the Biota of the Laurentian Great Lakes

Concurrent Oral Session 3:

Reading Room
Moderator: Dr. Evan Kirby, Associate Professor
Department of Physics and Astronomy

2:00-2:15 Keo Pangan
A study examining impact of county-level demographic, socioeconomic, and political affiliation characteristics on COVID-19 vaccination patterns in Indiana

2:15-2:30 Matt Kianpour
Salud, Stress, and Healthcare Seclusion: A Mixed Methods Study of Psychological Stress of Latina Mothers in South Bend, Indiana

2:30-2:45 Yutan Zhang
Well-Posedness of the Nonlinear Schrödinger Equations on the Line

2:45-3:00 Michelle Kwok
Supersymmetric Dark Matter Production Through Primordial Black Holes and Trigger Mechanism for Detection at the LHC

3:00-3:15 Henry Bloss
Modeling Lithium Depletion in Spite Plateau Stars using MESA

3:13-3:30 Beatriz Silva
Exploring the Effects of Plasma Radiation on Solution pH for Potential Medical Applications

Concurrent Oral Session 4:

Digital Visualization Theatre
Moderator: Dr. Philip Sakimoto, Professor of the Practice
Department of Physics and Astronomy

2:00-2:15 Avery Broughton
Creating Sustainable Consumption Habits In K-Pop for the Classroom

2:15-2:30 David DeBacker
Beyond the Word of Life: Exploring Advocacy and Inspiration Through Public Art

2:30-2:45 Patricia McCormack
Protect and Preserve: A Defense of the Sanibel Plan

2:45-3:00 Isabela Rascon
The Sea is Rising, Are We Moving?

3:00-3:15 Andrea Reisinger

From Energy Source to Summer Fun: Kentucky Lake's Change Through Time and Man-Made Lake Management

3:15-3:30 Emma Stern

Field of Vice and Victory

Poster sessions
There will be **two poster sessions.** Please check your poster number below. Odd numbered posters will be presented at poster session 1 from **1-2pm**. Even numbered posters will be presented at poster session 2 from **3:30- 4:30pm**.

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Samantha Blake	**6**	The role of her9 in zebrafish retinal regeneration
Katie Burns	**7**	Solid Phase Synthesis of des-OH Pseudouridimycin Analogues
Gabriela Cano Jackson Meyer	**8**	Breaking Down: Brine Fly Larvae Decomposition
Teresa Cato	**9**	Brine fly larval feeding: Biofilm and Detritus
Sisy Chen	**10**	The Role of DKK3 in the Secretome of Cancer-Associated Fibroblasts of Ovarian Cancer
Declan Creaney	**11**	New red-shifted pH biosensors for measuring intracellular pH
Edward Daubenspeck	**12**	Characterizing North American Ultra-Extreme Hydrometeorological Events
Jordan Eining	**13**	The Power of Poetry: How literature can aid in the fight against the Dakota Access Pipeline
Matthew Espeland Frances Harrington	**14**	From Iran to South Bend: The Application of Windcatchers in ASHRAE Zone 5
Jacob Finley	**15**	Dynamics and Fragmentation Channels Induced Through Dissociative Electron Attachment to Anisole
Erin Flannigan Anna Wang	**16**	Changing Views: Limited Color Vision Variability in Bluegill Sunfish Despite Contrasting Light Habitats

Allison Fleming	**17**	Pulsed Measurement of Fowler Nordheim Tunneling Current in Metal-Insulator-Metal Structures
Juan Flores	**18**	Scat as an Indicator of PFAS Uptake by Common Terrestrial Mammals
Ella Foster	**19**	Developing 3D tumor models for neuroendocrine prostate cancer to facilitate disease characterization and enhance sustainability in the laboratory
Brooke Friedman	**20**	The Relationship Between Stress, Allostatic Load, APOE, and Cortical Thinning
Benjamin Frostino	**21**	Transcriptional Control of Astrocyte Proliferation by BATF2
Dorothy Gan	**23**	Simulations and Transport Tests of Ions through the St. Benedict RF Carpet and Ion Guide
Sarah Gann	**22**	Investigating Multidrug Antimalarial Resistance in Bangladesh
Josephine Gery	**24**	As Life Expectancy Increases in People Living with HIV, Prior Nutrition Recommendations May Increase the Risk of the Development of Secondary Chronic Conditions
Claire Hackl **Maeve Sandeen**	**25**	Tiny Greens, Big Lessons: Testing the Efficacy of Online Learning Designed for Children
Meredith Heller	**26**	The Sneaker's Footprint: Designing a database that empowers retailers and consumers to understand the environmental impact of sneakers
Ethan Horvath	**27**	A longitudinal study of paternal influences and maternal mediation in adolescents' alcohol use amid socio-political violence
Grace Hsu	**28**	Structural Variations in Uranyl Oxalate Compounds Relating to Countercation Radii
Eric Huberty **Zach DiBiase**	**29**	Helping the Midwest Take Off: Harnessing Indiana's Ethanol Industry for Sustainable Aviation Fuel Transformation
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Thomas Joyce	**34**	Learning Analytics: Performance Group Analysis and Early Grade Prediction for a Foundational Organic Chemistry Course
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Therese Reisch	**59**	Complex effects of perfluorooctane sulfonic acid (PFOS) on stream ecosystem function
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Lauren Sallay	**63**	Plant Power: Determining the Potential of Aquatic Vegetation as Biodigester Input to Reduce Human Infectious Disease
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Ashley Schmidt	**65**	Assessing Stress Levels in Mice Subjected to Different Handling Techniques
Lauren Schnable	**66**	Hold the Salt: an investigation into the aquatic ecosystem effects of de-icing salt application at Notre Dame
Ava Schwan	**67**	Exploring Episignatures as a Potential Diagnostic Tool for Diabetic Embryopathy
Grace Speicher Jace Kruer	**68**	Aquatic Food Web Response to an Invasive Plant in the Copper River Delta of Alaska
Emma Speyrer	**69**	Visualizing Expansion Coastal Boulder Deposits Community using Inundation Signatures on Rocky Coastlines Datasets

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Gavin Sullivan	**73**	Assessing Titanization in Mutants of the Pathogenic Fungus Cryptococcus Neoformans
Stephanie Swegle	**74**	A Conversation Between the Gut and the Brain: Investigating the Influence Dietary Barcodes have on Gut Microbes Associated with Neurotransmitters
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The below High School students are the awardees of Indiana representative to **ISEF 2023 (International Science and Engineering Fair)**. They were selected to present their data at COS JAM.

The Impacts of Chemotherapy on AP Knockout Cells in Breast Cancer

Emily Archambeault
Marian High School

Abstracts for all presenters

(Posters and Oral Presentations)

Listed by the first author' last name alphabetically

Roles of Extracellular Vesicles in the Aging Microenvironment and Epithelial Ovarian Cancer Progression

Joshua Mijares[1], Christopher Barile[1], Katherine Schepke[1], Reihaneh Safavisohi[2], Jeff Johnson[1], Ceming Wang[3], Hsueh-Chia Chang[4], and M. Sharon Stack[1]

[1]Department of Chemistry and Biochemistry, Harper Cancer Research Institute, University of Notre Dame, Notre Dame, IN
[2]Department of Chemistry and Biochemistry, Seton Hall University, South Orange, NJ
[3]Aopia Biosciences, Inc., Pleasanton, CA
[4]Department of Chemical and Biomolecular Engineering, University of Notre Dame, Notre Dame, IN

With nearly 19,000 new cases and 14,000 deaths annually, epithelial ovarian cancer (EOC) remains a leading cause of mortality among gynecological cancers. Metastasis to the peritoneum, characterized by the adherence and invasion of tumor cells and multicellular aggregates to the mesothelial lining, represents a critical aspect of EOC progression. The median age of diagnosis for the disease is 63, and there exists a strong correlation between advanced age, EOC incidence, and disease stage. Therefore, we are investigating which age-related factors contribute to EOC metastasis. One potential factor is exosome-mediated communication. Exosomes are small extracellular vesicles that support a variety of biological processes, such as the reprogramming of cells within the tumor microenvironment to facilitate metastasis. The goal of this project is to explore the roles of exosomes in EOC metastasis and the relationship between exosome-mediated communication and aging. Exosomes from tumor-naïve hosts were isolated from peritoneal lavages of both aged (A exosomes) and young (Y exosomes) mice using a proprietary asymmetric nanopore microfluidics device. OVCAR5 cells treated with A exosomes displayed increased adhesion to LP9 mesothelial cells compared to OVCAR5 cells treated with Y exosomes. Treatment of OVCAR5 cells with A exosomes also enhanced *in vitro* invasion of collagen and *in vivo* adhesion to omental tissue. Moreover, proteomic profiling and western blot analysis revealed significant differences in cargo composition between A and Y exosomes. These differences included varying expression of many proteins between A and Y exosomes and the presence of hundreds of proteins only in A exosomes. For example, A exosomes were found to exhibit elevated levels of the protein integrin beta-1 (ITGB1). Adhesion assays confirmed the functional relevance of ITGB1, as pretreatment of A exosomes with an ITGB1 function-blocking antibody abrogated the increase in adhesive properties of OVCAR5 cells due to A exosomes. These data suggest that exosome-mediated communication, influenced by age-related differences in exosomal cargo composition, contributes to the metastatic capabilities of EOC cells and sheds light on the intricate mechanisms that underlie EOC progression.

Building a Computational Pipeline to Inform Dynamic Combinatorial Chemistry

Matthew K. Barnes, Matthew Gluckow, Carmen A. Magestro, Brock A. Stenfors, Olaf Wiest, and Brittany S. Morgan

University of Notre Dame, Department of Chemistry and Biochemistry

Dynamic Combinatorial Chemistry (DCC) holds a powerful role in compound elucidation by automating molecular design with the construction of stable and target-specific species via a thermodynamic equilibrium of reactive building blocks. As such, its success is largely dependent on the quality of the chosen molecular building blocks: their ability to react in a given system and achieve a rapid equilibrium. Here, we describe a computational pipeline which informs DCC by intaking a database of commercially available compounds to yield a tailored list of ready-to-react, physically characterized species. Commonly, chemical compounds are digitally represented in two-dimensional form through the Simplified Molecular Input Line Entry System (SMILES) notation. While these scripts are compound-specific, running the SMILES strings through a list of SMILES Arbitrary Target Specification (SMARTS) filters allows for chemical database tailoring by removing species with non-desired structures or chemical functionalities. This line-notation filtrate is then set for geometric modeling under the Merck Molecular Force Field (MMFF) and structural optimization under the M06 hybrid functional and 6-31G(d,p) basis set to quantify HOMO/LUMO energies with a Density Functional Theory (DFT) calculation. Finally, to ensure rapid equilibrium is reached, compounds with small inter-molecular HOMO/LUMO gaps are selected as molecular building blocks. We believe this pipeline will be a crucial means of informing DCC based molecular design across a variety of chemical environments.

The Effects of Human Land Use and Stream Restoration on the Benthic Invertebrate Populations of Juday Creek

Claire Bass

Human land use negatively impacts lotic ecosystems, with benthic invertebrate populations experiencing population declines as a result. Short-term monitoring programs of stream restoration programs are common, although few studies analyze the long-term efficacy of stream restoration. Over twenty years ago, two reaches of Juday Creek, a tributary of the St. Joseph River, were restored and relocated to "idealized" new channels as part of a golf course construction project. A recent study found that the restored reaches supported greater invertebrate populations than the unrestored reaches, although it remained unknown whether reduced populations were isolated within these reaches or were indicative of overall creek decline. To answer this question, I analyzed the long-term efficacy of the Juday Creek restoration by studying invertebrate communities and sedimentation of the restored and unrestored reaches, as well as two reaches upstream of the golf course construction site not yet sampled in a previous study. Monthly samples of invertebrates and sediment were collected at each site for one year. All invertebrates were identified, and sediment samples were separated by particle size and organic:inorganic content. The four locations within the golf course property were found to support greater invertebrate abundance and biodiversity relative to the unrestored upstream sites. However, populations were reduced relative to records from previous decades. Therefore, stream restoration was found to be relatively effective but unable to combat overall watershed effects. This study informs local management strategies and encourages restoration at a larger scale to be economically sustainable and support healthy streams.

Neuronal functional connectivity graph estimation with the Rpackage neurofuncon

Lauren Miako Beede and Giuseppe Vinci

Department of Applied and Computational Mathematics and Statistics, University of Notre Dame

Activity patterns across the cerebral visual cortex in response to visual stimuli are not yet fully understood. Researchers continue exploring neurons' intricate patterns of activity in the cerebral visual cortex in response to visual stimuli. The way neurons communicate and optimize their interactions with each other under different experimental conditions remains a topic of active investigation. Probabilistic Graphical Models are invaluable tools in neuroscience research, as they let us identify the functional connections, or conditional statistical dependencies, between neurons. Graphical models represent functional neuronal connectivity in the form of a graph, where nodes represent neurons and edges indicate the presence of functional connections between them. We developed the R package **neurofuncon** for the computation and visualization of functional connectivity graphs from large-scale data based on regularized high-dimensional Gaussian Graphical Models. We illustrate the use of this package with two-photon calcium microscopy imaging data recorded from about 10,000 neurons in a 1mm cubic section of a mouse visual cortex in response to visual stimuli.

Experimental Study of Carbon-Carbon Composite Oxidation in Hypersonic Airflow

Ryan Bencivengo, Alin Stoica, Richard Gulotty, Sergey B. Leonov

University of Notre Dame, Department of Aerospace and Mechanical Engineering

Carbon-Carbon (C-C) composites are prospective materials for the fabrication of components of hypersonic vehicles such as aeroshells and leading edges. These composites possess excellent performance characteristics, including a low density (1.60-1.98 $\frac{g}{cm^3}$), a low coefficient of thermal expansion (-0.85 to $1.1 * 10^{-6} \frac{1}{K}$), a high modulus of elasticity (200 GPa), and high thermal conductivities (~4-35 $\frac{W}{mK}$), while retaining mechanical properties in conditions up to ~2000°C in inert environments. However, a significant drawback of the C-C composite is its high rate of oxidation in the presence of oxygen at high surface temperatures. The mechanism and rate of oxidation are well-studied at ambient conditions, but data on the ablation and oxidation in hypersonic environments are limited. For this research project, various models made of a C-C composite were exposed to hypersonic (Mach 6) flow at controlled surface temperatures up to 1450 °C. The flow total pressure was setup up to 100 psi. The surface heating was performed by a CW IR laser at power levels up to 535W. Data was collected using an IR camera to capture surface temperature dynamics and distribution, an internal thermocouple to measure the internal temperature of the model, schlieren visualization, and macrophotography to capture physical changes of the model fibers. It was found that the C-C oxidation rate significantly increased in hypersonic airflow compared to ambient conditions, up to 30 times. The mechanism of the accelerated degradation is discussed as a combination of thermal ablation, chemical oxidation, and mechanical destruction of overheated individual carbon fibers.

The role of *her9* in zebrafish retinal regeneration

Samantha Blake

University of Notre Dame, Department of Biological Sciences

The zebrafish retina is a useful model for the human retina due to its similar morphology, cell types, and gene expression. However, unlike the mammalian retina, the zebrafish retina is able to regenerate lost neurons completely following injury with functional recovery of vision. In response to damage, Müller glial cells (MG) in the zebrafish retina reprogram and undergo an asymmetric cell division that gives rise to a neuronal progenitor cell (NPC), which continues to proliferate and migrate to differentiate into lost neurons. The Notch pathway plays dynamic roles throughout retinal regeneration. Specifically, the zebrafish Notch1a receptor was shown to be required for MG and NPC proliferation, and recent work in the Hyde lab has shown that *her9*, the zebrafish ortholog of human *HES1*, is expressed during the MG and NPC proliferation and is responsive to ectopic expression of the Notch1a intracellular domain in the zebrafish retina. The goal of this study was to elucidate the role of *her9* in retinal regeneration using morpholino-mediated knockdown following two damage paradigms that model neurodegenerative retinal diseases. Following either damage, eyes were collected at four time points and analyzed to examine cell death, MG proliferation, NPC proliferation, and differentiated cell fate. Unexpectedly, *her9* morphant retinas showed decreased cell death relative to control retinas following both damage paradigms, with no significant difference in MG or NPC proliferation. This was surprising because the number of proliferating MG and NPCs is usually proportional to the amount of cell death. This suggests that Her9 regulates two different pathways during retinal damage, activating neuronal cell death and repressing MG and NPC proliferation. Additionally, a greater percentage of regenerated cells was observed in the outer nuclear layer (photoreceptors) than in the inner nuclear layer and ganglion cell layer, demonstrating that Her9 also regulates neuronal commitment/differentiation.

Modeling Lithium Depletion in Spite Plateau Stars using MESA

Henry Bloss, Grant Mathews

University of Notre Dame, Department of Physics and Astronomy

The theory of Big Bang Nucleosynthesis (BBN) provides an explanation for the origin of light elements during the first few moments of the universe. Though this theory corresponds well with observational measurements of light elements, this agreement breaks down in the observation of 7Li in old, low-metallicity HALO stars. This disagreement, dubbed the ”Lithium problem,” poses a roadblock for BBN; if a solution is not found, BBN must be revisited. My research explores solutions to the lithium problem which do not force us to reconsider BBN. Instead we explore potential solutions which rely on thermonuclear destruction of lithium within a star, such as convective overshoot and mixing length theory (MLT) over the 1010 yr lifetime of the star. To test these solutions, I employ the code Modules for Experimentation in Stellar Astrophysics (MESA). I use this code to generate models of stars matching stellar properties of Spite plateau stars from Norris et. al. [1]. We impose astrophysical schemes on these models, and explore scenarios to induce gradual thermonuclear destruction of 7Li bringing its abundance closer to the value predicted by BBN. In particular, we show that the observed lithium resides in a thin surface convective layer for which gradual mixing into the interior is possible.

[1] ”A Critique of the Spite Plateau, and the Astration of Primordial Lithium,”

J. E. Norris et. al., MNRAS, 522, 1358 (2022), arXiv:2303.11297 [astro-ph.SR].

Work at the University of Notre Dame supported by the U.S. Department of Energy under Nuclear Theory Grant DE-FG02-95-ER40934.

1

Creating Sustainable Consumption Habits In K-Pop for the Classroom

Avery S. Broughton
University of Notre Dame, Department of Sustainability

K-pop is an industry with growing global influence that has the potential to produce substantial waste from merchandise, including physical CD albums that are commonly in the style of tactile hardcover books. This project worked to address the physical waste produced by K-pop CD albums through four objectives: 1) evaluate purchasing habits of K-pop fans and common points of waste in the packaging of CD albums through scholarly research; 2) conduct audits of K-pop CD album packaging and marketing; 3) survey college-age students to see what packaging preferences, listening habits, and purchasing tendencies are most common for the overall sample group; and, 4) design and share a teaching note based on survey results for sustainability and marketing lessons. This project aimed to highlight that industries with large, dedicated fan bases, such as K-pop, can mitigate their environmental impact by changing merchandise within the bounds of consumer preference.

Three key findings emerged from a survey of 122 University of Notre Dame students regarding CD albums and sustainability. First, while environmentally sustainable packaging is neither at the forefront of product packaging concerns for respondents nor essential to respondents, respondents are still more likely than not to purchase products with environmentally friendly packaging. Second, the quality of the packaging to protect the product and the product's display of information are most important to respondents in shaping their purchasing decision; however, album art/packaging is the primary reason that would incentivize an individual to purchase a CD album. Respondents who prioritize quality and aesthetics create a critical need for K-pop firms to prioritize aesthetics in CDs while maintaining sustainability and without compromising product quality. Third, most respondents don't purchase a CD for the additional merchandise accompanying it. Yet, there are clear preferences for merchandise with T-shirts, stickers, and posters/prints. The project shows that there may be a willingness among a generalized consumer base to see sustainable changes to packaging as long as the package quality and aesthetic appeal aren't compromised or result in a price increase above 10%. These insights leave questions about companies' ethical responsibility to make such adjustments, which are at the heart of many sustainability problems. The background reading and teaching note accompanying this report can prompt classroom discussion regarding ethical and practical responsibilities to sustainability.

Solid Phase Synthesis of des-OH Pseudouridimycin Analogues

Katie Burns [1], Avraz F. Anwar [1], Christopher Cain [1], Michael Garza [1], David Degen [2], Richard H. Ebright [2], Juan R. Del Valle [1]

[1] University of Notre Dame, Department of Chemistry and Biochemistry

[2] Rutgers University, Department of Chemistry and Biology

The rise of antimicrobial resistance is a key global health threat of the 21st century. The emergence of drug-resistant pathogens has led to increased demand for the discovery and development of new antibiotics that mitigate resistance mechanisms. Bacterial RNA polymerase (RNAP) is an enzyme that is essential for bacterial survival and is a target of several FDA-approved drugs. However, resistance to these drugs emerges rapidly through mutations in RNAP that alter their binding sites but not enzymatic function.

Pseudouridimycin (PUM) is a naturally occurring C-nucleoside antibiotic isolated from *Streptomyces albus*. In contrast to currently available RNAP-targeting drugs, PUM binds to the RNAP active site. As a result, mutations that might weaken PUM binding would also compromise RNAP function. PUM exhibits greater than 10-fold selectivity for bacterial RNAP over human RNAP and is not cytotoxic to mammalian cells. PUM displays antibacterial activity against drug-resistant and multidrug-resistant Streptococci *in vitro* and *in vivo*. These properties make PUM a promising candidate for further development.

Our research group identified two intramolecular decomposition pathways of PUM which greatly compromise its antimicrobial activity and clinical potential. At physiological pH, scission of the hydroxamate bond causes complete loss of activity and modifications to the hydroxamate bond have been found to considerably enhance its stability.

Here, we describe the synthesis and biological evaluation of des-hydroxy PUM analogues on solid support. These analogues feature modified dipeptide tails in search of lead compounds with enhanced stability and RNAP inhibitory activity. Our solid-phase approach enables the rapid generation of PUM analogue libraries for structure-activity relationship studies.

Breaking Down: Brine Fly Larvae Decomposition Analysis

Gabriela Cano, Jackson Meyer, and Gary Belovsky

The Great Salt Lake (Utah, USA) is hypersaline and fluctuates in temperature and salinity both seasonally and annually. Phytoplankton compose the base of the Great Salt Lake's simple food web supporting two macroinvertebrates, brine shrimp (*Artemia franciscana*) and brine flies (*Ephydra* sp.). Phytoplankton productivity is limited by nitrogen which is cycled in the environment through decomposition. The release of stored nitrogen can then be used by primary producers. Previous experiments have shown that the rate of decomposition within the pelagic zone of the Great Salt Lake is impacted by both temperature and salinity. This experiment is the first to investigate decomposition rates in the benthic zone by observing how the decomposition rate of brine fly larvae, the only macroinvertebrate present in the benthos, is affected by temperature and salinity. In order to determine the rate of decomposition, this study observed the change in mass of brine fly larvae bodies over five weeks under conditions of varying temperatures and salinities. Results of this study indicate that temperature, salinity, and the interactions between them significantly affect larval decomposition rate. Higher temperatures are shown to increase the rate of decomposition, while higher salinities have the opposite effect. This study suggests that these factors contribute to the rate of decomposition and, therefore, the rate of reintroduction of nitrogen to the ecosystem. Given the fluctuations in temperature and salinity of the Great Salt Lake, these findings, in combination with both previous and future experiments, will help determine the amount of nitrogen available under various lake conditions.

Brine fly larval feeding: Biofilm and Detritus

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Brine fly larvae (*Ephydra)* are a critical food source for many of the Great Salt Lake's (GSL) abundant waterbirds. While previous studies have examined brine fly larval feeding on microbialite biofilm, they also may feed on detritus, especially brine shrimp fecal pellets, which has not yet been investigated. Larval survival and pupation were examined for feeding on either biofilm or detritus at abundances typical for GSL. Larval survival did not differ between feeding on biofilm versus detritus; however, the larvae pupate faster on biofilm. This is due to the higher nutritional quality of biofilm, so larvae can maintain themselves on either food, but detritus provides less of the nutrition necessary to develop to the next life stage. To assess how much biofilm and detritus is consumed by larvae in the lake, DNA-based diet analysis using qPCR was conducted. This indicated that GSL brine fly larvae's diet is roughly 25% detritus. Therefore, brine fly larvae are not only an important food source for the lake's waterbirds but may be an important component of nutrient cycling by consuming detritus.

The Role of DKK3 in the Secretome of Cancer-Associated Fibroblasts of Ovarian Cancer

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Background: Ovarian cancer (OC) is the most lethal gynecologic cancer and the fifth leading cause of cancer deaths in women worldwide. A major contributor to ovarian cancer metastasis and therapy resistance is the cancer secretome, which plays an important role in immune response and facilitates cell-cell communication. Past studies have shown that
cancer-associated fibroblasts (CAFs) regulate tumor through the secretion of cytokines, recruitment of tumor cells, and activation of inflammation pathways. However, interactions between the CAF secretome, TME, and immune activation are poorly understood. In this study, we aim to determine how DKK3 in the CAF secretome impacts immune cell infiltration and survival in patients with ovarian cancer.

Methods: Dickkopf-related protein 3 (DKK3) was identified as a differentially expressed gene in CAFs compared with normal fibroblasts. Kaplan-Meier curves were generated to understand the relationship between DKK3 expression and survival in patients with OC. We then performed an in vitro co-culture assay of T-cells and murine CAF cells to evaluate an immune profiling panel and T-cell killing panel via flow cytometry. The Proteome Profiler Mouse Cytokine Array (BioTechne) was used to determine effect of DKK3 expression on cytokine levels. Finally, we used the Qiagen Ingenuity Pathway Analysis (IPA) software to determine interaction pathways between DKK3 and the tumor microenvironment.

Results: Our survival curve analysis demonstrated that increased DKK3 levels in the CAF secretome are correlated with worse survival outcomes in patients with OC ($p < 0.005$).
Immunoprofiling revealed DKK3 was also associated with greater levels of T-cell exhaustion marker TIM3. The inhibition of DKK3 in mCAF cells also led to greater cytokine levels of CXC12, CXCL2, CXCL10, TIMP-1 and CCL5 ($p < 0.05$), and further IPA analysis revealed that DKK3, CXC12 and CCL5 are regulated by shared TP53 and TWIST1 transcription factors.

Conclusion: DKK3-inhibited cells displayed a significant increase in various cytokines levels that are present in ovarian CAFs, which suggests that DKK3 contributes to the immune-suppressive nature of the tumor microenvironment. Furthermore, pathway analysis shows that DKK3 interacts with CCL5 and CXCL12 to impact shared downstream effects on the cellular and molecular levels. Taken together, we show that DKK3 is a potential target for future drug development efforts that aim to treat ovarian cancer. Future efforts should aim to increase technical and biological replicates in the immune profiling and T-cell killing assay.

The Last of Fung(Us): Evaluating the Antifungal Activity And Superlative Mechanism of Action of a Synthetic Enterocin Peptide Library

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The antimicrobial peptide (AMP) circularized bacteriocin enterocin AS-48 produced by *Enterococcus* sp. exhibits broad-spectrum antibacterial activity via dimer insertion into the plasma membrane that forms pore structures. A specific alpha-helical region of enterocin AS-48 is responsible for the membrane-penetrating activity of the peptide. The canon syn-enterocin peptide library, generated using rational design techniques to have ninety-five synthetic peptide variants from the truncated, linearized enterocin AS-48, was screened against three clinically relevant fungal strains: *Cryptococcus neoformans, Candida albicans,* and *Candida auris*. In screening, twelve peptides exhibited activity against *C. neoformans*, and two peptides exhibited activity against *C. albicans*. None of these fourteen peptides showed cytotoxicity to an immortalized human keratinocyte cell line (HaCats). Four peptides were identified with minimum inhibitory concentrations (MICs) below 8 μM against *C. neoformans*. In 36-hour cell growth tests with these fungicidal peptides, fungicidal peptide 32 exhibited *C. neoformans* cell counts slightly below those of the leading antifungal medication fluconazole. Screening of peptide 32 against a whole deletion library of *C. neoformans* mutants suggests that peptide 32's mechanism of action may relate to multivesicular bodies or polysaccharide capsule formation.

These findings importantly demonstrate that naturally derived AMPs produced by bacteria can be engineered and modified to exhibit potent antifungal activity. Our results will contribute to the development of new treatment alternatives to fungal infections and lend themselves to direct implications for possible treatment options for *C. neoformans* infections.

New red-shifted pH biosensors for measuring intracellular pH

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One of the newest emerging hallmarks of cancer is the alkalization of intracellular pH (pHi). As such, finding tools for studying these pH dynamics in cancer is relevant and essential. Ratiometric pH-sensitive protein biosensors have been previously developed to monitor pHi; however, issues related to deep-tissue imaging, cellular autofluorescence, and selective linear-dynamic range are still desired. This research seeks to create a novel far-red shifted ratiometric pH-sensitive protein biosensor, miRFP670-pHuji, for deep-tissue imaging sensitive to pH 8.5 in cancer research. The miRFP670-pHuji tandem hybrid biosensor was constructed in *E. coli*. Following the successful culture, N1 miRFP670-pHuji was transfected transiently in H1299 cancer cells and imaged on a Nikon CSU-X1 Spinning Disk System Laser Microscope. Afterward, long-term stability and imaging efficacy in stable cell lines and 3D spheroid models were used to study efficacy in deep tissue. The imaging results of this research indicate that miRFP670-pHuji displays ratiometric pHi-sensitivity up from pH 6.5 to 8.5. Furthermore, miRFP670-pHuji displays fluorescence in stably transfected 2D and 3D imaging, allowing long-term deep-tissue imaging. Compared to previously developed biosensors such as mCherry-pHluorin, miRFP670-pHuji displays further red-shifted fluorescence while sensitive to a higher pHi range, allowing for more thorough deep-tissue cancer imaging. The development of this novel biosensor provides a more sensitive and stable mechanism for monitoring cell dynamics, which has implications for studying various physiological and pathological cellular processes, especially cancer.

Leaf Litter Inputs and Their Biofilms Influence Size-Specific eDNA Removal Rates in Streams

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Seasonal dynamics in streams, such as allochthonous organic matter inputs during autumn leaf fall, result in physical and biological changes that may influence eDNA removal from the water column. We explored the impact of the experimental addition of leaf litter using short-term releases of Common Carp (*Cyprinus carpio*) and Steelhead Trout (*Oncorhynchus mykiss*) eDNA using recirculating mesocosms and outdoor experimental streams to quantify eDNA removal rates. We conducted replicate releases over time and quantified eDNA removal for different particle sizes using sequential filtration. For both mesocosms and streams, Carp and Steelhead eDNA were removed at similar rates (TukeyHSD, ANOVA; $p>0.05$). Using experimental streams, larger (>1.2µm) eDNA particles were removed 10x faster than smaller (0.4µm; ANOVA; $p<0.001$), which often persisted over the 50m experimental reaches. For larger particles, we observed faster eDNA removal in streams with added leaves on Day 4 (Two-way ANOVA; $p=0.048$), but not on Day 16, perhaps due to colder temperatures. In mesocosms, 0.4µm particles were removed from the water column 21% faster than larger particles (>1.2 µm; TukeyHSD; $p<0.001$), and this effect was more pronounced in treatments when leaves had biofilms. In the experimental streams, physical removal via benthic substrate preferentially trapped larger eDNA particles, whereas in mesocosms, which lacked benthic substrate, longer water column residence times achieved via recirculation increased the relative contribution of leaf biofilms to eDNA removal. These contrasting results demonstrate that environmental context (substrate composition, temperature, and microbial activity) can mediate the effect of leaf litter on size-specific eDNA removal in streams.

Characterizing North American Ultra-Extreme Hydrometeorological Events

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Human-caused climate change has brought increasingly frequent and highly-damaging extreme storms. Since 1980, storms which have individually caused over 1 billion dollars in damage have collectively caused over two trillion dollars worth of damage in America, and have taken over 5 thousand American lives. This trend in "ultra extreme" storms has already reached crisis levels for many affected areas, and impacts are projected to increase in the coming decades. The issue with preparing for these events is that they are rare enough that most places do not have a historical record to inform future decisions or provide design standards for infrastructure. In this project I have created a methodology for characterizing and quantifying ultra-extreme weather events for locations across the Midwest, including those which have not yet experienced such an event. The primary approach in the study is based on applying binomial statistics to estimate the probability of exceedance of a given ultra-extreme event occurring in a given year by counting standardized peak precipitation events across the Midwest that exceed X standard deviations from the mean. For each exceedance threshold, the number of events above threshold, divided by the total sample size (years x stations), is the observed probability of exceedance for that threshold. Probability of exceedance values estimated in this way are significantly greater than expected for the normal distribution. Four-sigma events, for example, have an observed probability of exceedance of over 0.03 from 2010-19, whereas for the normal distribution probability of exceedance for a four-sigma event is 0.00003. Counts above threshold (and probability of exceedance) are also shown to increase through time, confirming that ultra extremes are occurring more frequently in response to a changing climate.

Exploring the Effects of Plasma Radiation on Solution pH for Potential Medical Applications

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Despite cancer being the second leading cause of mortality worldwide, current treatments still have limitations, such as drug resistance, cytotoxicity to healthy tissues, and high recurrence rates. Plasma medicine, specifically low-temperature plasma (LTP), has provided effective cancer therapies in recent years, with potent effects on cancer cells and minimal side effects on healthy tissues. This study investigates how LTP irradiation affects pH in solutions, which is relevant to understanding cancer cell behavior, growth, and spread. Further experiments with glycine are conducted to assess how the process is altered in the presence of a biomolecule, given its relevance to cancer pathways and cell metabolism. Our findings indicate that a combination of high voltage, high frequency, and long irradiation times leads to greater acidification of pure water solutions. Additionally, when each irradiation time is analyzed separately, an increase in voltage seems to play a more significant role in lowering the pH of water solutions. Experiments with glycine showed that higher amino acid concentrations enhance pH stability, while lower concentrations cause similar pH variations as observed in pure solutions. These results offer insights into body pH stability during LTP treatments, which can inform effective cancer therapies targeting cancer cells without affecting healthy tissues.

Beyond the Word of Life: Exploring Advocacy and Inspiration Through Public Art

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Hesburgh Library, a cornerstone of the University of Notre Dame, stands as a testament to knowledge and enlightenment. Yet, most of its facade has remained blank for decades, presenting a unique opportunity for artistic expression and social messaging. Inspired by the iconic Word of Life mural gracing one side of the library, this project proposed the creation of three new artworks to adorn the remaining empty walls, transforming them into vibrant canvases of inspiration and reflection. Drawing upon the rich tradition of public art, particularly social justice murals, this effort sought to marry aesthetics with advocacy, amplifying Notre Dame's commitment to Catholic social teaching and global responsibility. By synthesizing my academic disciplines of architecture, sustainability, and poverty studies, the project aimed to spark dialogue on issues ranging from environmental stewardship to human dignity. Just as historical murals have conveyed powerful messages of resistance and hope, these new artworks endeavored to engage viewers in critical conversations about the university's identity and aspirations. Through themes of earth stewardship, social justice, and Catholic values, the murals may serve as beacons of inspiration, fostering a culture of reflection, empathy, and action within the Notre Dame community and beyond.

The Power of Poetry: How literature can aid in the fight against the Dakota Access Pipeline

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Exploring the connection between poetry and environmental violence, defined by Drew Marcantonio as direct and indirect harm experienced by humans due to human-produced toxic and nontoxic pollutants that are emitted into the Earth's system[1], can help show how literature can be a driving force for global change. Nature has been written about, especially in poetry, for centuries, but only in recent decades has the term "ecopoetry" been used, describing poetry written about the relationship between humans and their duty to the environment[2]. Ecopoetry has the power to expose environmental injustices and engage readers in debates about environmental issues, furthering attention and care to witnessing environmental violence in order to actively combat it. This paper will explore how works of literature of various genres have created societal and political changes in the past and how poetry focused on environmental violence can add to the holistic approach that is necessary to fight global ecological issues. In particular, this paper will focus on the Dakota Access Pipeline as an example of environmental violence within the United States which is a prime example of how communities, especially those living in poverty, have been – and will continue to be – disproportionately affected by climate change and other ecological issues. Though the primary group of people affected by the Dakota Access Pipeline are Native Americans living on the Standing Rock Sioux Reservation, the nature of this issue as a live site of debate and protest gives it a special capacity to rouse activist commitment for this instance of environmental violence and others. I will create my own collection of poetry about environmental violence and the Dakota Access Pipeline based on the research outlined in this paper and my own experience as a resident of South Dakota who has seen the effects of the proposed pipeline.

Endnotes

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From Iran to South Bend: The Application of Windcatchers in ASHRAE Zone 5

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With increased awareness of warming global temperatures, individuals have recently turned an introspective eye to their energy usage at home. Natural ventilation (NV) has proven to be a reliable source of passive cooling of homes in the past. Natural Ventilation allows for the cooling of interior spaces without the use of mechanical solutions, so there is much hope for NV to be a commonplace item in a post-carbon future. One particular method of NV, the *bagdir*, or windcatcher, has been utilized in Western Asia for thousands of years. These windcatchers are believed to have been developed in Iran, which boasts a particularly hot and arid climate. However, in order for windcatchers to be utilized by a broader audience than just those in a hot, arid climate, it is vital to understand its applicability in other climatic zones. As defined by ASHRAE Iran's climate is largely contained within climatic zones 2B, 3B, and 4B, making the southern edge of Arizona Iran's most accurate American comparison. The careful analysis of computational fluid dynamics modeling software as well as physical models determined the efficacy of utilizing windcatchers in residences located in ASHRAE Zone 5. The inclusion of 4 interior fins in a 1:2 rectangle shaped windcatcher was able to effectively cool and warm a home in ASHRAE Zone 5, as well as provide sufficient natural ventilation. Two story homes in this zone must further study effective layouts of the windcatcher in order to maximize efficiency. A newly proposed windcatcher that extends through the second floor and into the ground floor allows for greater ventilation and circulation than the tested control model. It was determined that through the application of tested design features, a windcatcher can be an effective tool to cool and warm houses in ASHRAE Zone 5.

Dynamics and Fragmentation Channels Induced Through Dissociative Electron Attachment to Anisole

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Dissociative electron attachment (DEA) is a resonant process by which a molecule captures an incident low-energy electron, causing an excitation into a temporary negative state, and fragments into neutral and anionic moieties. As low-energy electron sources pervade astronomy, medicine, and industry – ionizing stellar rays, modalities of radiation cancer treatment, and devices used in the synthesis of plastic materials – DEA studies probe dissociation dynamics with tremendous applicability and occurrence. In this study, we utilized an experimental apparatus equipped with an ultra-high vacuum pump, an electron gun, and a quadrupole mass spectrometer to study DEA to a gas-phase anisole, a monosubstituted benzene derivative. As a molecule representative of simple aromatic systems, anisole is chemically similar to purines; thus, the DEA of anisole is pertinent to the fragmentation of important biomolecules. Here, we measured ion yields that reflect the production of three anionic species – CH_3^-, OCH_3^-, and HC_2^- – at specific incident electron energies. The appearance of the HC_2^- fragment implies the cleavage of bonds located within the aromatic ring that can be a crucial fragmentation pattern for molecular damage. Moreover, we present energetically plausible dissociation channels for each observed anionic fragment: our calculations were obtained via density functional theory (DFT) performed with GAUSSIAN 06 software. In addition to clarifying the electronically excited states involved in the DEA of anisole, this data proposes the mechanistic dissociation of aromatic rings present within industrial and physiological systems.

Changing Views: Limited Color Vision Variability in Bluegill Sunfish Despite Contrasting Light Habitats

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Anthropogenic influences have profound effects in surrounding water systems, posing significant challenges to aquatic ecosystems. Among these challenges, changes in water clarity can become a critical threat to biodiversity, endangering native fauna. Understanding the impacts of water quality degradation on native species is paramount for safeguarding aquatic ecosystems and managing freshwater fish species of recreational and economic significance. Visual systems are essential traits that help fish navigate their environment and might be especially jeopardized by decreasing visibility. In this study, we combine field measurements from 10 lakes and gene expression data using both RT-qPCR and RNA-Seq from over 60 bluegill sunfish (*L. macrochirus*) to investigate their variation in opsin gene expression across a diverse range of underwater photic environments. While previous literature on different taxa showed considerable phenotypic variation in opsin gene expression along environmental gradients, our findings revealed limited variation despite significant environmental differences. This challenges existing paradigms in visual ecology and suggests that other traits might enable native sunfishes to cope with environmental changes. Alternatively, our results suggest that the visual systems of centrarchid fishes may be constrained, with limited capacity for adaptive tuning in response to changes in underwater light conditions.

Pulsed Measurement of Fowler Nordheim Tunneling Current in Metal-Insulator-Metal Structures

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Metal-insulator-metal (MIM) structures have the potential to aid the development of low barrier ferroelectric diodes for analog memory. In this study, two MIM structures with hafnium(IV) oxide and zirconium oxide layers are observed. Due to the low breakdown voltages of these oxides, a pulsing protocol must be implemented to these structures to reach high enough voltages that Fowler-Nordheim tunneling can be studied. In preparation for these measurements, the IV characteristics of these MIM structures were compared to metal-insulator-semiconductor (MIS) structures that acted as a control. Capacitance-voltage sweeps were used to confirm the expected oxide thicknesses of all five samples. Parameters pertinent to Fowler-Nordheim tunneling theory such as barrier height, effective mass, and oxide thickness were also considered. Finally, the pulsing protocol was carried out on the hafnium(IV) oxide sample to analyze the tunneling. When compared to the theoretical expectation of the device, the hafnium(IV) oxide sample appeared to not show evidence of Fowler-Nordheim tunneling even as the higher voltages where it would be expected was observed through the pulsing protocol. Measurements comparing the high resolution IV data with the pulsed protocol were made difficult by the presence of a noise floor of the pulsed measurement system in the region of a few tens of microamps.

Expression and Regulation of Human Endogenous Retrovirus K (HERV-K) in Ovarian Cancer

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Human endogenous retrovirus-K (HERV-K) belongs to the family of ancient endogenous retroviruses, which account for about 8% of the human genome. Although typically silenced in healthy cells, reactivation of HERV-K elements has been observed in many cancers. Elevated HERV-K Envelope (Env) protein expression has been shown in breast cancer and is thought to contribute to oncogenesis and metastasis, although its mechanism is poorly understood. Ovarian cancer presents a clinical challenge, lacking reliable biomarkers and symptoms in early stages. Considering the diagnostic potential of HERV-K apparent from its study in breast and prostate cancer, it warrants further study in ovarian cancer. This project aimed to evaluate the expression of HERV-K in ovarian cancer, and the impact of HERV-K expression on ovarian cancer cell proliferation and migration. Our results showed HERV-K Env is expressed in multiple ovarian cancer cell lines including CAOV3, OVCAR5, and OVCAR8 cells. Nitric oxide (NO) is implicated in several biological processes, including cancer progression. At low concentrations, it promotes cell survival and tumor progression; at high concentrations, it causes apoptosis and cell death. Associations have been observed between HERV-K and inducible nitric oxide synthase (iNOS) in breast and prostate cancer, suggesting a link between iNOS and HERV-K expression. To recapitulate the effect of NO release by iNOS, we treated cells with DETA NONOate (DETA/NO), an NO donor that mimics intracellular iNOS activity. Our results showed a role for iNOS in the induction of HERV-K Env expression in ovarian cancer cells. Effects of DETA/NO on cell proliferation and migration were also investigated. DETA/NO treatment induced a dose- and time-dependent reduction in cell viability. Collectively, our findings of elevated HERV-K Env expression in ovarian cancer support its potential utility as a clinical biomarker of ovarian malignancy and, along with NO, a potential target for treating ovarian cancer.

Scat as an Indicator of PFAS Uptake by Common Terrestrial Mammals

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Per- and Polyfluoroalkyl substances (PFAS) are man-made compounds with highly fluorinated carbon chains. These substances have been manufactured since the 1950s for many industrial and commercial applications, but their release and high persistence in the environment has led to health issues in wildlife due to their potential for bioaccumulation, especially with increasing trophic level. This biomagnification potential of PFAS has already been observed in aquatic environments, but limited research exists for terrestrial mammals due to the challenges of live mammal sampling. To overcome this limitation, we hypothesized that the feces (i.e., scat) of mammals may be a useful monitoring tool for PFAS ingested and egested by common terrestrial mammals often found associated with humans. We investigated the PFAS load in the scats of three species of mammals (i.e., coyote, raccoon, and deer) representative of different diet types and trophic levels (i.e., carnivore, omnivore, and herbivore, respectively) and two different geographic settings in Ohio (i.e., island habitat in Lake Erie, and mainland rural setting). We analyzed the PFAS compounds and concentrations in a total of 26 scat samples using

LC/MS-MS to determine if scat could be a non-invasive way to monitor PFAS load. We also conducted stable C and N isotope analysis to determine putative tropic levels for each species. Stable isotope analysis confirmed hypothesized trophic levels but also revealed dietary variation between the two study locations. PFAS analysis is ongoing to assess 21 different analytes in the scat samples for comparison with previous studies of mammal tissues. If indicative of body burden, scat could be used to suggest exposure levels to PFAS compounds and provide a non-invasive method for PFAS monitoring in the environment.

Developing 3D tumor models for prostate cancer cell lines to facilitate disease characterization and enhance sustainability in the laboratory

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Three-dimensional culture of cancer cells is gaining popularity in laboratories due to the ability to better mimic in vivo tumor conditions by recapitulating the extracellular matrix (ECM). While animal-derived matrices like Matrigel are currently the standard practice for 3D culture, plant-based alternatives like GrowDex are emerging that have been shown to promote similar spheroid morphology and proliferation to Matrigel in some cancer cell lines. Few studies exist examining the feasibility of culturing prostate cancer cell lines in GrowDex, or the effects of 3D culture on expression of prostate cancer genetic markers. Four prostate cancer cell lines (LNCaP, LASCPC-01, PC-3, and KUCaP13) were cultured in GrowDex and two animal-derived matrices (Matrigel and GelTrex) to perform a comparative analysis of the cell viability, morphology, and gene expression in each. GrowDex was found to promote equally high cell viabilities to Matrigel and GelTrex, and similar levels of spheroid formation in the LNCaP, KUCaP13, and PC-3 cell lines. RNA expression levels of various prostate cancer markers were also compared between 3D and 2D culture, and the significant variability between each scaffold type suggested the need for followup studies determining which method most accurately represents in vivo tumor conditions. However, across all scaffolds and in 3 out of the 4 cell lines tested, a general trend of upregulation of neuroendocrine prostate cancer (NEPC) markers was observed relative to 2D culture, suggesting the possibility of 3D culture facilitating a neuroendocrine transition for these cell lines. Taken together, these results suggest that GrowDex is a feasible alternative to animal-derived matrices for a number of prostate cancer cell lines, and that comparing the effects of 3D culture on the expression of prostate cancer markers is relevant to disease characterization and development of accurate 3D tumor models.

The Relationship Between Stress, Allostatic Load, APOE, and Cortical Thinning

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Although short-term stress is beneficial for increasing focus and performance, prolonged stress is associated with negative outcomes on brain function. Research suggests that stress can diminish the thickness of the cerebral cortex, a region essential for higher-level processing, which may cause adverse functioning. Several factors may influence this relationship such as allostatic load, a measure of the cumulative burden of stress, and the apolipoprotein E (*APOE*) gene, which has been implicated in cognitive decline and Alzheimer's disease. However, longitudinal studies are needed to understand the long-term cumulative effects of subjective stress, allostatic load, and *APOE* status on cortical thinning in late adulthood. The goal of this study is to examine how allostatic load mediates, and *APOE* moderates, the relationship between stress and cortical thinning. Participants were selected from the Notre Dame Study of Health and Wellbeing, which began in 2005 and includes 775 older adults (58% female, 84% Caucasian) between the ages of 57 to 84, recruited from the five counties surrounding the University of Notre Dame and participated in eleven waves of yearly data. Stress was measured using the Perceived Stress Scale, allostatic load and *APOE* status were calculated from blood samples, and cortical thinning was assessed using MRI scans. Data will be analyzed according to a moderated mediation model and will be finished by the end of February. We expect that (1) increased subjective stress will be associated with increased cortical thinning; (2) allostatic load will mediate the effect of perceived stress on cortical thinning; and (3) *APOE* status will moderate the mediating influence of allostatic load on stress and cortical thinning to a greater extent in *APOE4*-positive and a lesser extent in *APOE4*-negative individuals. This work may inform targeted interventions to preserve brain health in late adulthood by addressing chronic stress as a significant risk factor.

Transcriptional Control of Astrocyte Proliferation by BATF2

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Astrocytomas are the most common type of brain tumor, with nearly 15,000 new cases diagnosed in the United States each year. 60% of patients diagnosed with an astrocytoma will present as a grade 4 classification, commonly referred to as glioblastoma, which is the most malignant and aggressive form. Glioblastomas are identified based on a variety of characteristics that differentiate them from lower-grade tumors. One such factor is the excessive proliferative nature of the cells. A common contribution to excessive proliferation in tumors such as glioblastomas, is dysregulation of the cell cycle. Timely activation and suppression of specific genes at each stage fo the cell cycle by transcription factors is crucial for maintaining normal cell development. Basic Leucine Zipper ATF-Like Transcription Factor 2 (BATF2) has been previously shown to regulate cell cycle progression in gastric cancer by means of arresting tumor cells in the G1/S phase transition. Moreover, BATF2 expression is known to be downregulated in a variety of different cancers, including glioblastoma multiforme, thus making it a primary candidate for investigation. Using chromatin immunoprecipitation (ChIP) sequencing of BATF2 in primary human astrocytes, we demonstrate that BATF2 binds to genes associated with the cell cycle, and gene ontology analysis shows that these genes are involved in regulating the G2/M phase transition as well as G1/S checkpoint signaling. We also confirm that BATF2 is normally expressed in mitotic cells and that this expression is correlated with levels of phospho-histone H3 (pH3), a marker of condensed chromatin in mitosis. Further, we demonstrate that U87-MG glioblastoma cells have diminished BATF2 expression levels compared to primary human astrocytes. Taken together, our data suggest that BATF2 may play a critical role in the cell cycle regulation of glioblastoma cells and aid in preventing tumor progression.

Simulations and Transport Tests of Ions through the St. Benedict RF Carpet and Ion Guide

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This thesis presents a study on the optimization and performance evaluation of ion transport through the St. Benedict RF (Radio Frequency) Carpet and Ion Guide. The St. Benedict experiment is designed to probe the Standard Model, specifically through precision measurements of the $\beta - \nu$ correlation in nuclear decays. Utilizing the SIMION software to create ion optical simulations, this work investigates the dynamics of ion transport under various conditions, aiming to enhance the efficiency and reliability of the St. Benedict's extraction system. The study first focuses on optimizing the RF Carpet's parameters, including RF amplitude, LF (Low Frequency) amplitude, and the potential applied to various electrodes, to maximize the ion transport efficiency while minimizing beam radius, emittance, and transport time. Findings from these simulations reveal the critical role of RF amplitude in achieving high transport efficiency and beam quality, establishing optimal operational ranges for various parameters. Further exploration is conducted on the RFQ Ion Guide, analyzing its performance through systematic RF amplitude and frequency adjustments and identifying their optimal settings.

Investigating Multidrug Antimalarial Resistance in Bangladesh

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Malaria continues to be a significant global health issue in the world, especially in Bangladesh, and the emergence and spread of drug resistance threatens malaria control in this country. This study was the first record of in vitro IC50 assays on particular Bangladesh isolates, and the overall aim was to analyze antimalarial resistance in Bangladesh and understand the molecular markers and basis in Plasmodium falciparum. We investigated the in vitro susceptibility of 15 *P. falciparum* isolates, culture adapted from uncomplicated patients to 5 antimalarial drugs. These isolates were fairly susceptible to piperaquine (29.08±-3.4nM; mean+/-SEM), lumefantrine (4.47±1.12nM), mefloquine (29.8±3.4nM), and greatly resistant to cycloguanil (pyrimethamine) (1450±337nM) and chloroquine (245.3±37nM). Looking at the molecular markers of resistance to these 4-aminoquinolines, antifolates, and aryl amino-alcohol partner drugs, there are highly frequent mutations in the *pfcrt* and *pfmdr1* genes that confer decreased susceptibility to antifolates and chloroquine, as well as mutations in the *pfdhps/pfdhfr* gene for sulfadoxine-pyrimethamine. Therefore, there is prevailing evidence of chloroquine and sulfadoxine-pyrimethamine resistance in Bangladesh, as well as moderate sensitivity to lumefantrine and mefloquine, but still a high susceptibility to piperaquine. Overall, our results show that there is a high prevalence of antimalarial drug resistance to antimalarials historically used in Bangladesh. Routine surveillance is needed in order to combat the threat of multidrug resistance and the growth of malaria infection in the country.

As Life Expectancy Increases in People Living with HIV, Prior Nutrition Recommendations May Increase the Risk of the Development of Secondary Chronic Conditions

Josie Gery

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Improvements in HIV treatment have led to a greater than 30-year increase in life-expectancy for people living with HIV (PLWH) in the U.S. over the past 40 years. However, increased life expectancy also increases the risk of nutritionally associated secondary chronic conditions such as heart disease, diabetes, and cancer. Prior recommendations for PLWH included increased caloric consumption to avoid wasting, but further research is needed to determine if updated recommendations could decrease the risk of secondary chronic conditions. Therefore, the objective of this study was to determine if PLWH in the U.S. consume more total energy and other nutrients associated with poor health outcomes compared to those without HIV. Data used in this study was from the National Health and Nutrition Examination Survey (NHANES) from 1999-2017. Differences based on HIV status were examined for demographic and anthropometric variables. Dichotomous nutrient variables were calculated based on the specific recommended daily amounts (RDA). Simple and adjusted logistic regressions were used to determine the association between HIV status and meeting or exceeding the RDAs. Variables included in the final adjusted logistic regression were age, race, gender, BMI, monocyte %, red blood cell count, hemoglobin, and globulin. Results demonstrate that PLWH have a higher overall caloric intake, and an increased intake of nutrients associated with the development of secondary chronic conditions. PLWH were more likely to exceed the RDA of many nutrients, including sugar, saturated fat, and sodium. In conclusion, as treatments continue to prolong life for PLWH, previous recommendations of increased caloric consumption may no longer be viable. Further study is needed to determine an appropriate nutritional balance for PLWH to both maintain a healthy weight and avoid the increased risk of nutritionally related chronic conditions.

Tiny Greens, Big Lessons: Testing the Efficacy of Online Learning Designed for Children

Claire Hackl, Maeve Sandeen

University of Notre Dame, Sustainability Capstone

Our capstone tested the efficacy of direct online teaching in educating kids about sustainability. We created an online learning resource, to be used outside of the classroom, as a supplement to existing school curriculum for children ages 5-6. The online resource was designed to educate children about microgreens and serve as a pilot study for future development of online sustainability resources targeting children. Our module contains a series of ten short videos and associated quizzes. The quizzes aim to assess the children's understanding of the video content on microgreens and identify if they remember key concepts in the short-term. To supplement the quizzes in determining the efficacy of the online learning resource, a verbal questionnaire was administered to a small group of students in order to determine their engagement with content. Findings have implications for further content creation aiming to educate children on sustainability concepts. If it is effective to teach sustainability concepts online, directly to children, children will have the opportunity to learn through our online resource.

The Sneaker's Footprint: Designing a database that empowers retailers and consumers to understand the environmental impact of sneakers

Meredith A. Heller

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As the climate crisis intensifies, one of the world's biggest challenges is to reinvent the processes which inherently drive environmental degradation. The sneaker industry is one major contributor, producing mass greenhouse gas emissions, using large amounts of water, and creating copious water pollution through its most prevalent practices. In order to shift the industry toward more eco-conscious systems, retailers and shoppers need an accessible mechanism which enables them to understand the environmental impact of any sneaker model.

This project made a significant step in this mission by producing an adoptable database schema for environmental sneaker evaluation. By exploring the common and emerging production practices in the sneaker industry, I determined which metrics and production points factor into a sneaker's environmental impact, emphasizing greenhouse gas emissions, water use, and water pollution. I then researched and communicated with both producers and consumers to understand the variability in information access regarding a sneaker's environmental footprint. To meet these industry dynamics, I designed a score-based database system for comparison, able to guide production and consumption decisions by emphasizing what is known for any given product and producing a score for which it can be compared to other models.

The current environmental crisis requires compassion and innovative thinking to upend and reform the systems creating it. This project is a reflection of that notion, acknowledging the way in which our basic needs, including sneakers, impact the earth, and empowering those on both sides of the industry to influence it for the better.

Effects of an Invasive Plant (*Elodea canadensis*) on Sockeye Salmon and Ecosystem Structure in an Alaska Lake

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The establishment of non-native species in pristine environments can induce ecological changes that negatively impact ecosystem structure and function. Canadian waterweed *Elodea canadensis* is a freshwater submerged macrophyte that was introduced to Alaska in 1982. *Elodea* has been shown to reduce the growth and trophic position of juvenile coho salmon (*Oncorhynchus kisutch*) but effects on more pelagic-feeding sockeye salmon (*O. nerka*) are unknown. In summer 2021 and 2022, we investigated the potential effects of *Elodea* on juvenile sockeye salmon by utilizing full water-column permeable mesocosms (or limnocorrals) in a freshwater lake known to support a sockeye salmon fishery. Across three replicates in different areas of the lake, one limnocorral was placed over a bed of native vegetation and one over a bed of *Elodea*. We stocked limnocorrals with juvenile sockeye salmon (n = 33-40 depending on year) and collected water chemistry samples (e.g., water-column nutrients, dissolved organic carbon, chlorophyll-*a*, and dissolved oxygen) biweekly. After 6 weeks, community members (e.g., fish, invertebrates, zooplankton, and macrophytes) were harvested from the limnocorral. To infer resource use pathways between treatments, we analyzed carbon and nitrogen stable isotopes of community members. *Elodea* did not induce detectable changes to water chemistry, likely because of sparse populations and the permeable nature of the limnocorrals. However, we observed a shift in the carbon isotope ratios of sockeye salmon towards *Elodea* isotope signatures in the *Elodea*- containing limnocorrals. These findings indicate that water chemistry may not be a mechanism by which *Elodea* induces ecological change in this Alaskan lake, and that *Elodea* is partially incorporated into sockeye salmon food chains.

A longitudinal study of paternal influences and maternal mediation in adolescents' alcohol use amid socio-political violence

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Areas of high socio-political violence are positively correlated with continuous traumatic stress, which is indirectly related to increased alcohol use in these areas (Horenczyk & Schiff, 2019). Additionally, parental alcohol use and permissiveness to alcohol use are both strong predictors of adolescent alcohol use (Brody et al., 2000). This relationship is a problem, as early alcohol use in adolescence can lead to higher levels of alcohol dependence, mental health problems, and social harm (Marshall, 2014). It is also one of the largest risk factors for disease and contributes to many deaths, with 9% of 15-29 year old deaths being related to alcohol (Marshall, 2014). Maternal behavior has not been linked as a mediator to buffer a child's alcohol use from paternal alcohol use in environments without socio-political violence (Curran & Chassin, 1996). Given these findings, it is of critical importance to understand how paternal alcohol use affects early adolescent alcohol use and whether the maternal relationship with children is an effective mediator in environments with socio-political violence present.

This study utilizes mother and adolescent survey data over three consecutive years from a seven-year longitudinal study conducted in Northern Ireland. It focuses on mother-child dyads (n=196) with adolescents between the ages of 14 and 21. Adolescents reported on their alcohol usage and their relationship with their mothers, while mothers reported on paternal alcohol experiences. Simple linear regression is used to analyze the relationship between paternal alcohol use and child alcohol use. Moderation and mediation analyses are used to evaluate the mediating relationship between mothers' relationships with their children and whether gender is a moderator. Since these relationships have not yet been explored in areas of high socio-political violence, this study aims to provide a model for various regions worldwide that also experience sectarian socio-political violence.

Structural Variations in Uranyl Oxalate Compounds Relating to Countercation Radii

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Uranyl Oxalate Hydroxide Hydrate [M(UO2)2(C2O4)2(OH)·2H2O (M=Na, K, Cs, Rb, NH4)], with its rich tapestry of counter cations, serves as a vital platform for delving into the interplay between structural chemistry and its implications in the nuclear field. With a focus on the synthesis methods and structural variations induced by different countercations, these compounds offer insights into how size and chemical composition of the choice of countercation impact the geometry of uranyl compounds.

In this study, we explore the synthesis of uranyl oxalate compounds using hydrothermal methods, varying the ratios of countercation oxalate to uranyl oxalate, investigating how the inclusion of different countercations affect the structure and geometry of the compounds through characterization methods such as Raman spectroscopy and powder X-ray diffraction crystallography. This approach allows for a detailed examination of the counter cations' impact on the structural dynamics of uranyl oxalate complexes.

Our study concludes that the geometry of uranyl oxalate compounds is somewhat dependent on the ionic radii of the chosen countercation: more specifically, the inclusion of larger ionic radii cations, such as Rb and Cs, leads to notable changes in the structure, as contrasted with structures synthesized with countercations like Li or Na with smaller ionic radii.

The findings from this research not only introduce several unreported uranyl oxalate structures, but also deepen our understanding of uranyl oxalate solid-state chemistry.

Helping the Midwest Take Off: Harnessing Indiana's Ethanol Industry for Sustainable Aviation Fuel Transformation

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This research project addresses the societal challenge of sustainable aviation within the context of the industry's reliance on fossil fuels. We evaluated the environmental and economic viability of a business model that connects a local bioethanol producer, the South Bend Ethanol Plant (SBE), with a new commercial ethanol-to-jet (ETJ) process utilizing Honeywell's proprietary technology to supply sustainable aviation fuel (SAF) for local commercial aviation operations. Our research encompassed three key objectives: engaging with South Bend International Airport (SBN) and South Bend Ethanol (SBE) to understand this model's logistics, analyzing the environmental impact of this model, and conducting a financial assessment of the ETJ plant establishment. Our outcomes include a fully developed evaluation of a potential plan for an on-site ETJ facility adjacent to SBE, which could serve as a model for similar ventures in the Midwest.

Rooted in Data: Building an Online Resource for Local Regenerative Agriculture

Megan I. Hughes

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This project encompassed developing and sharing a digital advisory platform to bridge the knowledge gap between ideation and successful implementation of feasible regenerative agriculture practices. By filtering and transforming qualitative and quantitative data from publicly available sources and facilitating access to concise, actionable information, the culminating online platform, called *Good Ground*, evolved into a comprehensive guide and educational tool for farmers to connect and implement sustainable practices suitable to their financial capabilities and production requirements. Engaging with local stakeholders and organizations—the St. Joseph County Regenerative Agriculture Partnership (SCRAP), the St. Joseph County Soil & Water Conservation District (SWCD), Pure Green Farms, Tomato Bliss, and the Sustainable Farm at St. Mary's College—revealed a lack of online participation, impact measurement, and peer-to-peer learning tools in the regenerative agriculture space as clear moments of struggle, especially for smaller growers. Leveraging information and design principles, the *Good Ground* website promotes community engagement in St. Joseph County, Indiana, by establishing a shared understanding of what regenerative agriculture means in theory and practice, facilitating peer-to-peer learning, and encouraging the adoption of farming practices that promote soil health, resource consciousness, biodiversity, and resilience to climate change.

An Integrated Dual Multiplexing Analysis of the Tumor Immune Microenvironment of Rare Ovarian Granulosa Cell Tumors Identified Predictors of Recurrence and Potential Therapeutic Targets

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Ovarian granulosa cell tumors (GCT) are rare tumors, comprising 2-5% of all ovarian cancers. Women are usually diagnosed at an early stage, with a high survival rate, however, recurrence within 5-10 years results in ~80% of women succumbing to the disease. Investigating the immune profile of the tumor microenvironment may aid in elucidating targets to prevent recurrence and thereby improve patient survival. Due to the rarity of GCTs, a dual multiplexing approach, utilizing an immunofluorescence multiplexing assay detecting 16 markers and a Nanostring nCounter assay PanCancer Immune Panel screening for 770 immuno-related cancer genes, was undertaken to maximize the data output of 14 GCT samples (6 primary and 8 recurrent tumors). The goal of this project was to spatially profile immune cell subsets, angiogenic vessels, and markers differentially expressed between primary and recurrent tumors. The Nanostring nCounter assay PanCancer Immune Panel identified differential expression of 66 genes in recurrent tumors compared to primary tumors. Overexpressed genes of interest in recurrent tumors include IDO1, a key regulator of immune tolerance, with a 14-fold increase, SPP1, the gene coding for osteopontin, with a 9-fold increase, and VEGFA, a regulator of angiogenesis, with a 10-fold increase in expression. Osteopontin is associated with tumor associated macrophage (TAM) recruitment and inducing VEGF expression to stimulate angiogenesis. Furthermore, the immunofluorescence multiplexing assay displayed a 2.2-fold increase in the density of TAMs in recurrent tumors compared to primary tumors, corresponding to an increased macrophage score on the mRNA level. Additionally, the proximity of M2-type TAMs to angiogenic vessels was greater in recurrent tumors compared to primary tumors suggesting M2 TAMS play a role in promoting angiogenesis. Taken together, these data support the use of a dual multiplexing approach and suggest that IDO1 and osteopontin may be viable therapeutic targets for future investigation for GCT patients.

A New Algorithm for Characterizing the Identifiability of Robots via Algebraic Geometry

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Methods to gauge the identifiability of robotic models can aid in designing experiments for determining inertial parameters (e.g., link mass and moments of inertia) as needed for feedforward control. However, current techniques for characterizing identifiability are limited to open-chain kinematic trees and fail to generalize to models with closed-chain mechanisms, which are necessary for humanoid robots capable of dynamic and agile movement. Thus, a new approach for gauging identifiability through algebraic geometry techniques is proposed. The proposed algorithm solves for sets of unidentifiable inertial parameters for a given model by characterizing the robot's equations of motion via a linear combination of a certain set of basis polynomials. This set of basis polynomials describes the system's mathematical and physical constraints, forming what is known in algebraic geometry as a radical ideal. This approach was tested on two closed-chain models: the four-bar linkage and a humanoid leg that incorporates differential drive mechanisms for the hip pitch/roll and knee/ankle pitch. The algorithm runs successfully for the four-bar linkage, with results matching those of previous numerically-driven methods, but it encounters scaling issues with the more complex humanoid leg, where the constraint polynomials are correspondingly higher order. Future work will involve redefining the humanoid leg's model to reduce the order of the constraint polynomials.

Investigating the Molecular and Cellular Changes of the Adult Neural Stem Cell Niche Due to Demyelination

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Multiple sclerosis (MS) is a central nervous system autoimmune condition associated with demyelination, which has debilitating implications for cognitive function, emotional regulation, sensation, and motor ability. In MS, the immune system targets myelin, an insulating sheath that surrounds axons and facilitates signal conduction. While there is currently no known cure for MS, various research efforts have identified endogenous neural stem cell-mediated repair mechanisms as promising therapeutic options. Neural stem cells have the ability to self-renew and generate multiple lineages of cells such as neurons, astrocytes, and oligodendrocytes. We hypothesized that the adult neural stem cell niche of the subventricular zone (SVZ) of the lateral ventricles will display a distinct molecular signature and undergo transcriptional changes following demyelination in murine tissue. Single nuclei RNA-sequencing of SVZ tissue was previously completed using wild-type and demyelinated mice following the lysolecithin (LPC) model of focal demyelination to induce an SVZ cellular response. We performed an unbiased, global analysis of these single nuclei datasets after filtering the data. Seurat R toolkit was used for downstream quality control, analysis, and exploration to allow for unsupervised clustering and discovery of cell types and states. Following cell clustering and visualization via UMAP, we identified each cell cluster based on the expression for each population. Differential gene expression analysis revealed minimal changes between the LPC-injured SVZ and the contralateral saline-injected SVZ. Our next step is to repeat the tissue collection, sequencing, and bioinformatic analysis using different time points post-injection to determine when signaling pathways for remyelination peak.

Learning Analytics: Performance Group Analysis and Early Grade Prediction for a Foundational Organic Chemistry Course

Thomas Joyce

Advisor: Dr. Alison Cheng

Supporting and enhancing the student learning experience is a central objective of learning analytics. While current learning analytics approaches can elucidate student performance trends, their implications are limited due to a narrow focus on helping a small number of lower-performing students meet predetermined instructional goals. The purpose of this study was to use performance group analysis and early grade prediction to help instructors better support all students in organic chemistry. After consultation with course instructors, we classified students into Thriving, Succeeding, and Developing performance groups based on their final course grades. We identified significant performance gaps between the groups on specific exam topics and questions to provide instructors with potential learning interventions. We also used statistical and machine learning models to predict students' final grades before the midterm break, enabling instructors to promptly identify and support students who may be at risk of failing the course. By viewing the results of our study on an interactive online dashboard, instructors have adapted their pedagogical strategies to help more students thrive in a traditionally challenging course.

Salud, Stress, and Healthcare Seclusion: A Mixed Methods Study of Psychological Stress of Latina Mothers in South Bend, Indiana

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This mixed-methods study delves into the psychological stress experienced by Latina mothers in South Bend, Indiana, shedding light on the intricate intersection of social determinants of health (SDOH), systemic discrimination, and healthcare disparities. Drawing on a sample of fifteen Latina women (n=15), data were collected through a combination of qualitative surveys and quantitative measures, including Cohen's 10-item Perceived Stress Scale (PSS-10) (Cohen et al., 1983). Results indicate that Latina mothers in South Bend experience heightened levels of perceived stress compared to normative values, with factors such as migration status, socioeconomic status, and access to healthcare playing pivotal roles in shaping their stress experiences. The study reveals a complex interplay of structural inequalities, systemic racism, and socioeconomic barriers that exacerbate psychological distress among Latina mothers. Despite being the largest minority group in the U.S., Latinos/as face significant challenges in accessing affordable and equitable healthcare, with disparities in income, employment opportunities, and insurance coverage contributing to their healthcare seclusion. Furthermore, fears of deportation, systemic xenophobia, and cultural barriers further compound their reluctance to engage with the healthcare system. However, amidst these challenges, Federally Qualified Health Centers (FQHCs) and compassionate healthcare emerge as crucial mechanisms for bridging the gap in healthcare access, providing vital services to marginalized populations and fostering supportive patient-physician relationships. By prioritizing compassionate care and addressing the root causes of healthcare disparities, Latina mothers can be empowered to navigate their healthcare journeys with resilience and agency.

Comparing Peritoneal Immune Cells to Determine the Impact of the Gut Microbiome on Ovarian Cancer

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Ovarian cancer is the deadliest female reproductive cancer, with a prominent risk factor of age, as the median age of diagnosis is 63. This cancer interacts with several organ systems, including the immune system. Our two studies compared the gut microbiome of aged and young mice with ovarian cancer. The first study demonstrated variance in tumor burden among mouse groups, where aged mice housed with other aged mice exhibited a high tumor burden, while the young mice housed with young mice and the two cohoused groups of aged and young mice exhibited a low tumor burden. Upon these results, a second study was conducted by swapping microbiota of young and aged mice to reduce the social effects of cohousing and isolate the impact of the gut microbiome. The second study resulted in a low tumor burden in the aged mice receiving the aged microbiota group, the young mice receiving the young microbiota group, and the young mice receiving the aged microbiota group. However, the tumor burden for the aged mice receiving the young microbiota varied, depending on the mouse. This does not follow the normal pattern where aged mice have a greater tumor burden than young mice. To determine if the immune system had any effect on this deviation from the normal pattern, we have compared the differences in peritoneal immune cells in both studies to determine the effects of the microbiota swap. Immune cell gates were normalized to the young mouse control groups of each study to identify a connection between the immune profiles and tumor burdens. A few notable differences include changes in macrophage and myeloid-derived suppressor cell (MDSC) populations in the second study.

Feeding the Future: Examining ESG-Linked Executive Pay in the Fast-Food Industry

Abby Kinsella (Science-Business)
Advisor: Prof. Sandra Vera-Muñoz (Accountancy)

Abstract

High-quality environmental, social, and governance (ESG) reports are vital for enhancing transparency and trust among stakeholders, businesses, and consumers, offering insights into a company's long-term societal and environmental impacts. This study examines the impact of linking ESG metrics to executive compensation on the completeness, strength, and accuracy of companies' annual ESG reports. The ESG reports from six fast-food companies, three of which incorporate ESG metrics into executive pay, were compared to the Sustainability Accounting Standards Board (SASB) Materiality Map, to evaluate the depth and effectiveness of industryspecific ESG policies. Furthermore, quantitative metrics from the ESG reports are compared with Bloomberg Terminal public data to assess the accuracy of reported metrics, such as greenhouse gas emissions. The findings indicate that while linking ESG metrics to executive pay positively influences the strength of ESG policies within reports, it does not significantly impact the accuracy of reported metrics. This study underscores the value of linking ESG metrics to executive pay as a beneficial, albeit insufficient, practice for ensuring the quality of annual ESG reports.

Watching Hoosier RiverWatch: evaluating the reliability of the data gathered by a citizen science initiative

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Citizen science allows volunteer evaluators to collect data that scientists can then use to study trends over time as part of large-scale research projects. However, there are often concerns about the consistency and quality of the data taken by these citizen scientists. Hoosier RiverWatch (HRW) is a volunteer-based citizen science water quality monitoring program in Indiana that is managed by the Indiana Department of Environmental Management (IDEM). For people to become official Hoosier RiverWatch volunteers, they must attend one basic training workshop where they learn the essentials of biological, chemical, and physical stream monitoring. This citizen science initiative has amassed a large amount of data collected by eager citizens, much of which is contained within the St. Joseph River Basin (SJRB) of Lake Michigan. The SJRB contains a large proportion of HRW data entries, and it is the third-largest basin of Lake Michigan; this and access to the basin were motivating factors for focusing on the SJRB. However, the data collected from various waterways within the SJRB following Hoosier RiverWatch methods has never been evaluated for its accuracy or compared to laboratory testing for the same parameters. Here, I assessed the validity and reliability of Hoosier RiverWatch methods and the data they generate at several sites in South Bend (St. Joseph River, Bowman Creek, and Juday Creek) by comparing water chemistry data obtained using Hoosier RiverWatch methods with standard laboratory methods. Disagreement on meeting water quality standards was found between methods, especially with respect to nitrate concentration, and significant differences were found between the data generated via Hoosier RiverWatch methods and the data generated via laboratory analyses. I used the data gathered to suggest improvements to the methods of data collection utilized by the Hoosier RiverWatch program to ensure that the health of watersheds is assessed as accurately as possible.

Elucidating the Role of *Iroquois Transcription Factor 4a* in Kidney Development

Aisling Kruger, Hannah Wesselman & Rebecca A. Wingert

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Chronic kidney disease is a prominent problem in the US, impacting millions of Americans a year. In order to better address this issue, more advanced knowledge of kidney development is critical. The kidney is an essential organ responsible for both filtering waste from the blood, and balancing ion concentrations in the blood. These roles are carried out by the nephron, the functional unit of the kidney. Several genetic pathways play crucial roles in the process of nephron formation, one of which is the Iroquois (Irx) gene family of transcription factors. Of these, *Iroquois transcription factor 4a* (*irx4a*), is previously unstudied in regards to its role in nephrogenesis. The zebrafish is a useful model to study nephron development due to the high conservation in nephron composition with humans. Here, using whole mount *in situ* hybridization to assess spatiotemporal expression, we found that *irx4a* was expressed in the proximal straight tubule (PST) and distal early (DE) regions of the embryonic nephron. Further, *irx4a*+ cells exhibited a speckled expression pattern within the nephron, which suggests that it is likely a marker of multiciliated cells (MCCs).We hypothesize that *irx4a* acts redundantly with *irx2a*, another member of the Iroquois gene family, because the two genes have similar expression patterns. To examine whether *irx4a* is required for nephrogenesis, *irx4a* deficient embryos were created through the microinjection of a morpholino. *irx4a* knockdown caused a significant decrease in the number of MCCs present in the nephron. This implies that *irx4a* plays a vital role in proper MCC formation. Future studies will examine the consequence of dual *irx4a/2a* deficiency on MCC ontogeny. Gaining insight into the function of genes such as *irx4a* allows for greater understanding of how kidneys develop. This knowledge could provide critical insight into better understanding and eventually treating congenital and chronic kidney diseases.

Feeling under the feather: avian taxidermy restoration

Sophia Daly and Aisling Kruger

Advisor: Dr. Joanna Larson

Natural history museum collections play a vital role in research, education, and community outreach. As sources of knowledge about both extant and extinct species, museum specimens compliment and inform research in the modern age, often providing glimpses of times before the effects of climate change began to accumulate. Outside of research, museum specimens are also integral as teaching tools for students and in the public, help inspire curiosity and an appreciation for our natural world. The Notre Dame Museum of Biodiversity recently acquired a collection of 88 taxidermied birds through a donation from the Greensboro Science Center in North Carolina. The new collection contains a diverse array of species, including many species that were not previously represented in the museum's collections. However, most were in poor condition.

Since many of the specimens are nearly one hundred years old, they are dusty and have faded coloration, disheveled feathers, damage from pests, missing feathers, and loose or detached limbs. Additionally, several specimens were further damaged during the transportation. In order to address these issues, we cleaned the specimens, used steam to reshape and reorder feathers, and recolored feathers with powdered paints. Furthermore, we repinned and restructured damaged or detached limbs. This project is still ongoing but has thus far been successful in restoring many of the museum's specimens to their original condition. Ultimately, once restoration is complete, the collection can be used for education in various classes at Notre Dame, as well as in new public displays at the museum.

Epigenetic Modifiers Improve Temozolomide Efficacy in Combination Therapy on Human Glioblastoma Cells

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Histone deacetylase inhibitors (HDACi) have emerged as a new class of anti-tumor agents for various types of cancers, including glioblastoma multiforme (GBM). Recent studies have shown that modifying the GBM epigenome can enhance the effects of standard clinical therapies. Here, we utilized the human U87-GBM cell line to evaluate the cytotoxic properties of three blood-brain-barrier-penetrating HDACi—suberoylanilide hydroxamic acid (SAHA, or Vorinostat), valproic acid (VPA), and CAY10603—both as monotherapies and in combination with the chemotherapeutic agent temozolomide (TMZ). Human normal astrocytes (HNAs, SV40T) were used as cytotoxic controls. Quantification of cell viability following drug treatment was obtained through MTT assays. RNA expression profiling, flow cytometry, immunofluorescence staining, and morphological analyses allowed preliminary insights into the mechanisms of action of each individual drug.

We found that HDACi significantly reduced cell viability and increased cell death of human GBM cells, but not HNAs. Combination therapy of HDACi with TMZ generated increased cytotoxic activity in comparison to TMZ monotherapy, with the combination of VPA and TMZ having the strongest effect (30% viability following VPA/TMZ treatment). In contrast, when evaluating epigenetic modifiers as monotherapies, at intermediate concentrations, CAY10603 was most effective in decreasing U87-GBM cell viability (27%), compared to SAHA (36%) and VPA (51%). In HNAs, CAY10603, SAHA, and VPA decreased cell viability to 80%, 87%, and 90%, respectively. These findings suggest that HDACi synergize with TMZ to enhance its cytotoxicity. The promising anti-tumor effects of HDACi warrant preclinical studies.

Groundbreaking: Habitat Research and Wetland Restoration Sanctuary Proposal for Threatened Amphibian Species at the Potawatomi Zoo.

Karalina Kulis

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Conservation of native species through habitat restoration is an essential technique to prevent extinction in the face of environmental change. Human development and destruction of native habitats in which many organisms thrive has resulted in the extinction of millions of species worldwide. With no guarantee for the protection of the environment, specialized species, especially amphibians like the Blue-Spotted Salamander (*Ambystoma laterale*), are at a greater risk of extinction than ever before. So, along with habitat research, discussion with habitat restoration specialists and conservation professionals, I produced a comprehensive report and landscape design for wetland habitat restoration in the Potawatomi Zoo, South Bend, Indiana. This includes vital information such as existing site properties, including soil content, beneficial native flora, historic wetland extent, and existing examples of similar restoration projects. Using scientific information from various reliable and reputable sources has enabled me to produce a well-informed design grounded in both academic research as well as guided by aesthetic principles. This will allow me to design an recreated wetland environment effectively and harmoniously that is beneficial to native species, those who study them, care for them, and want to appreciate them in the future.

Supersymmetric Dark Matter Production Through Primordial Black Holes and Trigger Mechanism for Detection at the LHC

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The lightest supersymmetric particle (LSP) is a candidate for dark matter (DM). Although DM makes up 84% of matter in the universe, we do not know the origin or much information beyond gravitational interactions. A possible method of dark matter production in the early universe is through primordial black holes (PBHs). In the first part of this paper, we edit BlackHawk, a software that models black hole decay, to include the production of supersymmetric particles. We use this to analyze and predict the production of DM by PHBs, assuming that the dark sector is composed of SUSY particles. We found that much more of the BH's mass goes into DM when the initial temperature of the BH is around the DM mass. We also saw that a compressed dark sector drastically increases DM production. Both of those factors greatly increase the amount of DM that previous literature predicted PBHs can produce. The second part of the paper focuses on finding evidence of the LSP at CERN. A major instrumentation upgrade is planned for the LHC, providing the opportunity to implement a first-level trigger algorithm. This algorithm can be programmed directly onto silicon-based integrated circuits and will rely on data from the silicon inner tracker. It uses graph computing to detect charged particles that decay invisibly with one of the decay products being the LSP. The algorithm requires the hits recorded by the detectors to be partitioned in specific ways. In the second part of this thesis, we propose a method of partitioning the data so that the first level-trigger algorithm can be implemented.

Gut's all the Fuss? Combatting Ovarian Cancer with Healthy Gut Microbiota: A Pilot Study.

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Research has shown that gut microbiome affects treatment efficacy and outcomes of several different cancers, even some not originating in the gut. Gut microbiome modulation is therefore a promising field that currently has little research published on its use in treatment of ovarian cancer, the fifth leading cause of cancer deaths among women in the United States. To study the effects of gut microbiome modulation on the metastasis of ovarian cancer, a six-week study using fecal microbiota transplantation (FMT) was conducted. The primary mechanism of ovarian cancer metastasis is the dissemination of cancer cells from the primary tumor to the omentum of the peritoneal cavity, which we modeled by injecting mice intraperitoneally with ovarian cancer cells. We compared the metastasis of ovarian cancer in a group of mice gavaged with a fecal slurry from healthy donors in saline with a control group of mice gavaged with saline three times a week. Treatment began within the same week that the mice were injected with ovarian cancer. After six weeks, the mice were dissected and tumor burden and immune cell profiles were compared to determine the efficacy and potential mechanisms by which healthy FMT can alleviate ovarian cancer. This experiment has the potential to have rapid clinical implications as FMT is already an established procedure for curing other ailments, such as *C. difficile* infections, in human patients. This study will indicate whether FMT is a legitimate treatment to alleviate ovarian cancer in affected individuals.

Global Analysis of RNA-binding Preferences of hnRNP H and F

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RNA-binding proteins (RBPs) are a class of proteins that interact with RNA and regulate gene expression and RNA stability. Dysfunction of RBPs leads to improper gene expression, and they are implicated in neurodegenerative diseases and cancer. Because RBPs lack traditional binding pockets, targeting these proteins with noncovalent ligands is challenging. Heterogeneous nuclear RiboNucleoProteins (hnRNPs) H and F are two RBPs that are involved in alternative splicing of mRNA transcripts and bind to specific sequences of RNA through quasi RNA-Recognition Motifs. Covalent ligands may alter the conformations and dynamics of hnRNP H and F through the formation of a new covalent bond on the surface of these proteins. Therefore, it is necessary to quantify changes in the RNA sequence recognition of hnRNP H and F and the strength of these RNA-RBP interactions upon attachment of a covalent ligand. I am adapting the use of a technique known as **Se**lection, High-throughput Sequencing, and **S**equence-**S**pecificity **L**andscapes (SEQRs-SSL) for hnRNP H and F, which will be the first time this method has been used to visualize how RNA-binding preferences of an RBP change with the binding of a covalent ligand. This method involves screening hnRNP H and F against a randomized RNA library for multiple rounds of selection to determine the RNA sequences that bind with the highest affinity. The sequencing data is then mapped onto Substrate Specificity Landscapes (SSLs) that visualize the highest-affinity consensus motifs. I have currently done preliminary work towards this method including electrophoretic mobility shift assays to visualize RNA-RBP interactions and biotin labeling of hnRNP H and F.

Exploring Early Childhood Educators' Views on Engineering

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Due to the traditionally complex definition of engineering, the intersection between engineering and early childhood education (ECE) is not easily seen. Yet, providing young children with engaging engineering activities that leverage their natural curiosity and creativity can foster the development of early interest and understanding in engineering. For the past four years, the Research Exploring Activity Characteristics and Heuristics for Early Childhood Engineering (REACH-ECE) study has worked with early childhood educators in Portland, Oregon to engage children aged 0-5 and their families in engineering experiences at various classroom sites.

Throughout the project, the research team collaborated with nineteen early childhood educators to develop, test, and implement three research-based activities - Los Pollitos, Doggies, and Tacos
- all of which are composed of kid-friendly materials designed to engage children's creativity and problem-solving skills to achieve a given design challenge. These educators were surveyed and interviewed at various points, and of those nineteen, five educators participated in all four years of the program allowing for a further longitudinal study. Through analysis of the survey, interview, and longitudinal data, we aim to answer the following research questions: 1) How have educator's views of engineering changed? 2) What do educators think engineering is? 3) Who does engineering and where does it happen? The data indicates that educators adjusted their originally restricted definition of engineering to a more expansive one rooted in its iterative nature and attainability. Educators further described engineering as an inquiry-based, problem-solving process that fosters creativity, and in its simplest process-oriented form, can be done by anyone, anywhere. Overall, there was an increase in the educators' confidence, their understanding of engineering, and when and where it happens.

Characterization of Vacuolar Protein 8 in the pathogenic yeast *Cryptococcus neoformans*

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Cryptococcus neoformans is a leading cause of fungal infection, responsible for over 120,000 deaths per year in the HIV+ population alone. Despite the high medical burden, cryptococcal disease has been neglected, resulting in a lack of effective treatments and a mortality rate that can be as high as 81% (Rajasingham 2022). Both fungi and animal cells are eukaryotes, complicating the development of specific antifungal drugs. However, the vacuole is an organelle only found in fungal cells and is important for cell fitness. One protein that plays a critical role in *S. cerevisiae* vacuolar function is Vacuolar Protein 8 (Vac8). Here, we present our initial characterization of the previously uncharacterized Vac8 protein in *C. neoformans.* Firstly, wildtype (WT) and mutant (*vac8* and *pfa4*) *C. neoformans* cells were stained and vacuole morphologies were categorized using light microscopy. *Pfa4* and *vac8* on average displayed more abnormal vacuoles than WT cells. Additionally, both *vac8* and *pfa4* cells showed significant growth defects under caffeine, CFW, $NaNO_2$, and Congo Red stress-plate conditions, suggesting that a functional vacuole is important for *C. neoformans* persistence. A *Galleria mellonella* (waxworm) model was then used to test the *in vivo* virulence of WT and *vac8 C. neoformans.* Waxworms were injected with PBS (control), *vac8*, and WT *C. neoformans,* and incubated at 37C. The survival curves demonstrated that while WT-injected waxworms had the lowest median survival (~5 days), the mortality rate of *vac8*-injected waxworms was attenuated (median survival ~7 days), indicating that Vac8 may play an important role in *C. neoformans* virulence *in vivo.* Future experiments to assess *C. neoformans* burden in waxworms can determine the extent to which the yeast multiplies in this host. Ultimately, defining the Vac8 protein as an important *C. neoformans* virulence factor could guide the development of Vac8-targeted drug therapies effective against this important pathogen.

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A Meta-Analysis of Per- and Polyfluoroalkyl Substances (PFAS) in the Biota of the Laurentian Great Lakes

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Per- and polyfluoroalkyl substances (PFAS) are a family of synthetic organofluorine chemicals with over 15,000 recognized congeners. The strong C-F bonds and electrostatic interactions of these organofluorines, especially of the perfluorinated carboxylic acid (PFCA) and perfluorinated sulfonic acid (PFSA) subgroups, make them resistant to degradation, bioaccumulative, and toxic to biota. To assess gaps in our knowledge of PFAS dynamics in freshwater ecosystems, we performed a systematic, statistically-rigorous meta-analysis of PFAS distributions and spatiotemporal variance in the biota of the Laurentian Great Lakes watershed. We reviewed 47 publications spanning 42 years of sampling and focused on 11 PFCAs, PFSAs, and emerging precursor/replacement compounds that have been consistently detected in biological tissues. We found a general gradient from West (Lakes Superior and Michigan) to East (Lakes Erie and Ontario) of increasing concentrations of PFAS in aquatic (e.g., fish) and water-associated (e.g., birds) biota. However, PFAS profiles of specific lakes, particularly Lake Huron, have less clear patterns, perhaps due to latitudinal breadth. This dynamic is also influenced by different mechanisms of contamination (e.g., neighboring lake influx, point-source inputs, atmospheric deposition), which can conceal inter-lake differences in longer-chain (> C10) PFAS. Temporal trends of PFOS in biota were highly significant but non-linear, and are likely correlated with industrial production, the timeline of phase-out, food web shifts, and lake- specific conditions. Our review also revealed that Lake Michigan and the Canadian shores of Lakes Superior, Huron and Erie remain comparatively underrepresented in the literature.

Synthesis and Evaluation of 14-azaequilenin

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This research focuses on the synthesis of 14-azaequilenin, aiming to assess its biological activity, as well as measure and calculate its photophysical and pharmacokinetic properties using computational methods. While the final product is still in progress, a closely related cholesterol mimic, a luminescent 15-azasterol [1], has been successfully synthesized in the laboratory. The preliminary findings from this compound shed light on the potential of novel sterol mimics for various applications. Most notably, the previous synthesis found that the synthesized 15-azasterol was 32 times brighter than the standard dehydroergosterol probe.

Furthermore, this research contributes to the understanding of sterol trafficking, which is of great significance in diseases characterized by ineffective transport of sterol and other lipids. Having a fluorescent mimic of sterol offers enhanced insights into the mechanisms of lipid transport, providing valuable tools for investigating and addressing related disorders. Notably, the previously synthesized luminescent 15-azasterol could bind to NPC (Niemann-Pick Type-C) proteins, suggesting that the azasterol probe has a similar structure to the point where it could accurately bind.

As our research progresses, we aim to extend these findings to synthesizing 14-azaquienelin, enabling further exploration of its properties and potential applications.

Keywords: Azasterol, Luminescence, Lipid

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Protect and Preserve: A Defense of the Sanibel Plan

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Southwest Florida is home to one of the most incredible ecosystems in the world; the Everglades. No other ecosystem like this one exists elsewhere on the planet; it is subtropical wilderness home to hundreds of species of flora and fauna–several of which are endangered such as manatees and the Florida panther–that serves as a natural water filtration system. The everglades, and its estuaries, remain in grave danger due to anthropogenic activities reliant on fossil fuel combustion; there is also an overabundance of waste and poor waste management that contaminates the estuaries. As a result of these activities, the island of Sanibel, located in the estuary, suffers ecological damage as well. However, one single piece of legislation exists that fiercely combats this by protecting almost 70% of the land on the island it protects. The Sanibel Plan protects Sanibel Island from overdevelopment and remains an indispensable piece of legislation that protects the island from the harmful effects of anthropogenically induced climate change. This project utilizes land use assessments, documents evaluating different uses of the land (residential, public parks, and nature preserves), and testimonials in order to demonstrate the powerful effect that this plan has had on Sanibel. This project will serve as evidence for why this plan should be preserved as a successful historic document that prevents harmful overdevelopment which threatens the existence of the Sanibel Plan.

A Significant Discovery? Multiple Hypothesis Correction Methods in Genomics

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Multiple hypothesis test correction is necessary to reduce the number of incorrectly rejected null hypotheses in studies that implement numerous tests simultaneously. Correction methods are vital in genomic studies because genome wide association studies (GWAS) contain hundreds of thousands to millions of single nucleotide polymorphisms (SNPs) and gene expression studies compare ribonucleic acid levels of many genes and cells simultaneously. P-values are initially calculated using various hypothesis testing methods, including t-tests and ANOVA, and then multiple hypothesis corrections are applied to control the family-wise type I errors or false discovery rates. While the permutation test appears to be the ideal correction method, the amount of tests in genomic datasets makes this approach computationally prohibitive. To this end, we compared alternative computationally efficient methods that could provide corrections similar to the permutation test. Specifically, we considered the Bonferroni correction, Sidák's method, Fisher's method, false discovery rate, and simpleM. Computations and visualizations of results were implemented in R.

Purification and Characterization of Monoclonal Human Plasminogen Antibodies

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Monoclonal antibodies (mAbs) are immunoglobulins with a high degree of specificity for an antigen or epitope. They are useful in identifying important domains in protein-protein interactions and as blocking agents to disrupt disease-causing interactions. Group A streptococcus (GAS) is a bacterial pathogen responsible for common human disorders like pharyngitis and impetigo, in addition to severe diseases like toxic shock syndrome and necrotizing fasciitis. The interaction between GAS and human plasminogen (hPg) is of interest since GAS dissemination during infection is aided by two virulence factors, human plasminogen-binding M-protein (PAM) and streptokinase (SK2b). To better understand the interaction between these virulence factors and hPg, mAbs from two murine hybridoma cell lines were isolated, purified, and characterized: JOY and VAP. These hybridoma cells were cultured in media composed of CD Hybridoma AGT medium, Fetal Bovine Serum, and GlutaMAX-I supplement. The hybridoma cells secreted mAbs that were purified using an hPg-Sepharose 4B affinity chromatography column and an NAb Protein A Plus Spin Kit. Epitope mapping was carried out for the purified mAbs through dot-blot screening and surface plasmon resonance (SPR), using hPg and its corresponding Kringle fragments, K1, K1-3, K4, and K5-SP (K5-Serine Protease). Competitive binding assays revealed that the VAP mAb recognizes K1-3. Further analysis narrowed this recognition down to an epitope associated with K1. Additionally, epitope mapping showed that the JOY mAb binds specifically to K5-SP. A comprehensive characterization of these mAbs will provide valuable tools to better understand the interaction between hPg and GAS as well as other plasminogen binding factors. This knowledge will ultimately enable the development of more effective treatments for GAS-related disorders and diseases.

Better Safe Than Sorry? Tracking the Association Between Safety Behaviors and Anxious Symptoms During the COVID-19 Pandemic

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As the third most lethal type of cancer in the U.S, colorectal cancer (CRC) kills more than 52,000 patients per year, with most patients dying of metastatic diseases. The peritoneal cavity is one of the major metastatic sites for CRC (13% of all CRC cases). Compared with other sites of metastasis, such as the liver and lung, peritoneal metastasis (PM) in CRC cases usually means that patients lose the possibility of conversion therapy and have a worse prognosis. PM is initiated by adhesion of CRC cells to peritoneal mesothelial cells. Epidemiologic studies suggest that female colorectal cancer patients have better survival than males; however this gender preference in survival was only observed under age 65, suggesting an age-related component to CRC survival. The goal of this study is to investigate the effect of age and gender differences in CRC intraperitoneal (i.p.) metastatic success. Initial experiments analyzed metastatic tumor burden in mouse cohorts of varied age and gender. Overall aged male mice showed more tumor burden than the others, consistent with the epidemiologic data. Males have more CRC metastatic lesions on visceral adipose relative to young males and to females of both ages. To investigate potential candidate proteins, we isolated mouse primary peritoneal mesothelial cells (MPPMC) lining the peritoneal cavity of tumor naïve mice for proteomic analysis. We identified Prl-1, one of the proteins exclusively expressed in male aged MPPMC, which could potentially contribute to the different metastatic patterns observed in the in vivo cohorts. Thanks to Dr. Bai from Purdue University, we obtained one of their Prl-1 inhibitors, CMPD-43. Inhibiting Prl-1 in tumor naive cells in vitro or ex vivo environments both showed significant reduction of CRC cell adhesion onto mesothelial cell monolayer or peritoneum & omentum tissue explants respectively. In the future of this study, we will investigate the effect of inhibiting Prl-1 on colorectal cancer PM in vivo. We will be also looking for other candidate proteins based on the proteomics data to build a portrait of the contribution of gender and age to CRC interaction with MPPMC in peritoneal metastasis.

The effectivity of Harnessing Sub Bandgap States in AgInS2 Quantum Dots through Electron Transfer

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Solar energy represents the largest new source of non-fossil energy and the current technology can be improved upon. Photocatalysis research has shifted its focus to ternary I-III-VI_2 nanocrystal semiconductor systems as a solution to the current problems found in silicon solar cells. Semiconductor nanocrystals, otherwise known as quantum dots, are capable of transferring photogenerated electrons through interfacial electron transfer to redox active molecules, which can enhance energy transfer capabilities and extend the length of photoresponse time.

Quantum dot $AgInS_2$ provides mechanistic insights into intragrap states and interfacial electron transfer to an acceptor molecule. Through spectroscopic analysis, the excited state dynamics of $AgInS_2$ were studied to understand the relaxation of electrons to intrinsic trap states below their known bandgap energy. Ethyl viologen, an electron acceptor, was added to the solution to elucidate the kinetic differences between charge-charge carrier trapping processes and interfacial electron transfer. The quantum dot-electron acceptor structure confirmed that intragrap states can release electrons to redox active molecules through interfacial electron transfer. This process allows for improvement in harnessing solar energy below the energy level of the bandgap, which cannot be currently utilized in silicon solar energy technology.

Previous research shows that diet has an influence on gut microbiome composition. Research also shows that microbes in the gut can produce neurotransmitters. My research project aimed to understand the links between diet, microbiome composition and neurotransmitter production in yellow baboons (*Papio cynocephalus*) living in Amboseli, Kenya. In order to investigate these connections, I performed mantel tests and linear models to investigate these connections.

Mantel tests showed very little correlation between DNA diet and microbiome composition. Prevalence and relative abundance linear models showed that enzymes necessary for the production of select neurotransmitters and microbes known to produce these neurotransmitters are intimately linked to certain microbes. My findings show that a diet constructed with DNA metabarcoding data is not an accurate predictor of microbiome composition, leading to a need for more research into why this could be. There is a need for individualized diet data that goes down to the level of dietary components, versus the level of plant species, in order to accurately measure the impact of diet on microbiome composition. My findings also show that prevalence and abundance of certain microbes can predict the prevalence and abundance of certain microbes associated with neurotransmitters, meaning that these microbes may be intimately connected with the production of neurotransmitters.

A Descriptive Data Analysis of RespiCast Forecasting Data

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The RespiCast project, developed by the European Centre for Disease Prevention and Control (ECDC), aims to provide forecasts of respiratory virus activity across European countries.Respiratory viruses affect millions of people each year globally. Due to overlapping seasonality and other factors, multiple respiratory viruses often co-circulate within populations at the same time. Considering the potential interactions between co-circulating respiratory viruses is crucial as simpler approaches that treat each virus independently may overlook important mutualistic or antagonistic effects. In this project, a descriptive analysis was conducted on the RespiCast data which includes influenza-like-illness (ILI) values and respiratory disease incidences such as influenza, COVID-19, and respiratory syncytial virus (RSV). The datasets reveal patterns such as seasonality trends - an increase in cases during the winters and decrease in the summers - and the decline in COVID-19 counts over the years. There are also challenges such as pathogen-specific gaps and seasonal gaps in the data collection. The findings from this project can be used to inform future RespiCast modelers of possible issues and explain trends in order to aid predictions of ILI incidence.

Circular Fashion and the College Aged Population: Attitudes and Awareness Surrounding Online Clothing Rental Platforms

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As concern surrounding the environmental impact of clothing manufacturing processes continues to rise, apparel manufacturers and retailers are seeking to provide their customers with alternative consumption offerings, including online rentals and the sale of second-hand clothing pieces. The objective of this research is to analyze the clothing consumption patterns of college- aged students and the implications that sustainability has on marketing the use of clothing rental platforms. Through a combination of qualitative and quantitative research methods, including initial screening surveys and in person focus groups, I will gauge an understanding of how knowledgeable consumers are about the sustainability movement surrounding the fashion industry, the willingness to explore other models for clothing consumption, and the marketing stimuli that appeals most to this demographic. The results of this research may be used to inform major clothing rental brands on effective marketing strategies for the college aged population and the Gen Z population on the importance of mindful consumption and reducing the environmental footprint of the fashion industry.

Detecting XOR relationships in multivariate point-processes

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The XOR (exclusive or) of two binary inputs equals one when the inputs are different, and zero if the inputs are the same. XOR relationships can be difficult to detect in multivariate scientific data, e.g. neuroscience. We show theoretically and via simulations that for certain XOR relationships, inputs and output of the XOR function can be statistically independent. In the case of three binary point processes, dependence and conditional dependence manifest non-trivial behaviors under various settings. We investigate the use of interaction terms in multivariate regression to facilitate the identification of XOR relationships, and demonstrate the utility of interactions using simulations and closed-form derivations.

Constructing Natural Products Scaffolds

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The spirooxindole moiety serves as a pivotal heterocyclic framework found in numerous biologically active molecules, with several compounds with this core structure exhibiting diverse and promising pharmacological activities and the ability to be potential drug candidates. The stereochemical constraints imposed by the spiro center are particularly noteworthy, as they not only enable specific binding to target molecules but also hold promise for enhancing drug oral bioavailability and metabolic stability. However, the enantioselective and efficient construction of chiral spirooxindole frameworks remains a formidable challenge.

Rodriguez et al. developed a RhII-catalyzed formal [4 + 1]-annulation to construct the core spirooxindole cyclopentenone framework. Similarly, Meloche demonstrated the use of diazo oxindoles as C1 synthons in a RhII-catalyzed, formal [4+1]- cycloaddition toward the construction of spirooxindole pyrrolones.

In continuation of our interest in spirooxindole, we envisioned that, in the presence of a base, oxepino[b]indole could be further converted to cyclopentene spirooxindole in a one-pot fashion. While lots of spirooxindoles are made from heteroatoms, to make an all-carbon spirooxindole, the synthesis of allene is required.

To form cyclopropane, a couple of mechanistic pathways could occur. First, analogous to forming cycloheptaindolone, an oxy-Cope rearrangement would provide direct access to spirooxindoles. On the other hand, cyclopropane ring opening, driven by the formation of a benzylic, tertiary carbocation, could facilitate oxygen addition to the α,β-unsaturated ester to generate an ionic intermediate. Subsequent regeneration of the ester moiety would form the desired O-heterocycle. Further studies are underway in our lab to confirm the proposed mechanistic pathways and investigate how removing the electron-withdrawing substituent affects heterocycle formation.

This project is a bio-collaboration as these molecules are being tested on sandflies on their potential effects on DYRK1A expression, which can help prevent neurodegenerative diseases(Alzheimer’s), Down syndrome, cancer, and diabetes.

5-ALA ester prodrug for enhanced photodynamic inactivation of cancer cells

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5-aminolevulinic acid (5-ALA) is an FDA approved molecule and frequently used method for fluorescence imaging, fluorescence-guided surgery, and photodynamic therapy (PDT). Such methods utilize the conversion of 5-ALA to protoporphyrin IX (PpIX) within the heme biosynthesis pathway. Excitation of PpIX with 405 nm light produces reactive oxygen species that induce cell death. Cellular uptake of 5-ALA is mediated by membrane transport proteins which can be hindered in mutated cancer cells. To overcome this limitation, 5-ALA was structurally modified with ester components to form the derivative Ester 5-ALA. Due to the enhanced lipophilicity, Ester 5-ALA can enter cells by passive diffusion. Once inside, intracellular esterases, abundantly expressed in colon and liver cancers, convert Ester 5-ALA into 5-ALA. Low concentrations of Ester 5-ALA ($\leq$ 50 μM) are required to produce an equivalent PpIX expression as 5-ALA ($>$ 100 μM). HepG2 liver carcinoma cells were treated with Ester 5-ALA ($\leq$ 5 μM) and irradiated with 405 nm light exhibit a marked decrease in normal cell metabolic activity. Ester 5-ALA is an effective 5-ALA prodrug that facilitates a greater production of PpIX and photodynamic inactivation of cancer cells.

A study examining impact of county-level demographic, socioeconomic, and political affiliation characteristics on COVID-19 vaccination patterns in Indiana

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The COVID-19 vaccination campaign resulted in uneven vaccine uptake throughout the United States, particularly in rural areas, areas with socially and economically disadvantaged groups, and populations that exhibited vaccine hesitancy behaviors. This study examines how county-level sociodemographic and political affiliation characteristics differentially affected patterns of COVID-19 vaccinations in the state of Indiana in the year 2021. We linked county-level demographics from the 2016-2020 American Community Survey Five-Year Estimates and the Indiana Elections Results Database with county-level COVID-19 vaccination counts from the Indiana State Department of Health. We then created twelve, monthly linear regression models to assess which variables were consistently being selected, based on the Akaike Information Criterion (AIC) and adjusted R-squared values. The vaccination models showed a positive association with proportions of Bachelor's degree-holding residents, of 40-59 year-old residents, non-Hispanic White populations, and a negative association with proportions of Republican-voting residents, uninsured and unemployed residents, and persons living below the poverty line. Overall, after April, the variables selected were consistent, with the model's high adjusted R^2 values for COVID-19 cumulative vaccinations demonstrating that the county sociodemographic and political affiliation characteristics can explain most of the variation in vaccinations. Linking county-level sociodemographic and political affiliation characteristics with Indiana's COVID-19 vaccinations revealed inherent inequalities in vaccine coverage among different sociodemographic groups. Increased vaccine uptake could be improved in the future through targeted messaging, which provides culturally relevant advertising campaigns for groups less likely to receive a vaccine, and increasing access to vaccines for rural, under-resourced, and underserved populations.

Using the waxworm *Galleria mellonella* to assess virulence of the environmental yeast *Cryptococcus neoformans*

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Fungal pathogens have a high disease burden that has been traditionally neglected by the public, the press, and funding agencies. Collectively, there are ~7 million cases of severe infection yearly, resulting in ~3.8 million deaths. One of the leading causes of these deaths is the environmental yeast *Cryptococcus neoformans*, which has a mortality rate that can be as high as 81%. Reasons for this high mortality rate include a poor understanding of its pathogenesis. Hence, there is a clear need to study its fungal-host interactions to uncover new molecules or pathways that could be targeted for the development of new therapeutics. The invertebrate waxworm *Galleria mellonella* has become a popular model in the last few years to study complex host-microbe interactions. This model is cheap, easy to manipulate, has a fast development of disease, and has an innate immune system similar to that of vertebrates. Here, we are using this invertebrate model to test the virulence of several mutant strains of *C. neoformans* missing genes that could be attractive drug targets. We infect *G. mellonella* with 5 µL of *C. neoformans* at a concentration of 2.0*10^7 cells/mL. We are assessing the survivorship of *G. mellonella* injected with two mutant *C. neoformans* samples, one missing the gene *VAC8* and the other missing the gene *PDR4*. We are also using waxworms injected with wild-type *C. neoformans* as a positive control and waxworms injected with PBS, a buffer solution, as a negative control. Preliminary results show that waxworms infected with wild-type *C. neoformans* will start to die within 4-7 days after injection while those injected with PBS will survive in this time frame. In conclusion, we believe this system will accelerate the discovery of potential genes of interest that can then be more carefully studied in animal models.

Macroinvertebrate Diversity as a Measure of the Long Term Effectiveness of the 1997 Restoration of Juday Creek on the University of Notre Dame's Warren Golf Course (St. Joseph Co., Indiana)

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Local stream restoration is a commonly proposed but somewhat controversial method of mitigating the effects of urban stream degradation due to development and changing land use in and surrounding riparian areas. Restoration projects are often followed by short-term monitoring to determine their effectiveness, but these studies are usually no more than 5 years. The long-term effectiveness of these projects is less commonly studied. Changes in aquatic insect diversity is one way of evaluating the degree of stream health over time. In 1997, two stretches of Juday Creek of the University of Notre Dame's Warren Golf Course were relocated and restored to create an improved habitat for invertebrates and fish. Insect diversity data was collected from 1997-2005 in both restored and unrestored areas of the creek. These studies showed improvement in the restored areas compared to the unrestored areas in the golf course for the five years following the initial restoration. In this study, I resampled aquatic macroinvertebrates in both the restored and unrestored areas of the stream to evaluate and compare the condition of Juday Creek 25 years following the completion of the restoration project. I also examined diversity above the golf course stream sediment trap to determine whether this project impacts aquatic macroinvertebrates. The lower sites within the golf course had a much higher abundance of aquatic insects present throughout the year. The % EPT in the lower and upper sites were similar and higher than the sites above the sediment trap. Therefore, it is possible to conclude that the habitat above the sediment trap is more polluted and less suitable for aquatic insects. Analyzing the long-term effectiveness of stream restoration projects is important in planning similar endeavors in the future, so that the best course of action can be undertaken to benefit biodiversity, habitat preservation, and ecosystem health overall.

Growing Food to Grow Community: Unity Gardens, Inc.

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It is critical to understand the impacts of food security organizations due to the increasing lack of access to fresh, nutritious, and affordable food, especially in low-socioeconomic communities. Community gardens can specifically address these issues in a sustainable way by providing access to food while simultaneously encouraging positive community and environment interactions. Unity Gardens employs a unique community garden model wherein all the produce is free-to-pick for all community members. This radical approach removes economic and labor barriers for access to fresh, nutritious, and affordable food. This study uses ethnographic observations and interviews at Unity Gardens Inc. in South Bend, IN over the course of 6 months in 2023 to generate an understanding of how this model influences individuals' motivation for visiting the gardens. Interviews reveal that most individuals visit the gardens for a wide variety of reasons, most frequently for community and environment based reasons. While volunteers and employees commonly reference the community-based aspect of Unity Gardens, it was less present among interviews of individuals who were solely identified as visitors. These respondents were more likely to cite access to food as a reason for visiting. While roles influence reasons for visiting the gardens, interview responses demonstrate Unity's efficacy in creating a sustainable model that provides access to food, cultivates community, and encourages positive interactions with the environment.

Sustainable Alaskan Salmon: A Plan of Adaptation for The Coventina Fishing Vessel

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Despite the fishing practices in Alaska being the gold standard for wild caught and sustainable salmon, the fishing industry is heavily reliant on fossil fuels in the capture, production, and transportation stages causing large greenhouse gas emissions. This indirectly impacts the resource itself and the environment, such as increased water temperatures, changes in spawning patterns, and competition for food. Looking closely at the environmental impact of one commercial fishing vessel, the *Coventina*, I suggest ways in which it could improve its efficiency, decrease its emissions, and reach carbon neutrality. The plan involves the use of renewable energy sources, such as solar panels, as well as installing exhaust scrubbers and the potential implementation of biodiesel from salmon oil. These measures benefit the environment and improve the vessel's profits in the long run. The project also highlights how such measures could be adopted by other fishing vessels and companies across the industry in Alaska.

An Analysis of the Potential of Solar Panel Recycling as a Sustainable Regional Redevelopment Tool in Fukushima, Japan

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In Japan, many rural areas are experiencing population decline, and skewed gender ratios in some areas further threaten population sustainability. This study uses estimated employment factors and population trends to analyze the potential impact of solar panel recycling on local populations using a case study of Namie, Japan considering the research question "To what extent would population in Namie, Japan, be impacted by jobs created from a 1500-ton solar recycling and refurbishment facility with varying scenarios for potential expansion?" I further analyze the potential changes in Namie's gender ratio if female employment increased by considering "To what extent would the gender ratio in Namie, Japan change due to employment at the recycling facility if a 70% female worker ratio was established?" I project Namie's future population based on current trends of rural decline and then model the potential job creation of a hypothetical new photovoltaic (PV) panel recycling facility in Namie, Japan under three scenarios: the facility has a constant capacity of 1500 tons, the facility expands from 1500 tons to 5000 tons, and the facility expands from 1500 tons to 20000 tons. The model also considers a change from status quo 30% female employment to an incentivized 70% female employment. The calculations showed that jobs created would account for 7%, 23%, and 92% of the projected 2035 population in Namie for the 1500-, 5000-, and 20000-ton scenarios, respectively. An incentivized 70% female employment at the facility would increase the percent of women in Namie's projected 2035 population by 2%, 5%, and 14%, respectively. The results showed that PV panel recycling could be used as a long-term regional redevelopment strategy, but policy needs to be implemented to improve worker work-life balance and remove systemic barriers to women in the workplace.

The Effects of Repeated Finger Flexion Movements on Self-Reported Approach Motivation and Affect are Inconsistent and Weak

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Research indicates that there are at least two fundamental motivational systems critical in regulating emotions and behavior: the approach system and the avoidance system. The approach system regulates behavior to attain rewards and goals whereas the avoidance system inhibits behavior in response to threat. Within this motivational perspective, higher levels of approach system activity are associated with greater levels of psychological well-being. Thus, researchers have searched for activities and strategies that might stimulate this system. The purpose of this research was to conduct both a direct (n = 212) and conceptual replication (n = 247) of an experiment that used repeated finger flexion movements to increase approach system activation. The direct replication found a small, but statistically significant, effect of the repeated flexion movements on self-reported positive affect, but not self-reported approach motivation or performance on a difficult anagram task. The conceptual replication found a small, but statistically significant, effect of repeated flexion movements on self-reported approach motivation, but no effect on affect or performance on a difficult anagram task. These results indicate that there is not a strong or reliable effect of repeated flexion movements on approach motivation and affect. We suspect that the statistically significant effects reported in prior research may have been due to chance findings.

The Sea is Rising, Are We Moving?

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The escalating risks of sea level rise, attributed to climate change, pose significant challenges for coastal communities worldwide. With the increasing frequency and severity of extreme weather events and projections of rising sea levels, understanding the determinants of relocation decisions becomes crucial for effective adaptation strategies. This study explored the determinants of relocation decisions in response to sea level rise risks in coastal communities in Florida. Drawing on data collected from a comprehensive household survey, the analysis employed two-sample tests and logistic regression to investigate the effect of various factors on the likelihood of relocation. The findings revealed that concerns about sea level rise, past storm experiences, and the requirement to purchase flood insurance acted as significant push factors, increasing the probability of relocation. Conversely, factors related to place attachment, such as longer residency years and yearlong residency status in Florida, served as pull factors, decreasing the likelihood of relocation. Sociodemographic factors like age, gender, and income also played significant roles. Additionally, a non-linear effect of time on relocation decisions was observed, with the initial willingness increasing over time but then decreasing if an extended period of time was specified. Household composition variables such as family size and the presence of children or seniors did not significantly influence relocation decisions. Overall, the study highlighted the complex interplay of push and pull factors and sociodemographic variations in shaping relocation decisions in the context of sea level rise risks.

The Drug Test Expansion Pack: Extending the detection and quantification capabilities of a paper-based drug-checking device

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Drug-checking methods serve as a harm reduction measure to prevent overdoses, as they inform the user if a drug sample is contaminated with additional illicit substances. Paper test cards have emerged as a low-cost, field-friendly alternative to current lab technologies. In this study, we investigated the quantitative capabilities of an affordable field test: an illicit drug paper analytical device (idPAD) combined with a commercially available fentanyl test strip.

To improve quantification, we examined device stability, reagent dispensing, and solid sample application. Device stability was investigated by a 12-week study of fentanyl test strips (FTS) packaged with idPADs. Repackaging these hybrid devices in sealed aluminum bags with desiccant extended their stability to 6 weeks until the occurrence of false negatives on the FTS. The FTS failed after 4 weeks in ambient conditions. When the fentanyl test strip was stored in its original packaging, then attached to the idPAD at the time of use, it performed properly for the entire 12 week study. The idPADs remained stable throughout the 12-week study.

Reagent dispensing and solid application were manipulated to observe their effects on quantification. The quantities of both reagents and solid samples affected the color response of a model lane reaction, establishing the need for consistent and controllable deposition. A semi-automated pipettor was found to dispense reagents more precisely than the current manufacturing method. A “dosing device” stencil was created for solid application. While it did not improve reproducibility, the stencil device attachment decreased the amount of solid deposited, aiding to prevent saturation behavior. This study introduced strategies for improving quantitation that can extend to paper analytical devices beyond the idPAD.

Complex effects of perfluorooctane sulfonic acid (PFOS) on stream ecosystem function

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Chemical anthropogenic stressors can alter ecosystem functions that are important for nutrient cycling and overall ecosystem health. Per- and polyfluoroalkyl substances (PFAS) are a diverse class of fluorinated chemicals that are now ubiquitous in the environment. A recent field study suggested that increased levels of PFAS, including PFOS, in a stream ecosystem emanating from a point source reduced leaf litter decomposition rates and ecosystem respiration, both largely driven by heterotrophic microbes. However, other studies of PFAS effects on terrestrial decomposition and microbial respiration have shown varying results. We conducted a laboratory experiment to further examine the relationship between PFOS and organic matter decomposition by dosing aquatic mesocosms with three levels of PFOS – 0, 10, and 100 ppb – within a randomized block design (n=6 per treatment). Three 2-g packs of sugar maple (*Acer saccharum*) leaves were placed into each mesocosm. One leaf pack was removed from each mesocosm after 7, 14, and 28 days and measured for decomposition and ecosystem respiration. After 28 days, water samples were taken from each mesocosm and analyzed for DOC concentrations. No significant differences were observed in decomposition rates among treatments. Similarly, no differences in respiration were measured on days 7 or 14. On day 28, however, respiration was significantly lower on leaves from the high PFOS treatment than from the control, while the low PFOS treatment was intermediate. DOC concentrations were significantly higher in the low and high treatment levels compared with the control. While leaf decomposition results from the field study were not replicated in the laboratory, decreased ecosystem respiration by microbes at higher PFOS concentrations supported field observations. In addition, the higher DOC concentrations with increasing PFOS further suggest suppression of microbial activity. Therefore, the effects of PFOS on aquatic heterotrophic communities warrants further study.

From Energy Source to Summer Fun: Kentucky Lake's Change Through Time and Man-Made Lake Management

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In 1944, the Kentucky Dam was put in place impounding the Tennessee River. For the past 80 years, this dam has helped control flooding, provide cheap hydroelectric power, and create recreational opportunities as planned. However, it has also created quite the vacation spot for many people in Southern Indiana, Kentucky, and Tennessee. Industry along the Tennessee River and domestic development around Kentucky Lake call into question how sustainably these waterways are being managed. Namely, have there been any concerning changes to water temperature, dissolved oxygen, turbidity, or water level over time? While looking at trends and average levels of different water quality parameters throughout time along with qualitative data on invasive species from local fish blogs, the conclusion that Kentucky Lake is sustainable for human use in the near and distant future was reached but there are possible concerns that should be looked into and remediated. Through analysis, it was discovered that the average water temperature is increasing and there is a high turbidity in the water column. Both of these characteristics lead to long-term concern about Kentucky Lake's sustainability.

Novel Combination Therapy of SREBP1 Inhibitor with Standard-of-Care Chemotherapy Leads to Delayed Recurrence of Ovarian Cancer in the Obese Host

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Ovarian cancer (OvCa) is the most fatal gynecological cancer in the United States and the fifth most lethal cancer among women. OvCa is lethal largely due to its often late diagnosis (FIGO stages III and IV) and its resistance to chemotherapy. Obesity is a recognized non-infectious pandemic. In the United States, 27.5% of women are overweight, and 41.9% of women are obese. Studies have shown that obesity increases OvCa risk and incidence, enhances metastatic success, and reduces survival. We previously demonstrated a link between obesity and OvCa metastatic success. Our published data showed enhanced metastatic tumor burden in diet-induced obesity (DIO) murine models and increased expression and nuclear localization of sterol regulatory element binding protein 1 (SREBP1), a master transcriptional regulator of *de novo* lipogenesis that triggers lipogenic reprogramming of tumor cells, in metastatic lesions. In this study, we evaluate the efficacy of a novel combination therapy of an SREBP1 inhibitor (Nelfinavir) with standard-of-care chemotherapy (paclitaxel/carboplatin, PC) in treating OvCa in DIO obese pre-clinical murine models. Nelfinavir inhibits SREBP1 maturation through inhibition of site-2 protease activity, suppressing regulated intramembrane proteolysis. The tumor burden was imaged and quantified. Immunohistochemical analysis tested expression of SREBP1, PCNA, iNOS, and CD206. Flow cytometry analysis evaluated the immune cell populations from murine peritoneal lavage and ascites fluid. Adipocyte cell number and size were examined and quantified. Our results show a poor response to standard-of-care chemotherapy alone in HFD mice, while a lower tumor burden and delayed recurrence were observed after combination therapy. Taken together, our findings demonstrate that obesity-induced changes in the tumor microenvironment promote OvCa metastatic success and impede response to standard-of-care therapy, resulting in poor clinical outcomes. These innovative analyses will identify mechanisms through which host obesity can affect treatment response and reveal new therapeutic targets for clinical intervention.

Added Value of Biomeme Franklin® Real-Time PCR Thermocycler in Pathogen Surveillance

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Pathogen surveillance has become increasingly important with the rise of emerging zoonoses worldwide. Many sampling sites lack the capacity to efficiently process material, thus, delaying outputs by requiring samples to be sent to external laboratories. REDI-NET is a consortium of global partnerships designed to overcome barriers to surveillance in order to detect, predict, and contain emergent zoonoses. REDI-NET currently uses Next- Generation Sequencing (NGS) with Oxford Nanopore Technology (ONT) to monitor pathogen presence in Belize. The Biomeme Franklin® Real-Time Polymerase Chain Reaction (RT-PCR) Thermocycler offers a less expensive alternative to the more expensive NGS. The Biomeme Franklin is a portable, battery-operated device controlled by a mobile application and designed for testing samples in remote field settings. The added value of integrating the Biomeme Franklin into REDI-NET's current pathogen surveillance protocol, specifically in the testing of water and tick samples, was evaluated through experiments conducted during June 2023-March 2024. The Biomeme Franklin test results were significantly different from NGS outputs for water samples, but no significant difference in pathogen detection identified between the two methods for tick samples. Currently, the device adds little benefit to REDI-NET's pathogen surveillance. If improvements are made to Biomeme's test assays in the future to improve accuracy and reduce the occurrence of invalid results, the Biomeme Franklin device could significantly speed up the pathogen surveillance pipeline of the REDI-NET program.

Plant Power: Determining the Potential of Aquatic Vegetation as Biodigester Input to Reduce Human Infectious Disease

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Schistosomiasis is a devastating parasitic disease, spread to humans through intermediate snail hosts by contact with the infectious form of the parasite in freshwater. Human control of schistosomiasis faces many challenges, such as preventing reinfection. Reducing snail intermediate hosts and snail habitat is likely an effective way to control disease transmission and reduce the chances of reinfection. A proposed method of snail control is removal of the aquatic vegetation, which is snail habitat, and using the vegetation as input to biodigesters that produce cheap and sustainable fertilizer and cooking gas. However, research to understand which vegetation to target with this objective is lacking. In this capstone project, I investigated associations of snail hosts with aquatic vegetation in the literature and assessed their strength of potential usage in biodigesters. We found several genera that fit these criteria, including *Ceratophyllum* spp., *Commelina* spp., and *Potamogeton* spp. This study provides a guide for further research into these vegetation genera of interest to local endemic communities across broad spatial scales and contributes to scalable schistosomiasis prevention.

PFAS Regulations for Human Health in the Great Lakes Region

Kristin E Schaars, Alison M Zachritz, Gary A Lamberti, Daniele A Almeida

Per- and polyfluoroalkyl substances (PFAS) are of growing public concern, due to their association with a variety of adverse human health effects, including cancer, thyroid dysfunction, impaired fetal development, and decreased vaccine response. Despite these warnings, PFAS remain minimally regulated at the federal level. In response, some states have issued regulations and/or guidelines to protect citizens from PFAS exposure. One source of exposure in humans is the consumption of fish, as PFAS can biomagnify in aquatic food webs and into fisheries. Here, we investigated states surrounding the Laurentian Great Lakes, where wild fish are routinely harvested, and compared their respective guidelines, regulations, and advisories. Six of the eight states have fish consumption guidelines based on perfluorooctanesulfonic acid (PFOS) levels. Five states follow 2019 Great Lakes Consortium Guidelines, while Michigan follows their own 2014 recommendations. As of 2024, neither Illinois nor Ohio had published PFOS guidelines. The Great Lakes consortium recommends a Tolerable Weekly Intake (TWI) of 140 ng PFAS/kg human weight, while Michigan recommends a TWI of 98 ng/kg. Inconsistent TWI levels between states leads to differing protection for anglers between states. These differences are magnified by testing and monitoring discrepancies between states. Therefore, certain state populations will likely experience higher PFOS exposures than others, which may have unknown health consequences. Additionally, we investigated waterbodies across the states that had fish consumption advisories. At the extremes, Michigan has 111 lakes and rivers currently listed with PFOS advisories for fish consumption, whereas Illinois and Ohio had none. In addition, certain human demographics that harvest and eat more wild fish will bear a disproportionate public health risk from PFAS. We recommend universal strategies across state agencies combined with federal oversight to reduce the vast differences in public health protection regarding PFAS.

Carbon Food-Print: estimating food-related Scope 3 emissions of Notre Dame's dining halls to research the effectiveness of a carbon labeling program on carbon-conscious consumption

Clayton Glasgow, Ellie Rey, Lauren Amrol, Dr. Peter Burns, Cheryl Bauer, Karim Tinoco, Angela Fox

Changing how we eat thus has the potential to be a powerful method of addressing the ecological crises currently threatening the planet. For Campus Dining at the University of Notre Dame, the beginnings of this process was accomplished by implementing a carbon labeling pilot program that analyzed and presented a sample of the dining halls' food-related Scope 3 emissions. After assessing student responses to the pilot program, we found that more education in unique and captivating ways is needed, as a majority of student responses to the survey said they only *sometimes* consider the environmental impacts of the food they eat in the dining halls at Notre Dame, but generally do think about sustainable eating overall. The majority of student responses also revealed that the addition of carbon labels to stations in the dining hall would increase their sustainably-driven decisions in the dining hall. Overall, our findings show that students at Notre Dame expressed a desire to have sustainability information in the form of carbon labels in dining halls, but shared that they would need more education about the aspects of carbon labeling and general sustainability initiatives with a personal appeal in order to effectively change behavior.

Assessing Stress Levels in Mice Subjected to Different Handling Techniques

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There exists different types of handling techniques when it comes to dealing with laboratory mice. Tail handling involves capturing and picking up mice by the tail. Tunnel handling entails guiding mice into a tunnel with a free hand and utilizing the tunnel to transfer the mice for cage cleaning or procedures.

Previous research demonstrates that tail handled mice consistently show greater anxiety than tunnel handled mice. An experiment was designed to investigate the relationship between handling techniques and mice stress levels. The experiment consisted of eight full cages of mice, four male and four female. The experiment was conducted over a nine-week period. The cages were randomly assigned to be handled by a certain technique, either tunnel or tail, in a stratified manner. The mice were handled once a week during cage changing by a singular researcher. Each week the time it took to transfer the mice to a clean cage was documented along with behavioral observations. Fecal samples were also collected weekly for measurement of cortisol levels. At the conclusion of the experiment, tissue was harvested from the mice to identify potential histologic changes correlating with cortisol levels. The results of the cage change time data revealed that it takes a significantly longer time on average to change the cage of the tunnel handled mice. The results of the fecal cortisol analysis show that tail handled mice possess significantly higher cortisol levels than tunnel handled mice. A significant difference in cortisol levels across time and between genders was also found. The results of the tissue analysis revealed no differences in the adrenal tissues between the two groups of mice. The findings of this study support the practice of tunnel handling as a means of minimizing stress when working with laboratory mice.

Hold the Salt: an investigation into the aquatic ecosystem effects of de-icing salt application at Notre Dame

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Chloride-based deicing salts are used widely throughout the U.S. to combat harsh winters. The University of Notre Dame uses road salt (NaCl) and calcium chloride (CaCl2) as its prime method for de-icing campus. Despite their popular use, the negative effects of these de-icing salts on the environment, public health, and infrastructure are extensive. I investigated the impact of de-icing salts on the aquatic ecosystems at Notre Dame to gauge the ecological consequences of their use. I conducted a temporal and spatial analysis of the impact of salt application in both lakes to observe how salinity changed before and throughout winter, and in regions of varying proximities to salt application. I compared historical salinity data on the lakes taken by the Aquatic Ecology Lab to current data to assess how salt application may have influenced lake salinity over a decadal time scale. I performed a temporal analysis of salinity changes in the Architecture pond to examine the effects of salt use on a smaller, more concentrated system, as well as tested the input from St.Mary's Lake drainage pipe to examine the implications of campus runoff on lake conditions. Lastly, I conducted salinity tolerance experiments on zooplankton, sampled from Portland Arch Nature Reserve and the campus lakes, to determine the potential consequences of Notre Dame's de-icing salts on their survival and fitness, and on the larger aquatic food web. I produced an evaluation table on the various alternatives to de-icing salts as a way to objectively evaluate different solutions based on a set of ecological and economic criteria. My research suggests that campus de-icing practices are affecting the salinity of these water sites both spatially and temporally, posing potential consequences to the structure and function of aquatic ecosystems, but that alternative solutions that are both ecologically and economically viable exist.

Exploring Episignatures as a Potential Diagnostic Tool for Diabetic Embryopathy

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Diabetic embryopathy (DE) encompasses a group of congenital anomalies observed in infants of diabetic mothers (IDMs). DE presents with a wide spectrum of phenotypes across various organ systems. There is no currently recognized diagnostic tool for DE due to lack of knowledge about pathogenesis. Changes in DNA methylation, known as episignatures, have shown promise as diagnostic biomarkers in other congenital conditions. A previous study examining episignatures as a biomarker of DE was able to differentiate between DNA methylation patterns for infants with DE, healthy infants born to mothers with diabetes, and healthy unexposed infants. However, the small sample size and lack of adequate population diversity prevents clinical application of episignatures as a diagnostic tool for DE from this study alone. We conducted a literature review of case studies, journal articles, reviews, and meta-anaylses within the past 15 years (2009-2022) to extract the 57 most common congenital anomalies associated with DE. We recruited IDMs under the following criteria: HbA1C level greater than 6.5%, pattern of congenital anomalies consistent with DE, and negative genetic testing results. The most common categories of anomalies observed with DE involved structural development of the central nervous system and cardiovascular anomalies. Several patterns of anomalies had a much greater frequency in IDMs compared to the general population, and from this we designed a severity score to determine likelihood of DE. We recruited 15 patients, 12 IDMs and 3 controls. We are awaiting the results of the methylation arrays. We hope to find a methylation pattern in infants with suspected DE that is distinguishable from the methylation pattern in infants with congenital anomalies who are not IDMs.

Aquatic Food Web Response to an Invasive Plant in the Copper River Delta of Alaska

Jace Kruer, Gracie Speicher, Amaryllis Adey, Natalie Levesque, Carmella Vizza, Martin Berg, Gordon Reeves, Gary Lamberti

The Copper River Delta (CRD) of southcentral Alaska is a remote ecosystem; however, in 1982, Canadian waterweed *Elodea canadensis* was documented as the first known aquatic invasive plant introduced to the CRD. *Elodea canadensis* grows quickly, reproduces vegetatively, and outcompetes other aquatic vegetation, creating monocultures. To assess the impact of *E. canadensis* on aquatic food webs, we utilized carbon and nitrogen stable isotopes of biota collected from freshwater ponds in the CRD and analyzed niche space and niche overlap of consumers. We expected *E. canadensis* to occupy a similar niche space to other primary producers, which might have bottom-up effects depending on *E. canadensis* consumption by primary consumers. Stable isotope samples from food web members (primary producers, invertebrates, fish, and waterfowl) were collected from 11 freshwater ponds across the CRD from 2006 to 2013, again in 2019, and most recently in 2023. We calculated isotope metrics and used generalized linear mixed-effects models to determine which environmental factors impacted these metrics. We found that total isotopic area and nitrogen range did not differ between the ponds with and without *E. canadensis*. However, the carbon range was greater in ponds with *E. canadensis* than those without, suggesting a broadening energy base. As a C4 plant, *E. canadensis* occupied a unique isotopic space compared to native C3 plants, and therefore a potentially different trophic pathway. This separation indicates that limited competition may exist between *E. canadensis* and native vegetation. Further, we found limited incorporation of *E. canadensis* by invertebrate consumers. These results indicate that the native aquatic plants may face increased competition from and exclusion by *E. canadensis*, but that energy flow pathways to consumers within these systems may expand. This study provides insights into potential ecological effects of *E. canadensis*, but exploration of bottom-up effects will further our understanding of community responses.

Visualizing Expansion Coastal Boulder Deposits Community using Inundation Signatures on Rocky Coastlines Datasets

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Over rocky coastlines, coastal boulder deposits (CBD) and CBD creation are proxies for historical storm and tsunami records. The study of CBD also contributes to understanding storms' and tsunamis' effects on coastal environments and infrastructure, particularly as frequency and strength increase. CBD have interdisciplinary focuses in coastal engineering and geomorphology, and both disciplines have active research occurring presently. Due to CBD being an emerging research field, studies chose sites based on accessibility, current storm or tsunami activity intensity, prehistoric and historic activity, and so forth. Many studies are concentrated around a few geological locations, like Ireland and Japan, despite rocky coastlines being found worldwide. Therefore, this study will visualize how the locations of CBD studies have expanded throughout the field's history. We will use newly created Inundation Signatures on Rocky Coastlines (ISROC) datasets and bibliography to consolidate locations and time of publication of historical and current studies. We will look at CBD data over a temporal and spatial scale by coding markers and geographical bubble maps. We hope formating the information into maps with show the extension of the field over time and the geographical concentration of studies. These visualizations will help the field determine common trends in study locations and research gaps by location in CBD data for the future. The ISROC datasets are part of a discipline-wide database to improve academic collaboration, which will soon be in the public domain. The ISROC, an NSF-funded research network, funds this study.

Effect of Land Cover on the Estimated Risk of Tick-Borne Pathogens in Belize, Central America

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Abstract

Land cover changes frequently occur from extraction of natural resources, human population expansion, and natural disasters. Such environmental alterations can increase the risk of arthropod-borne diseases, including those transmitted by ticks. Knowledge on the influence of land cover change and risk of tick-borne diseases is limited. Commonly known as the "brown dog tick," *Rhipicephalus linnaei* is considered the most widespread tick species in the world and represents an important vector of pathogens that cause human diseases such as Rocky Mountain Spotted Fever, Anaplasmosis, and Ehrlichiosis. The current study aimed to quantify and associate land cover change linked to deforestation with presence of *R. linnaei* in Belize, Central America. Adult ticks were collected from animal hosts in San Lazaro and Indian Church communities of the Orange Walk district in January 2020. Deforestation within a 200 km circumference of each community was characterized by quantifying the change in forested areas over a 5-year period (2017-2022) using satellite imagery. Results indicated a higher presence of *R. linnaei* in San Lazaro (91.5%) compared to Indian Church (77.2%), associated with an increased level of deforestation in San Lazaro (31.2%) compared to Indian Church (4.6%). These findings can contribute to the knowledge of tick-borne disease risk in Belize for greater public health awareness and help guide tick control campaigns for at-risk communities.

Cost analyses of an as-needed 60-actuation vs. 120-actuation budesonide-formoterol pMDI for patients with mild asthma from a United States payor perspective

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Abstract

RATIONALE: As-needed inhaled corticosteroid (ICS)-formoterol therapy is now preferentially recommended for the treatment of mild (Global Initiative for Asthma [GINA] Step 1-2) asthma. However, in the United States (US), budesonide-formoterol (BUD-FORM) is commercially available only via a pressurized metered-dose inhaler (pMDI), which, per manufacturer labeling, should be discarded 90 days after unpackaging. In the US, both a 60-actuation (60-BUD-FORM) and 120-actuation BUD-FORM (120-BUD-FORM) pMDI are commercially available, although the 60-BUD-FORM is rarely prescribed. In this study, we: 1.) determined how frequently patients with mild (GINA Step 2) asthma use as-needed BUD-FORM in a 90-day period, and 2.) compared the cost of a 60-BUD-FORM vs. 120-BUD-FORM from a US payor perspective, assuming the 90-day user-life after unpackaging was followed.

METHODS: We aggregated data on as-needed BUD-FORM actuation frequency (collected via electronic inhaler sensor monitoring) from four landmark randomized controlled trials, which examined usage of as-needed BUD-FORM in patients with GINA Step 2 mild asthma. We entered this aggregated actuation data into Monte Carlo Simulation models to produce probability distributions representing the expected frequency of BUD-FORM actuations used over 90 days. Then, we inputted the US Average Wholesale Prices (AWP) for each inhaler into this model to compare the cost between both versions of the pMDI to US payors if inhaler expiry recommendations were followed.

RESULTS: Based on BUD-FORM actuation frequency reported in prior trials, our Monte Carlo Simulation's probability distribution predicted that 72% of patients with mild asthma use ≤60 actuations of BUD-FORM in the 90-day period after unpackaging while only 8% use ≥120 actuations of BUD-FORM. Using Merative Micromedex's® reported AWP of $318 and $468 for 60-BUD-FORM vs. 120-BUD-FORM respectively, the annual expected cost to healthcare payers of 60-BUD-FORM ($1,582 US dollars [USD], cost in 95% of simulations $1,273 USD to $3,928 USD) would be less than 120-BUD-FORM ($1,946 USD, cost in 95% of simulations $1,874 USD to $2,891 USD) in 84% of simulations assuming inhaler expiration recommendations were followed.

CONCLUSIONS: When used on an as-needed basis, only 8% of patients on GINA Step 2 therapy would be expected to use ≥120 actuations of BUD-FORM pMDI within the 90 days before inhaler expiration. Nonetheless, the 120-BUD-FORM is generally prescribed when used as-needed in mild asthma, which thus results in many patients using expired inhalers or discarding inhalers with remaining actuations. Prescription of a reliever 60-BUD-FORM could help mitigate this issue in the US and would be less costly for payors.

Field of Vice and Victory

Emma Stern

Abstract

Often, environmental legislation and legal events are written in a language that is only accessible to lawyers, experts, and environmental scholars who are familiar with this language. My capstone project, *Field of Vice and Victory*, worked to take the important messages and sentiments of legal environmentalism, and place them into common language and real world, relatable occurrences in the form of ten poems. I created mini summaries of five selected cases to further fill the gaps to reader's understandings, to ensure accessibility. The poems of *Field of Vice and Victory* aimed to show the elements of the cases' backgrounds, events, actors, challenges, and results so that readers can gain a better understanding and appreciation for the significant cases of legislation about major corporate entity's impact on the environment, and the change that law can make.

Vegan Dogs?

An integrated nutritional, environmental, marketable, and palatable approach to examine the rise of vegan dog food

Kaitlyn Donton and Honey Stukes

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Studies highlighting shortcomings in the nutritional aspect of dog food, combined with the high carbon emissions of animal meat consumption, have kickstarted a new and relatively unstudied market: vegan dog food. During our study, we conduct a multilayered investigation to determine the viability of three leading brands within the vegan dog food industry (Wild Earth, V-dog, and Bramble) by examining the nutritional and environmental implications of choosing a specific vegan dog food, as well as each brand's feasibility in a market-based setting through a survey and a dog preference study. By scoring these three brands on their nutrition, environmental impacts, human perceptions, and palatability to dogs, we determine which brand is the strongest alternative to standard dog food, as well as if vegan dog food as a whole is a viable industry.

Assessing Titanization in Mutants of the Pathogenic Fungus Cryptococcus Neoformans

Gavin Sullivan

Cryptococcus neoformans is a fungal pathogen with over 200,000 cases yearly and an 81% mortality rate[1]. A unique characteristic of *C. neoformans* is its ability to form 'titan cells', or dramatically enlarged cells which can reach up to 100 microns in diameter, compared to the average diameter of about 5-7 microns[2]. Cells typically 'titanize' in the lungs, and this process is associated with latency since these cells are too large to be removed by the immune system. They are also resistant to the oxygen and nitrogen free radicals released by host immune cells to lyse pathogens[3]. Moreover, these cells produce normal-size and small cryptococcal cells (called "seed cells") that are better able to escape the lungs and disseminate into other tissues, hence, indirectly, titan cells also promote dissemination[4]. For these reasons, it is important to understand the mechanisms of titan cell formation, particularly what cryptococcal genes are responsible for it. To this end, we tested several conditions known to induce titanization and optimized a procedure using fetal bovine serum (FBS) to generate titan cells in several different strains of *C. neoformans.* These cells were then imaged and the size measured manually using Image J. However, to increase the throughput and remove human bias, we adapted a published computer algorithm[5] to measure the size of the polysaccharide capsule to measure the size of the cells and calculate the percentage of titan cells in a population. Hence, we have developed a semi-automatic pipeline to assess titanization in this fungus. After the cells are induced, they are imaged with India Ink and the images fed to the computer program, where they are measured and counted automatically. The program was validated using cells lacking *USV101*, a key virulence regulator that has been shown to be involved in titanization[6]. We are now assessing several mutants lacking specific factors of interest such as *PDR6* (pleiotropic drug resistance gene 6) and *HAM1* (hyphal anastomosis gene 1) and we have found some that formed titan cells at lower rates than wild-type.

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A Conversation Between the Gut and the Brain: Investigating the Influence Dietary Barcodes have on Gut Microbes Associated with Neurotransmitters

Stephanie Swegle

Previous research shows that diet has an influence on gut microbiome composition. Research also shows that microbes in the gut can produce neurotransmitters. My research project aimed to understand the links between diet, microbiome composition and neurotransmitter production in yellow baboons (Papio cynocephalus) living in Amboseli, Kenya. In order to investigate these
connections, I performed mantel tests and linear models to investigate these connections. Mantel tests showed very little correlation between DNA diet and microbiome composition. Prevalence and relative abundance linear models showed that enzymes necessary for the production of select neurotransmitters and microbes known to produce these neurotransmitters are intimately linked to certain microbes. My findings show that a diet constructed with DNA metabarcoding data is not an accurate predictor of microbiome composition, leading to a need or more research into why this could be. There is a need for individualized diet data that goes down to the level of dietary components, versus the level of plant species, in order to accurately measure the impact of diet on microbiome composition. My findings also show that prevalence and abundance of certain microbes can predict the prevalence and abundance of certain microbes associated with neurotransmitters, meaning that these microbes may be intimately connected with the production of neurotransmitters.

Micro-Organoids Generation by a Gel Droplet Platform for Cancer Drug Screening

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Several alternatives have been applied for modeling disease progression. In the context of cancer progression modeling, spheroids provide a more physiologically relevant tumor microenvironment. However, spheroid production faces limitations in reproducibility and time efficiency.

To address these challenges, we proposed the production of microgels using an elliptical pipette for cell encapsulation by droplet emulsion for high-throughput drug screening. This approach enabled rapid and reproducible creation of micro-organoids, with microdroplets uniformly sized (380-420 μm in diameter) in < 5 minutes per channel, scalable for multi-channel systems. The controlled microenvironment enhances reproducibility and allows for size control of tissue constructs.

The microgels were generated using norbornene-modified hyaluronic acid (NorHA) polymer as ECM mimic. Prostate (LNCaP) and ovarian (RFP-OVCAR5) cancer cells were seeded on an Aggrewell. The spheroids were encapsulated using the polymer solution and combinations of DTT and MMP-sensitive crosslinker to allow for ECM degradability and increase the rate of the cell proliferation. Viability assays demonstrated 77% viability at day 1, rising to 91% by day 8. WST-1 proliferation assays indicated increased mitochondrial activity post-encapsulation.

The platform facilitated anticancer drug screening on micro-organoids, with IC50 calculations revealing the viability of multi-cellular constructs when exposed to doxorubicin (DOX) and enzalutamide (ENZ). IC50 values for LNCaP spheroids were approximately 0.037 μM for DOX and 1 μM for ENZ, while for OVCAR, DOX's IC50 was ~1 μM. Concentration curves highlighted limitations in drug diffusion within spheroids, with a plateau indicating reduced effectiveness beyond a diameter threshold (>200 μm).

The observed plateau in drug concentration implies that larger tumor sizes may not respond optimally to certain drugs, highlighting the importance of considering tumor size in treatment decision-making. Incorporating such knowledge into drug screening platforms allows for more targeted and personalized cancer therapies, ensuring that patients receive treatments that are most effective for their specific tumor conditions.

Efficacy of Mammalian Aquaporin Inhibitors in Treating Breast Cancer Metastasis

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Breast cancer is the most diagnosed cancer among women and the second leading cause of cancer related deaths in the U.S. Aquaporins (AQPs) have been identified as having roles in breast cancer progression and metastasis. Aquaporin-7 (AQP7) is a channel protein belonging to the family of aquaglyceroporins. AQP7 facilitates the permeation of water and glycerol in addition to other small uncharged molecules. AQP7 as well as other AQPs are essential for water homeostasis, fat metabolism, and proliferation. While AQP7 expression has been detected in the breast, the physiological role of AQP7 remains largely unknown. Previously, we established that abnormally high AQP7 expression is associated with the progression and metastasis of breast cancer. We demonstrated genetically, both *in vitro* and *in vivo*, that AQP7 is necessary for proliferation, primary tumor progression, and metastasis. AQP7 knockdown significantly reprogrammed cell metabolism and changed oxidative stress tolerance. We reasoned that AQP7 is a targetable vulnerability that can overcome breast cancer metastasis and increase treatment efficacy. Utilizing AQP inhibitors in this study, we investigated whether therapeutic inhibition of AQP7 can reduce tumor progression and increase the therapeutic efficacy of endocrine therapy in breast cancer. To do this, we evaluated the consequences of the aquaporin inhibitors Auphen, a pan-AQP inhibitor, and Z433927330, an AQP7 selective inhibitor. Interestingly, the aquaporin inhibitor Auphen cooperates with endocrine therapy Tamoxifen to reduce the viability of breast cancer cells in culture and tumor *in vivo*, which suggests that Auphen treatment makes the cells more responsive and susceptible to Tamoxifen. Together, this study highlights that AQPs, such as AQP7, are a potential cancer-specific therapeutic vulnerability, and AQP inhibition can be exploited for therapeutic benefit in overcoming endocrine therapy resistance. Also, further development of novel aquaporin inhibitors and developing a better mechanistic understanding of the physiological role of aquaporins remains needed to advance treatments for breast cancer.

Fishing for Clues: Identifying Green River Formation Fossils via Morphological Traits

Katiebelle Thompson

University of Notre Dame, Museum of Biodiversity

The Green River Formation is a collection of rock layers dating back to the early and middle Eocene era (53.5 to 48.5 million years ago). Its two fossil beds have produced some of the most intact and well-preserved specimens of fishes, bats, insects, and plants from this period. In this project, I worked to identify, to the lowest possible taxonomic level, 13 fish specimens from the Green River formation that were recently donated to the Museum of Biodiversity. By examining their body plan, scale morphology, facial shape, and fin ray counts, I was able to identify 6 individuals to species, and 3 to family; two specimens were unrecognizable because of condition, and two multiple taxon slabs require further investigation. The most notable specimen was identified as *Amphiplaga brachyptera*, a species which makes up 1% of the fish population at these sites. These results reveal the specimens' great educational and research value for students and researchers at Notre Dame, as well as at other research institutions. They can be utilized for studies of comparative ecology, evolution, and paleoecology. In this project, I have also developed a polychotomous key for the fishes of the Green River Formation that can be used in conjunction with the museum's specimens. Using this, students of all age levels can be introduced to fossil observation in a classroom setting. It will also be used in a new interactive museum display that will allow visitors to Notre Dame to step into a paleontologist's shoes.

Adult Human Heart ECM Improves Human iPSC-CM Function via Mitochondrial and Metabolic Maturation

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During myocardial infarction, billions of cardiomyocytes die, and while cell-based therapies have potential applications, their success is limited by the immature characteristics of in vitro generated induced pluripotent stem cell (iPSC) derived cardiomyocytes (iCMs). Extra cellular matrix (ECM) has recently been shown to retain tissue memory and can drive unspecified cells towards tissue specific differentiation for multiple organs. From this, we characterized adult human heart left ventricular ECM components and its effect on iCMs maturity from pre- conditioning iPSCs with ECM prior to differentiation to iCMs. We examined if the generation of a cardiac microenvironment caused cells to differentiate prior to small molecule-based iPSC differentiation techniques and which component of the ECM were responsible for these effects.

Preconditioning iPSCs with ECM yielded enhanced iCMs with increased metabolic maturity and a more complex mitochondrial network and coverage providing an enhanced energy metabolism. To determine which component of the ECM caused these effects, ECM was heat denatured to eliminate protein content and sonicated to release matrix bound vesicles. Subcellularly, mitochondrial network structure differed based on ECM manipulation with ECM, sonicated ECM, and EV treated groups having increased network structures. We conclude that the factors benefiting iCMs maturity are not only the ECM proteins, but might be contributed to the glycoproteins and proteoglycans. Cardiac ECM pretreatment of iPSCs can be applied to promote the maturation of iCMs for implementation in iCMs cell-based therapies, in vitro cardiac disease modeling, and drug screening assays.

Investigating the Relationship between Legal Evidence Standards and Exoneration Rates

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This research paper investigates the relationship between legal evidence standards, and the frequency of exonerations in the United States criminal justice system. Legal evidence standards serve as criteria for the admission of expert testimony and scientific evidence in court proceedings, with variations in their application across different jurisdictions. Drawing on empirical data and case studies, this study seeks to analyze whether there exists a discernible association between the severity of these standards and the number of wrongful convictions overturned through exonerations. By examining exoneration rates in states that adhere to different legal evidence standards, this research aims to provide insights into the efficacy of these legal frameworks in safeguarding against miscarriages of justice. The findings of this study may contribute to ongoing discussions surrounding evidence admissibility standards and their implications for ensuring fairness and accuracy in criminal trials.

Optimization of Tryp-N™ for Pyroglutamic Acid Avoidance

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Mycobacterium tuberculosis, the causative agent of tuberculosis, leads to over a million deaths each year. The ESX-1 secretion system is vital for *M. tuberculosis* pathogenicity, and the majority of the substrates it secretes are dependent upon EsxA, which is itself dependent upon the ESX-1 secretion system. N-terminal acetylation (NTA) of EsxA has been shown to correlate with *M. tuberculosis* virulence. As a result, protein N-terminal acetylation is an area of increasing interest in tuberculosis research. Our lab previously developed a method of NTA quantitation using mass spectrometry for bottom-up proteomics, but this method is hindered by a highly prevalent contaminant, pyroglutamic acid. Pyroglutamic acid forms from cyclization of glutamic acid exposed at the N-terminus of a peptide after the proteolytic digestion used for bottom-up proteomics. The removal process is lengthy and changes the peptide amino acid sequence, complicating peptide identification and analysis. The N-terminal protease Tryp-N has unique cleavage sites that should prevent formation of N-terminal glutamic acid and thus of pyroglutamic acid. However, digestion conditions for Tryp-N have yet to be optimized. Here, we synthesized a putative colorimetric Tryp-N-specific substrate and tested its digestion. Substrate absorbance did not change when exposed to Tryp-N, but we successfully optimized Tryp-N digestion conditions using the generic substrate Azocasein. We demonstrate that Tryp-N prevented pyroglutamic acid formation in digests of bovine serum albumin and *Saccharomyces cerevisiae* lysate even when the digested peptides were aged at high pH or treated with the enzyme Qcyclase to promote pyroglutamic acid formation.

Plating for the Planet:Using Psychology to Slash Dining Hall Food Waste

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Addressing the pervasive issue of food waste in college dining halls, 'Plating for the Planet' emerged as a targeted intervention integrating psychologically persuasive signage, informed by cognitive and social psychology principles. Collaborating closely with dining hall staff, the project leveraged insights from an extensive literature review into visually impactful signage aimed at behavioral influence. Initial findings revealed slight evidence of a positive effect of the signs, with a smaller increase in a waste-per-transaction measure during the first month of the signage compared to the same period in the previous year. Additionally, there was a larger decrease in this measurement during the last three weeks of the signage compared to the same time period in the previous year. The initiative aspired to cultivate enduring sustainability habits among students. Finally, we point towards possible future studies that might survey students before and after the signage manipulation to measure baseline knowledge and attitudes toward food waste and any change in them.

Determining a Timeline for AR Inactivation in Androgen Sensitive Prostate Cancer

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Androgens, male sex hormones causing a broad range of physiological effects in development, are known to exert their effects via the androgen receptor (AR), and studies have shown that AR activity is largely involved in regulating human health with aberrant AR function leading to many diseases including prostate cancer. While AR activation has been widely studied, AR deactivation is under-investigated. Here, we hypothesize that androgen metabolism can eventually lead to AR inactivation, and AR may be exported from the nucleus for secondary rounds of activation or degraded. To test our hypothesis, we utilized two prostate cancer cell lines: LNCaP, which expresses enzymes capable of metabolizing androgens, and C4-2, which is unable to metabolize androgen. Both cell lines were starved in charcoal-stripped FBS, and were subsequently treated with DHT, a more biologically active form of testosterone, and the stable synthetic androgen R1881, which cannot be metabolized in both LNCaP and C4-2. Cells were lysed and samples were collected at 6 time intervals (0hr, 6hr, 10hr, 24hr, 34hr, 48hr) spanning a 48-hour period, and the change in AR activity was reflected by measuring the mRNA levels of AR target genes (PSA, FKBP5, TMPRSS2) in comparison to RPLP0 as a control through RT-qPCR. In LNCaP cells, it was determined that AR target genes are transcribed up to 24 hours after treatment when treated with DHT, indicating that with androgen metabolism, AR deactivation occurs after 24 hours; when treated with R1881, target genes are continuously transcribed due to the lack of R1881 metabolism. In C4-2 cells, target genes are continuously transcribed at high levels with both DHT and R1881 treatments due to the cell line's incapability of metabolizing androgens. These results support the hypothesis that androgen metabolism leads to AR inactivation, and suggest that this change occurs around 24 hours after androgen treatment.

Understanding Disaster Resilience: Insights from Low-Income Communities in Puerto Rico

Yoyo Wang

University of Notre Dame

As the frequency and intensity of climate change-related disasters continue to rise globally, this project seeks to address the urgent need to improve disaster resilience for low- income communities in Puerto Rico. By integrating literature reviews, empirical studies, and household survey data, the study identifies high levels of concern among residents about natural disasters, coupled with low levels of preparedness and inadequate actions for resilience. Specifically, vulnerabilities were most pronounced among the elderly, those with lower educational attainment, childless and unemployed individuals, and residents of flood- prone areas. Furthermore, the research highlighted a significant gap in insurance coverage across similar demographics. These insights inform several policy recommendations aimed at enhancing disaster resilience. Key suggestions include the development of affordable insurance plans with rapid payouts, specifically through microinsurance policies tailored to the needs of vulnerable populations. Additionally, the study advocates for universal preparedness education that emphasizes inclusivity and accessibility for all community members, ensuring that resilience-building efforts are broadly implemented. The research underscores the critical need for targeted interventions to improve disaster preparedness and response among Puerto Rico's low-income households. By addressing the specific vulnerabilities and challenges identified, these policy recommendations aim to foster a more resilient and supportive infrastructure for facing natural disasters in Puerto Rico and similar settings.

Grains of Saliency:
Optimizing Saliency-based Training of Biometric Attack Detection Models

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Incorporating human-perceptual intelligence into model training has shown to increase the generalization capability of models in several difficult biometric tasks, such as presentation attack detection (PAD) and detection of synthetic samples. After the initial collection phase, human visual saliency (e.g., eye-tracking data, or handwritten annotations) can be integrated into model training through attention mechanisms, augmented training samples, or through human perception-related components of loss functions. Despite their successes, a vital, but seemingly neglected, aspect of any saliency-based training is the level of salience granularity (e.g., bounding boxes, single saliency maps, or saliency aggregated from multiple subjects) necessary to find a balance between reaping the full benefits of human saliency and the cost of its collection. In this paper, we explore several different levels of salience granularity and demonstrate that increased generalization capabilities of PAD and synthetic face detection can be achieved by using simple, yet effective saliency post-processing techniques across several different CNNs.

Novel Strategy to Block Obesity-Induced SREBP1 Activity Via HSP90β-Selective Inhibition For Ovarian Cancer

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Obesity exacerbates ovarian cancer (OvCa) outcomes by increasing metastasis and reducing therapy response. Our previous research establishes a link between obesity, metastasis, and a decrease in therapeutic response, with sterol regulatory element binding protein 1 (SREBP1), a transcription factor governing fatty acid biosynthesis and lipid transport, playing a pivotal role. Therefore, targeting mechanisms stabilizing SREBP1 offers an alternative strategy worth exploring. Our prior study showed that the combination of a SREBP1 processing inhibitor with standard chemotherapy reduced OvCa recurrence rates without impacting initial treatment response. SREBP1 is a client protein of HSP90β, which helps with the stabilization of SREBP1. Pan-inhibition of HSP90 results in on-target toxicity due to the inhibition of HSP90α, which contributes to cardio and ocular toxicities in clinical trials. HSP90β activity is more clinically relevant to lipid dysregulation in multiple metabolic diseases and studies suggest that HSP90β isoform-specific inhibitors might be very useful for the treatment of metabolic diseases. We hypothesize that selective inhibition of HSP90β will lead to down-regulation of SREBP1 and will enhance therapeutic efficacy when used in combination with standard-of-care chemotherapy (SOC). Human OvCa cells (OvCar8) were treated with increasing concentrations of an HSP90β-selective inhibitor NB21 or the pan-inhibitor 17-AAG and the expression of SREBP1, HSP90α, and HSP90β proteins were evaluated by western blot. In contrast to the modulation of HSP90α expression observed with the pan-inhibitor 17-AAG, HSP90α levels remained constant when treating with HSP90β-selective inhibitor. Additionally, reduced expression of the precursor and nuclear SREBP1 were observed with the HSP90β-selective NB21 treatment, supporting the use of HSP90β inhibitors as an alternative therapeutic strategy in OvCa to regulate SREBP1 processing with lower on-target toxicity. In conclusion, our data suggested that HSP90β -specific inhibition is a feasible strategy to block obesity-induced SREBP1 activity and provided alternative approaches for long-term combination therapeutics.

Self-Efficacy's Moderating Role in Emotion Regulation and NSSI

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Non-suicidal self-injury (NSSI) is a pervasive concern among young adults, often serving as a coping mechanism for managing emotional distress (McRae et al., 2020, Taylor et al., 2018, Bentley et al., 2014). Despite its prevalence and adverse outcomes such as suicide, limited research has explored the intricate interplay between emotion regulation (ER), regulatory emotional self-efficacy (SE), and NSSI. This study aimed to investigate the moderating role of SE in the relationship between positive and negative ER and NSSI behaviors among undergraduate students.

Using a sample of 252 participants, including individuals with and without NSSI history, participants completed measures assessing ER, SE, and NSSI behaviors. A logistic regression was run to examine the relationship between positive and negative ER and NSSI; then, a moderation analysis was conducted using the SPSS PROCESS Macro to examine the effects of SE. Demographic characteristics were tested for potential inclusion as covariates. Significance was determined at $p<0.05$.

Results indicated that there was a direct effect of negative ER on NSSI. SE did not emerge as a significant moderator in the relationship between positive and negative ER and NSSI behavior. This finding contributes to the growing body of literature highlighting the complexity of NSSI (Hasking et al., 2008). While past research has suggested the potential role of SE in mitigating maladaptive behaviors, such as NSSI (Pilch et al., 2021), these findings underscore the need for continued investigation into the mechanisms underlying NSSI and the factors that may influence its development and persistence (Chen et al., 2022). Understanding these relationships is essential for informing targeted interventions aimed at promoting healthier coping strategies and reducing reliance on self-injury as a maladaptive behavior among college students.

Well-Posedness of the Nonlinear Schrödinger Equations on the Line

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The nonlinear Schrödinger equation $\partial_t u + \partial_x^2 u + \lambda N(u) = 0$ is a type of dispersive partial differential equation, which describes the behavior of wave-like phenomena in nonlinear media. We study the well-posedness of the Cauchy problem (initial value problem) of the nonlinear Schrödinger equations on the line with two types of cubic nonlinearities with initial data $u_0(x) = u(x, 0)$ in rough Sobolev spaces. Specifically, we show that given initial data in some Sobolev space, a solution exists, is unique (in some solution space), and depends continuously on the initial data. First, using Fourier analysis, we solve the forced linear problem to obtain a solution formula in terms of the data and the forcing. Then we replace the forcing by the cubic nonlinearities to obtain an iteration map for which its fixed point will be the weak solution. Then, we estimate this solution in Bourgain spaces and bound it by the Sobolev norm of the data and different Bourgain norm of the forcing. This suggests that the iteration map can become a contraction on an appropriate solution space so that we can invoke Banach fixed point theorem to get well-posedness, provided that we can prove the required trilinear estimates for the cubic nonlinearities. We prove that for nonlinearities $N_1 = u|u|^2$ and $N_2 = \bar{u}|u|^2$, the Cauchy problem of the nonlinear Schrödinger equation on the line is locally well-posed for sufficiently small initial data $u_0 \in H^s(\mathbb{R})$ for $s > 0$.