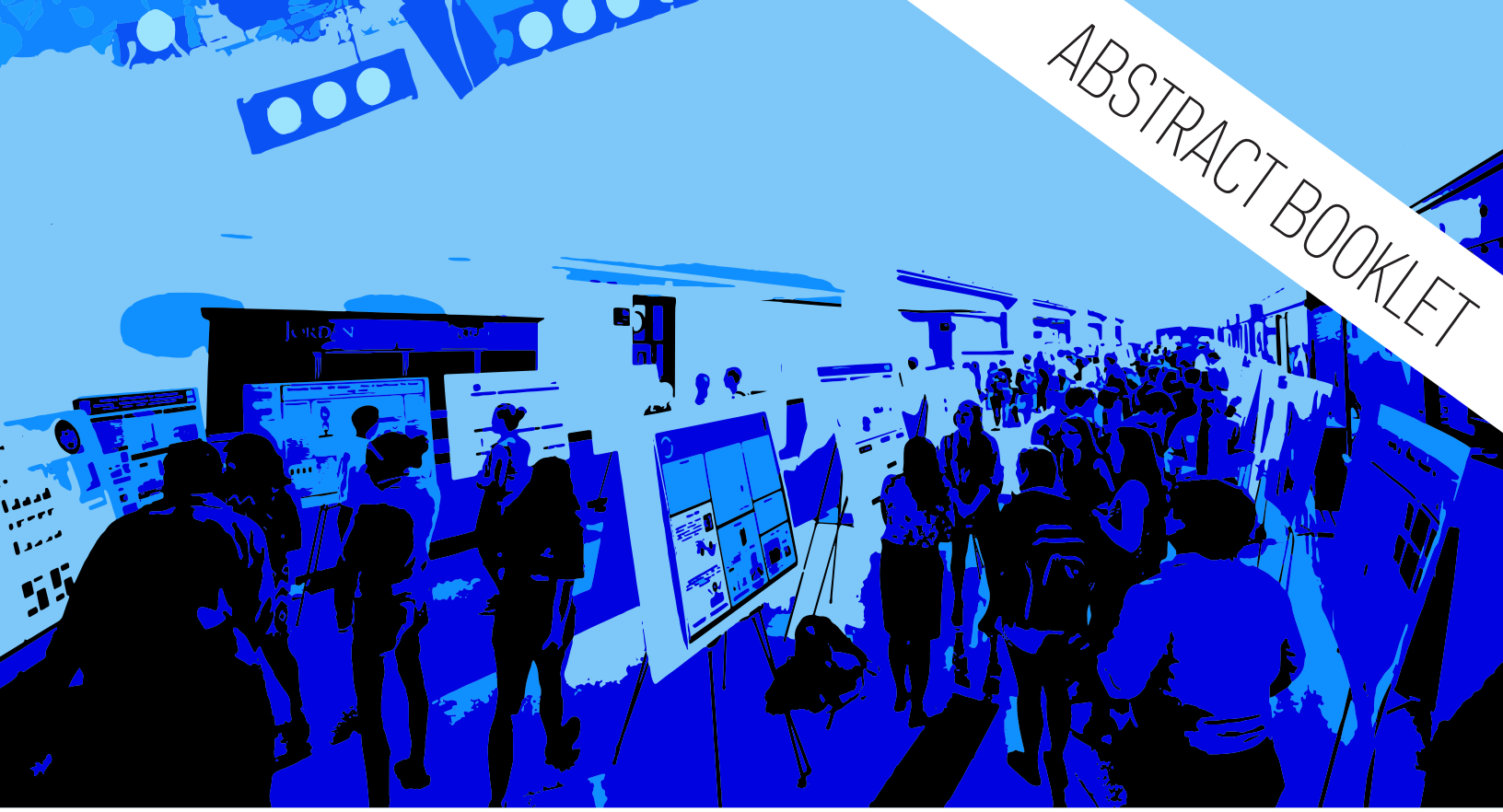

ABSTRACT BOOKLET

COS JAM 2023

COLLEGE OF SCIENCE JOINT ANNUAL MEETING

Thursday, May 4th · 1-5 PM · JORDAN HALL GALLERIA

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

2:00-3:30 Concurrent Oral Session talks

3:30-4:30 Poster Session 2 (Even numbered poster presentation & Spirit of Science Presenters)

refreshments will be provided

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COS JAM Schedule

Thursday, May 4, 2023 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) & NIRSEF Presenters

Refreshments will be provided during poster sessions.

Concurrent Oral Session 1:
Jordan 101
Moderator: Dr. Steve Wietstock

2:00-2:15	**Dorrian Cohen** The Last of Fung-Us: Evaluating the Antifungal Activity of a Synthetic Enterocin Peptide Library Designed From Minimal Bioactive Alpha-Helical AS-48-Bacteriocin
2:15-2:30	**Katherine Minton** Investigating Drug-Induced Inhibition of VRK1-Mediated Phosphorylation as a Novel Cancer Therapeutic Approach
2:30-2:45	**Ciara Fay** Palladium or Zinc Triggered Leakage from Engineered Liposomes
2:45-3:00	**Garrett McFadden** Automated well-to-well MALDI spotting and analysis using lower cost robotics and custom 3D-printed hardware
3:00-3:15	**Matthew Cauley** Purification and Characterization of Monoclonal Human Plasminogen Antibodies
3:15-3:30	**Brooke Friedman** Pattern Similarity Analysis of Episodic Memory using EEG

Concurrent Oral Session 2: **Jordan 105** Moderator: Dr. Diane Lane

2:00-2:15	**Keo Pangan** An Ecological Study Linking County-Level Demographic and Political Affiliation Characteristics to COVID-19 Cases and Vaccinations in Indiana
2:15-2:30	**Erik Curtis** Leaf litter colonization alters removal rates of eDNA from Common Carp and Steelhead Trout in experimental mesocosms
2:30-2:45	**Jonathan Gilman** Biofilm colonization, nitrate, and labile carbon control nitrate removal in experimental streams
2:45-3:00	**Megan Hilbert** Using experimental streams to understand how ammonium and labile carbon can limit reach-scale nitrification and metabolism
3:00-3:15	**Logan Barrios** Estrogen and progesterone concentrations predict gut microbiome composition throughout reproductive states in female baboons
3:15-3:30	**Brooke Rodriguez** Added Value of Biomeme Franklin™ Real-Time PCR Thermocycler in Pathogen Surveillance

Concurrent Oral Session 3:
Jordan Reading Room
Moderator: Dr. Philip Sakimoto

2:00-2:15	**Nathan Voss** Guiding Sustainable Ecosystem Management and Riparian Development Through Climate Informed Flood Modeling of the St. Joseph River
2:15-2:30	**Savannah Vetterly** Father-Adolescent Attachment and Adolescent Anxiety: A Multi-Informant Growth Curve Analysis
2:30-2:45	**Cameron Sprague** Exploring Gravitational Wave Data for Binary Neutron Star Systems
2:45-3:00	**Piper Shine** Mount Rainier: the Challenge on the Horizon
3:00-3:15	**Isabella Balder and Erin Maron** Play Like a Green Champion Today: How to Make Notre Dame Athletics More Sustainable
3:15-3:30	**Erin Goldman** EIH Waste Management and Application of Design for Sustainability Principles in the College of Engineering

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**.

Name	poster #	Abstract Title
Semeon Afework	**1**	Generational Obesity Alters the Ovarian Metastatic Niche and Promotes Ovarian Cancer Metastasis
Christopher Aiello	**2**	Understanding the Role of Communication in the Father-Teen Relationship within Families Using a Mixed Methods Analysis
Kayla Anderson & Joe Afuso	**3**	Overview of historical mosquito surveillance projects and present-day efforts in St. Joseph County
Shea Aquilano	**4**	Problematic Pipelines: An Analysis of the Performance of LiDAR Technology and Geographic Intelligence Systems to Mitigate Natural Gas Leakage in Appalachia
Alan Avalos y Arceo	**5**	Cellular Reconstruction of Somatosensory Vertebrate Circuitry
Logan Barrios	**6**	Estrogen and progesterone concentrations predict gut microbiome composition throughout reproductive states in female baboons
Matthew Baumstark	**7**	Automated galaxy morphology classification from telescope images
Lauren Beede	**8**	Functional connectivity graphs of large neuronal populations
Chessley Blacklock	**9**	Investigating Relationships between Students' Demographic Characteristics and Competency in AP-Statistics' Attributes
Halen Carbonel	**10**	Synthesis and Complex Formation of (R)-2,2'-binaphthalene-bis-(4,6-di-tert-butylquinone-2-imine) "(R)-Biniq"
Kirsten Bains Williams &	**11**	Better Safe Than Sorry? Tracking the Association Between

Jane Stallman		Safety Behaviors and Anxious Symptoms During the COVID-19 Pandemic
Connor Coyle	**12**	Large Ammonites and Nautiloids of the Lower Lyme Regis Blue Lias Limestone Formation in the Museum of Biodiversity, University Notre Dame, Indiana
Robert Crawford	**13**	Grave-to-Cradle: A Comparison of Reuse and Demolition Approaches to Reconstruction of Detroit's Highland Park High School
Carmela D'Antuono	**14**	Why are Malaria-Carrying Mosquitos Now Biting Outside the Standard Bed Netting Usage Time?
Rebecca Daly	**15**	Paper Analytical Device Lane Development for Qualitative Detection of Chemotherapy Supportive Drug Mesna
Lily Darman	**16**	Anti-tumor efficacy of pan-KRAS SOS1 inhibitors, BI-3406 and BAY-293, in preclinical cholangiocarcinoma models
Eva Deegan	**17**	Drought-driven Changes in Terrestrial Water Use Efficiency Impact Lateral Carbon Transport
Christine DeRosa	**18**	PrIntMap-R: An Online Application for Intraprotein Intensity and Peptide Visualization from Bottom-Up Proteomics
Charlie Desnoyers	**19**	Testing the Tests: Chemical Interferences and Variability in Fentanyl Testing Strips
Chanelly Diaz	**20**	Generational Obesity Alters the Ovarian Metastatic Niche and Promotes Ovarian Cancer Metastasis
Anna Falk	**21**	The relationship between neurophysiological responses and emotional memory after periods of sleep and wake
Ciara Fay & Claire Marshall	**22**	Palladium or Zinc Triggered Leakage from Engineered Liposomes
Meghan Figueras	**23**	Initial Studies Characterizing Vacuoles in the Pathogenic Yeast Cryptococcus neoformans
Julia Florek Carlson	**24**	Effects of para-substitution and protecting groups on gold-catalyzed diyne cyclization

Michael Garza	**25**	Synthesis of a sidechain modified analogue of the bacterial RNAP inhibitor pseudouridimycin
Clayton Glasgow	**26**	Eyes to Ecosystems: a review and meta-analysis of phenotypic plasticity in the fish visual system
Grace Gorman	**27**	Heart Rate Variability in Response to Stress: A Prospective Investigation on the Link with Depressive Symptoms
Emma Hamilton & Rachel Gutierrez	**28**	Irish Choose to Reuse: A Campaign to Reduce Coffee Cup Waste at Notre Dame's Au Bon Pain
Matthew Hicks, Cecilia Cesa, Crystal Lockett, Bailey Brumbaugh	**29**	Investigating the Role of *enah* in Dorsal Root Ganglia Entry into the Spinal Cord during Embryonic Development
Meg Hilbert and Regan Hultquist (Group)	**30**	Game Day Farmer's Booth Pilot Project
Corbin Hite	**31**	There's Something in the Water: The Effects of an Invasive Pondweed (*Elodea canadensis*) on Water Chemistry of an Alaskan Lake
Grace Hsu	**32**	Exploring the Change in Uptake and Interatomic Distances of Ion Mixing of Uranyl Oxalate Hydroxide Hydrate with Rubidium and Cesium Counter Cations
Nicole Iamonaco and Teresa Lyons	**33**	Meta-Analysis of the Relative Influence of Landscape, Diet and Phylogeny on the Gut Microbiome of Macaques Living Throughout Asia
Koryn Isa	**34**	Age Mediates Malignant Peritoneal Mesothelioma and the Peritoneal Microenvironment
Carolina Andrea Jimenez Soto	**35**	Mechanistic Studies of Radical Iridium-Carbon Bond Formation in Iridium Iminoxolene Complexes and Synthesis of Allyl-Iridium Complex and its Characterization

Madeline Johns	**36**	Malaria Knowledge, Attitudes, and Practices in Mankranso, Ghana
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Megan Krause	**41**	Investigating the role of affect on creative problem solving success and intrinsic solving mechanisms
Xiaotong Alex Lin	**42**	Investigating the Role of the CXCL5/CXCR2 Signaling Axis in PyMt Cell proliferation at the Bone Metastatic Niche
Graeme Marshall and Joseph Hagerty	**43**	Palladium Promoted Isomerization of Fatty Acid Double Bonds: A New Approach to Bioorthogonal Chemistry
Anna McCartan	**44**	Quantifying Leaderless Translation Efficiency in Mycobacterium Tuberculosis
Benjamin McCarthy	**45**	Invertebrate Diversity in Great Lakes Coastal Wetlands
Kaitlin McGowan	**46**	Philadelphia Toxics Profile: A Review of the Neurologic Risks Posed by Chemical Releases
Gabe McKenna	**47**	Synthesis of a Substituted Amino-Furanyl
Diane Medina Batista	**48**	Chemiluminescence as a Mechanism to Test for Artesunate in Solution Using Luminol and Hemin in Basic Media
Joshua Mijares	**49**	Roles of Extracellular Vesicles in the Aging Microenvironment and Epithelial Ovarian Cancer Progression: Cell Adhesion and Proteome Profiling
Katherine Minton	**50**	Investigating Drug-Induced Inhibition of VRK1-Mediated Phosphorylation as a Novel Cancer Therapeutic Approach

Kevin Murphy	**51**	Poop in the Pool: How Shrimp Fecal Pellets Affect Nitrogen Flux in the Great Salt Lake
Keo Pangan	**52**	An Ecological Study Linking County-Level Demographic and Political Affiliation Characteristics to COVID-19 Cases and Vaccinations in Indiana
Ana Peczuh	**53**	Happy Planet Hygiene Sustainability Capstone
Madeline Petrikas	**54**	Delineating the Role of Iroquois 5b in Kidney Development
Mikayla Copley, Jake Fuehrmeyer, Emme Hemmerich, Finn Mahoney, Caroline Potts	**55**	Expression and Localization of Arrestin 1, Arrestin 2 and Aaop1in Wh Aedes aegypti during Light Transitions.
Brooke Puccini and Kaela Reisch	**56**	Irish eating green: student sentiment and motivations towards sustainable dining at the University of Notre Dame
Brian Ram	**57**	Does Geography and English Fluency Matter? Measuring Cognitive Vulnerability to Depression in African, European, and U.S. Samples
Christina Randazzo	**58**	My Friend, The Lake: A children's book that explores toxic algae blooms in Lake Erie and how we talk about the Earth
Emily Rao	**59**	Investigating CB1 Receptor-Mediated Mechanisms in Fragile X Syndrome Patient-Derived Induced Neurons
Madeline Reynders	**60**	Challenges Resulting in Low System Effectiveness of Reactive Case Detection Strategies for Malaria Control in the Ashanti Region of Ghana
Emily Richardson	**61**	Evaluation of The Effect of SREBP1 Inhibitor With Chemotherapy As A Potential Combination Therapy Against Obese Ovarian Cancer
Julia Ruelle	**62**	An Analysis of the Effects of Experience and Training on Mental Health and the Ability for Mexican Physicians to Cope During the COVID-19 Pandemic
Jose Salazar Saavedra	**63**	Knockout of the ABC transporter, *SCARLET*, leads to altered behavior and differential gene expression in *Daphnia magna*

Sophia Santoso	**64**	Evaluation of the Effect of SREBP1 Inhibitor with Chemotherapy As A Potential Combination Therapy Against Obese Ovarian Cancer
Olivia Schneider	**65**	Capillary Isoelectric Focusing - Fraction Collector System to Examine Electrophoretic Mobility of Bacteria
Ian Shuman	**66**	Applying a Generalized Joint Attribute Model to the Historical Vegetation-Environment Relationship in the Midwestern United States
Adison Steinke	**67**	Cxcl5/Cxcr2 as Potential Therapeutic Targets in Breast Cancer Bone Metastasis
Seunghoon Sun	**68**	Senescence-associated secretory phenotype induces pyroptotic cell death in normal mammary epithelial cells
Ian Tibbals	**69**	The Development of Small-Molecule Inhibitors of Glycogen Synthase to Treat Cori Disease
Joyce Tipe	**70**	The Feasibility of Solar Technology in Dschang, Cameroon
Victor Tsang	**71**	Sulfur Insertion into Tris(pyrazolylborate) Zinc Thiolate Complexes
Savannah Valerio	**72**	Traditional Adobe Construction: A Future Sustainable Building Practice
Amanda Waelde	**73**	Optimization of Tryp-N for Pyroglutamic Acid Avoidance and Design of a Novel Colorimetric Substrate for N-Terminal Proteases
Josh von Werder and Kristin Schaars	**74**	Ecosystem Contamination by PFAS — the DDT of Our Generation
Rachel Whitehead	**75**	Out With the Old Enemy, In With the New Enemy: Methodology Foundation to Explore Neuroendocrine–to-Luminal Redifferentiation as a Potential Treatment Direction for Neuroendocrine Prostate Cancer
Jessica Williams, Luzmarialena Flores, Brian Johny, Jordan Lam,	**76**	Analyzing The Impact of norpA Exon 4/4a CRISPR-Mediated *Aedes Aegypti* Mutants on Phototransduction and Arrestin Localization in Photoreceptor Cells in Light Transitions

Britney Solis		
Dashiell Wuller	**77**	Mechanistic Studies and Characterization of Radical Iridium-Carbon Bond Formation in Iridium Iminoxolene Complexesn
Therese, Juan, Kaitlin Reisch, Flores, Mohlenkamp (Group)	**78**	Distribution of Per- and Polyfluoroalkyl Substances (PFAS) in the Great Lakes Ecosystem: A Review
Neil McAdams	**79**	Assaying Salinity Tolerance of a South Michigan Zooplankton Daphnia Pulicaria Population

Spirit of Science Presenters—3:30 pm to 4:30 pm

The below Middle School students are the awardees of **The Northern Indiana Regional Science and Engineering Fair (NIRSEF)** that is open to schools in the counties of Elkhart, Fulton, Marshall, and St. Joseph, LaPorte, Porter, and Lake. They will be presenting their data at COS JAM.

Name	**Abstract Title**
Brynleigh Oakes and Ellie Foster, Kankakee Valley Middle School	Mirror Magic
Matthew Huemmer, Mishawaka Catholic School Project titled	How High does a Marble have to start to complete a double loop-the loop on a track
Eleanor Niemier, Schmucker Middle School	How does habitat impact stream water quality? Comparing chemical and biological indicators across four habitats along Juday Creek

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.

Name	**Abstract Title**
May Weston, Marian High School	Platinum Induced Gene Expression Yields Mechanistic Insights to Chemotherapy Resistance
Lucinda Flanagan, St. Joseph High School	The Effect of APC loss on Response to Chemotherapy in Ovarian Cancer Cells
Madelyn Samuels, Marian High School	Identification of Contaminant Proteins in Food
Luke Reynolds, Marian High School	Identification of amino acid residues required for dimerization of the transferrin receptor
Sophie Pairitz, Marian High School	Measuring the Magnetic Field of a Superconductor using a Kitchen Scale

Abstracts for all presenters (Posters and Oral Presentations)

Listed by the first author' last name alphabetically

Generational Obesity Alters the Ovarian Metastatic Niche and Promotes Ovarian Cancer Metastasis

Semeon Afework1, Chanelly Diaz2, Katelyn Dungan 1, Kayla Nenninger1, Yueying Liu1, 3, Jing Yang1, 3, Marwa Asem1, 3, Jeff Johnson1, 3, Phillip Petrasko4, Gifty Marfowaa4, Brooke Kowalski1, Elinor Schnautz1, Morgan McCabe1, M. Sharon Stack1,3 and Tyvette Hilliard1,3

1Department of Chemistry and Biochemistry, University of Notre Dame, Notre Dame, IN, 2Department of Science Business University of Notre Dame, Notre Dame, IN

3Harper Cancer Research Institute, University of Notre Dame, Notre Dame, IN,

4Department of Pre-professional Studies, University of Notre Dame, Notre Dame, IN

Obesity has been linked to an increase in ovarian cancer (OvCa) incidence. OvCa is the most fatal gynecologic malignancy with 75% of women diagnosed at an advanced stage. Poor survival is associated with the metastasis of OvCa, whereby tumor cells detach from the primary tumor and undergo intraperitoneal dissemination homing to secondary sites, often the adipose-rich omentum. The aim of this investigation was to assess the impact of multi-generational obesity on OvCa metastasis and the tumor microenvironment. We utilized a mouse model of generational diet-induced obesity that included maternal cohorts fed either a control (10% Fat; Con) or a western diet (45% Fat; Wes). The female offspring from the maternal cohorts were fed either diet resulting in four offspring cohorts ConCON, ConWES, WesCON, and WesWES. Using MRI, second harmonic microscopy, and flow cytometry we examined the body composition, omental collagen characteristics, and peritoneal immune profile among the offspring cohorts. Our studies indicate that western diet-fed offspring exhibit increased body weight, decreased lean mass, and increased fat mass independent of the maternal diet. Second harmonic generation microscopy revealed an increase in omental collagen meshwork and an increase in anisotropy in mice exposed to a western diet, potentially increasing homing of tumor cells to the omentum. Additionally, omental-specific Tim4+ macrophages, known to play a role in the invasive progression of OvCa, were significantly increased in the peritoneal cavity of WesWES offspring compared to ConCON offspring. A tumor study examined peritoneal tumor metastasis using fluorescently tagged mouse OvCa cells injected into each offspring cohort. Tumor burden was quantified and ascites fluid composite was analyzed by cytokine arrays and flow cytometry for immune cell quantification. WesWES offspring displayed increased omental tumor burden compared to all the dietary offspring cohorts. Western diet-fed mice accumulated more ascites fluid than control diet-fed mice. Furthermore, ascites fluid expressed a significant increase in CXCL13, a major chemokine in adipocytes, and an increase in neutrophils and M2 macrophages in WesWES offspring suggesting an additive effect from generational obesity. These findings demonstrate generational obesity increases OvCa's metastatic tumor burden and negatively impacts the tumor microenvironment.

Understanding the Role of Communication in the Father-Teen Relationship within Families Using a Mixed Methods Analysis

Christopher Aiello

Adolescence is a period of life in which marked change occurs as children adapt to their new roles as emerging adults. Emotional security within the family, or child's sense of confidence in the health of their family unit, has been proposed to protect against negative adolescent outcomes associated with stress (Davies & Cummings, 1994). It is theorized that strengthening emotional security within the family decreases a child's vulnerability to the types of adjustment problems associated with adolescence (Davies et al., 2006). The father-adolescent relationship has been historically under-studied, largely due to societal norms and unquestioned sexist theories (Phares, 1992). Additionally, the Fathering Vulnerability Hypothesis, which proposes that the father-adolescent relationship may be more vulnerable to the negative effects of negative marital conflict (Goeke-Morey & Cummings, 2007). The vulnerability of the father adolescent relationship is significant because it marks a relationship that may be particularly responsive to intervention. The current study used data from the Family Communication Project, an intervention program that aimed to improve communication within the family and improve relationships. A mixed methods protocol was used to better understand if improvements in father teen communication as a result of the study resulted in positive effects in emotional security of the teen. It was determined quantitatively that the intervention treatment conditions did have significant positive effects on communication between fathers and teens, and this improved communication was significantly correlated with increased emotional security longitudinally. Preliminary qualitative analyses confirmed these findings and showed that teens involved in the intervention project talked about changes in communication with their father differently than those that did not experience the treatment conditions. These contribute to the existing literature and call for further emphasis on the father teen relationship in future intervention programs.

Overview of historical mosquito surveillance projects and present-day efforts in St. Joseph County

Kayla Anderson, Joe Afuso, Samuel Rund, Jennifer Robichaud, Brett Davis, and Mary Ann McDowell

University of Notre Dame & St. Joseph County Dept. of Health

Abstract

Mosquito-borne diseases are a significant cause of morbidity and mortality. Specifically in the Midwest, mosquito-borne West Nile Virus (WNV) and Eastern Equine Encephalitis (EEE) are of major concern. In response to these diseases, the state of Indiana has implemented surveillance of mosquito populations with virus pool testing and population abundance measurement. With this project, our lab aims to contribute to the surveillance of vector mosquitoes in St. Joseph County while also gleaning insight from historical records to attain abundance data. Based on predicted mosquito behavioral patterns,, traps were set to monitor mosquito populations at Spicer Lake Nature Reserve starting in summer 2021, with a site at Lydick Bog added in 2022. In addition, historic records monitoring populations within St. Joseph County were organized and examined to be used for further analysis of past trends. Data acquired suggest seasonal patterns in mosquito abundance, and will be further analyzed to find potential connections to environmental factors. This data is essential to inform decisions regarding the ideal time for effective preventative measures and how they may change in the coming years.

Problematic Pipelines: An Analysis of the Performance of LiDAR Technology and Geographic Intelligence Systems to Mitigate Natural Gas Leakage in Appalachia

Shea Aquilano

Abstract

This proposal aims to develop a novel approach to harnessing and analyzing the performance outcomes of integrating remote sensed LiDAR imagery and geographic information systems in the natural gas (NG) pipeline industry. Since 2010, pipeline leaks in the United States have accounted for the emission of over 26.6 billion cubic feet of gas. In 2020 alone, this equated to 21 million metric tons of CO2 equivalent emissions–equating to the emissions of over 4.5 million cars annually. Using light detection and ranging (LiDAR) technology and the latest in machine learning, there is the potential to drastically reduce the level of pipeline incidents by monitoring geographic hazards, changes in land movement, vegetation encroachment and mapping climate risk areas that may contribute to causing a pipe breakage and subsequent spill. By focusing on proactive measures and addressing areas identified as high risk with precision, there is potential to prevent climate related catastrophes, reduce emissions, benefit human health and safety, and direct limited resources to fortifying areas along a line where it's needed the most, eliminating retroactive repair costs and cleanup.

https://environmentamerica.org/center/resources/methane-gas-leaks/

https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle

Cellular Reconstruction of Somatosensory Vertebrate Circuitry

Authors:

Alan Avalos y Arceo, Khang Chau, Zachary Koh, Antonio Dolojan, Fabian Svara, Michel Januszewski, Johann Bollmann, Winfried Dink and Cody J. Smith

Abstract

Sensory neurons are critical to relay external stimuli to the brain. Our understanding of the sensory neuron circuitry relies upon knowledge of its connectivity and interactions with neighboring neuronal populations. However, a detailed description of sensory circuitry in vertebrates and the underlying mechanisms of such information acquisition and transmission needs deeper investigation. Here, we reconstructed vertebrate dorsal root ganglia somatosensory neurons using serial block electron microscopy of the zebrafish spinal cord to understand the neuroanatomical features of a vertebrate sensorimotor circuit. We first manually skeletonized the somatosensory neurons and then utilized automated approaches to reconstruct all the synaptic connections of the somatosensory neurons. Skeletonized tracing of the somatosensory neurons demonstrated their stereotypical bifurcation inside the CNS. We show that these neurons extend multiple hemisegments in the spinal cord, with few secondary branches extending from the primary bifurcated neuron. While in the peripheral nervous system, our reconstructions show the close association that somatosensory axons have with the underlying radial glia limitans. As we reconstructed sensory axon projections and synaptic sites we present quantifications essential to our understanding of a somatosensory neuron's features. This contribution to the larval zebrafish connectome, combined with previous reconstructions in Drosophila, and C. elegans, better allows us to interrogate the foundational neuroanatomical features that impact behavior.

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

Kirsten N. Bains Williams, Jane K. Stallman, Gerald J. Haeffel

University of Notre Dame, Department of Psychology

Research shows that safety behavior use is a risk factor for future anxiety. However, the perception of some safety behaviors changed during the COVID-19 pandemic; behaviors that were once considered unnecessary or excessive were now commonplace (e.g., extra hand washing, monitoring bodily symptoms, avoiding crowds). The purpose of this study was to determine the degree to which the pandemic changed the status of health-related safety behaviors as a risk factor for symptoms of anxiety. To this end, we tested the effect of safety behavior use on future anxious symptoms using a one-year longitudinal design with 8 time points and participants (n = 233) from over 20 countries. Despite possible changes in their perception, high levels of safety behavior use continued to be associated with greater levels of anxious symptoms throughout the pandemic year. However, the outcomes for those engaging in safety behaviors were not all negative. Safety behavior use at baseline was the only predictor of participants' willingness to receive the COVID-19 vaccine (measured one year later).

(Oral Presentation)

Play Like a Green Champion Today: How to Make Notre Dame Athletics More Sustainable

Isabella Balder & Erin Maron

Abstract

Athletics is a large part of the college experience, and Notre Dame is no exception as one of the top Universities in the country. Many universities across the country follow Notre Dame's examples in academics, athletics, and the University's larger mission. Notre Dame has the opportunity to become a leader in another area: sustainability.

Awareness regarding sustainability in athletics is growing throughout the country, and Notre Dame Athletics is in a position to implement change and influence athletics across the country. Every area within athletics can impact the department's sustainability efforts. From the administration to sports nutrition to operations, everyone has a role to play.

In this report, we benchmark Notre Dame to key peer institutions and their sustainability initiatives in athletics. Next, we furthered our research into sustainable athletics and even calculated the carbon emissions of one team's travel. We then hosted a competition among all athletics teams called the Green Cup. Finally, we propose sustainability initiatives for different areas of the athletics department and provide the next steps for Notre Dame.

College athletics needs to be more sustainable and this is possible without fear of hindering athletic performance. Notre Dame has the opportunity to be a leader within this space and can support the university's larger goal by being a powerful force for good and caring for our common home. Notre Dame Athletics can either wait until they are forced to be more sustainable, or they can make changes now and be a leader in this fight.

(Poster & Oral Presentation)

Estrogen and progesterone concentrations predict gut microbiome composition throughout reproductive states in female baboons

Logan A. Barrios University of Notre Dame Department of Biological Sciences Advisor: Dr. Elizabeth A. Archie Coauthors: Chelsea A. Southworth, Mauna Dasari, Jeanne Altmann, Susan C. Alberts, Luis Barriero, Ran Blekhman, Jenny Tung, Elizabeth A. Archie

The mammalian gut microbiome is a complex microbial community whose dynamics affect host health and fitness. In mammals, gut microbial composition shifts across phases of female reproduction (ovarian cycling, pregnancy, and postpartum amenorrhea), but the details of these changes (e.g. what species are involved and how much they change) vary considerably across species and populations. Changes in the steroid hormones estrogen and progesterone may contribute to these dynamics, but the connections between female reproduction, hormone levels, and gut microbiome composition are poorly understood. We will address these gaps using data from the Amboseli Baboon Research Project, a long-term field project based in the Amboseli ecosystem in Kenya. Our dataset consists of 4,060 fecal-based, 16S rRNA microbiome profiles collected from 147 adult female baboons (Papio cynocephalus) over a ten year span. We also have data on fecal estrogen and progesterone concentrations for each profile measured via radioimmunoassay. Using mixed effects models, we will test how Shannon diversity, species richness, and the principle components of a microbiome community composition vary with estrogen and progesterone concentrations, both across all phases of reproduction and within each phase. Our study will be the first to use longitudinal sampling to test the relationships between hormones, microbiome composition, across reproductive states in wild female mammals. Our results will help improve our understanding of the connections between the gut microbiome composition, hormone regulation, and female reproduction.

Automated galaxy morphology classification from telescope images

Matthew Baumstark

Abstract:

The classification of galaxy morphologies is an important step in the investigation of theories of structure formation. While human visual classification remains quite effective and accurate, it cannot keep up with the massive influx of data from emerging sky surveys. Therefore, machine learning methods have been used to automatically classify morphologies. A variety of approaches have been proposed, including crowdsourced visual classification, machine learning methods using designed features, and deep learning. In this work, we first propose simplified versions of three existing image statistics that have been widely used in the literature of galaxy morphologies. We further develop two new interpretable galaxy morphology statistics that can be efficiently extracted from telescope galaxy images. We utilize the massive galaxy image data from the Sloan Digital Sky Survey and demonstrate the effective performance of our proposed image statistics at accurately detecting galaxy shapes, such as spiral and elliptical, when used as features of a random forest classifier. We further compare performance results with other existing automated classification approaches. Our proposed classification procedure can be implemented efficiently in R and Python.

Functional connectivity graphs of large neuronal populations

Lauren Beede

Advisor: Dr. Giuseppe Vinci, Department of Applied and Computational Mathematics and Statistics, University of Notre Dame

Responses to visual stimuli produce a pattern of activity whose structure across the cerebral visual cortex is not yet fully understood. Researchers continue to investigate how neurons communicate with each other and optimize interactions under a variety of experimental conditions. Probabilistic Graphical Models are insightful for neuroscience research, as they let us characterize the relationships between neurons and their functional connections, or the statistical dependence of neural signals, in the form of a graph, where nodes represent neurons and edges connect nodes to denote the presence of a neuronal functional connection. In this study, we estimate functional connectivity graphs from two-photon calcium microscopy imaging data recorded from about 10,000 neurons in a 1mm cube portion of mouse visual cortex in response to visual stimuli consisting of 2,800 natural images. Because of the high-dimensionality of the problem, we use regularized estimation methods, such as the graphical lasso, to recover meaningful functional connectivity graphs. We discuss the statistical problem of graphical model selection in the analysis of high-dimensional neuronal data and describe changes of functional connectivity across different stimuli and other conditions.

Investigating Relationships between Students' Demographic Characteristics and Competency in AP-Statistics' Attributes

Chessley Blacklock

Abstract

This study is motivated by the need to understand more specifically where disparities in learning based on student demographic variables exist within AP Statistics, among its learning attributes. High school students across three cohorts (N=1,036, M age=16.71 years, SD age=0.88; 49.5% female) answered questions of varying AP Statistics attributes as well as providing information about their age, sex, educational attainment by their parents, free/reduced lunch eligibility, and racial identity. Logistic regression revealed that nearly 85% of attributes had at least one variable demonstrate significant disparity, with parental education being the most prevalent. Such findings suggest that certain backgrounds (female sex, URM, low socioeconomic status) of students may disadvantage them in developing mastery of certain AP Statistics attributes. Identifying these disparities may allow organizations to take action against such educational inequalities. However, further investigation is required to verify and proceed.

Synthesis and Complex Formation of (R)-2,2'-binaphthalene-bis-(4,6-di-tert-butylquinone-2-imine) "(R)-Biniq"

Halen Carbonel and Seth N. Brown

University of Notre Dame, Notre Dame, IN

Bis(iminoxolene)metal complexes show promise in catalytic reactions, but enantioselective catalysis would require optically active ligands. The optically active bis(aminophenol) (R)BiniqH4, can be prepared by condensing (R)-(+)-1,1'-binaphthyl-2,2'-diamine, with 3,5-di-tertbutylcatechol in the presence of catalytic acetic acid. The bis(aminophenol) reacts with palladium acetate or potassium tetrachloroplatinate in the air to give the bis(iminosemiquinone) complexes (R)-(Biniq)Pd and (R)-(Biniq)Pt. The free iminoquinone (R)-Biniq, which would be a useful precursor for other bis(iminoxolene) complexes, can be generated either by iodobenzene diacetate oxidation of (R)-BiniqH4 or by condensation of the diamine with 3,5-di-tert-butyl-obenzoquinone.

(Oral Presentation)

Purification and Characterization of Monoclonal Human Plasminogen Antibodies

Matthew Cauley

Dr. Francis J. Castellino

Monoclonal antibodies, through competitive binding, offer a useful advantage in identifying interacting domains in protein-protein binding studies. Group A streptococcus (GAS) bacteria, a human specific pathogen that causes mild to severe infections, expresses virulence factors, including M-protein, streptokinase, and surface enolase which interact with human plasminogen (hPg). To gain insight into the pathogenesis of GAS, particularly the interaction of GAS virulence factors with hPg, monoclonal hPg antibodies isolated from two murine hybridoma cell lines were purified and characterized. VAP-1 and JOY3 hybridoma cell lines were revived and cultured in CD Hybridoma AGT medium containing Fetal Bovine Serum and GlutaMAX-I supplement. The cell culture medium contained the secreted antibodies, which were purified using a hPg-Sepharose 4B affinity chromatography column. The purified antibodies were subjected to epitope mapping through initial dot-blot screening using intact hPg variants and fragments, K1-K3, K4, and K5-SP. Enzyme-linked immunosorbent assay (ELISA) was used to validate the identity of the hPg epitopes. The results indicated that both antibodies recognize similar epitopes through their ability to interact with the K1-K3 fragment of hPg and lack of interaction with the K4 fragment. However, the antibody JOY-3 also interacted with the K5-SP fragment, unlike that of VAP-1. ELISA further demonstrated that the affinity of VAP-1 antibody for hPg and the K1-K3 fragment were comparable, having dissociation constant (KD) values of 0.64 ± 0.22 nM and 0.91 ± 0.13 nM, respectively. The development and continued characterization of additional monoclonal antibodies to hPg may allow for a more extensive evaluation of the domains involved in the interaction of hPg with GAS virulence factors.

(Oral Presentation)

The Last of Fung-Us: Evaluating the Antifungal Activity of a Synthetic Enterocin Peptide Library Designed From Minimal Bioactive Alpha-Helical AS-48-Bacteriocin

Advisor: Dr. Shaun Lee, College of Science, Department of Biological Sciences

Dorrian Cohen

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 previously generated by the Lee Lab 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*. One of these four peptides, peptide 24, has previously been shown to be effective against gram-negative and gram-positive bacteria and another one of these peptides, peptide 19, has previously been shown to be effective against the protozoan parasite *Leishmania donovani*. Early fungistatic/fungicidal tests show that three of the four peptides, 24, 32, and 40, are fungicidal. In 36-hour cell growth tests with these fungicidal peptides, peptide 32 exhibited *C. neoformans* cell counts slightly below those of the antifungal medication fluconazole and peptides 24 and 40 exhibited *C. neoformans* cell counts below those of vehicle control. These findings 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.

Large Ammonites and Nautiloids of the Lower Lyme Regis Blue Lias Limestone Formation in the Museum of Biodiversity, University Notre Dame, Indiana

Connor Coyle

Advisors: Dr. Ronald Hellenthal, Barbara Hellenthal

Fossils from a famous geological formation called the Blue Lias, from Lyme Regis, England, were at the center of the fossil revolution in the 19th Century. In the process of re-identifying and cataloging cephalopod mollusk fossils in the University of Notre Dame Museum of Biodiversity collection, I became curious as to whether unidentified ammonites and nautiloids in the collection might be from Lyme Regis. The purpose of this research was to study these fossils to determine their likely origin and identity.

Ammonoids are an extinct subclass of cephalopods that resembled a squid or nautilus, with the animal residing in the largest shell chamber. Most ammonites and nautiloids were predacious and free swimming (Moore et al. 1952). The Blue Lias is a specific colored limestone and shale in the British Isles of the Lias group, a lithostratigraphic unit (Hallam 1960). Fossils found in this formation are encased in a distinctive blue limestone matrix. The Blue Lias formation spans the Late Triassic Rhaetian stage (208.5 Ma) to the Early Jurassic Sinemurian stage (190.8 Ma) (Ambrose 2001).

In order to identify the fossils, I used the following method: Determined likely locality of each fossil, identified the type of fossil (Ammonite or Nautiloid), used resources to identify fossil characteristics (coiling, whorling, rib splitting, spines, tubercules) and used resources based on gathered information to determine genus and species where possible.

I identified six fossils in the collection to be from the Blue Lias formation. Four fossils were identified as nautiloids of the genus Cenoceras with two identified to species as Cenoceras striatum (Sowerby 1817). The remaining two fossils were identified to be ammonites of the species Arietites bucklandi (Sowerby 1816). This research contributed valuable information to the Museum's fossil collection and database.

Grave-to-Cradle: A Comparison of Reuse and Demolition Approaches to Reconstruction of Detroit's Highland Park High School

Robert Crawford

Advisor: Professor John Onyango, PhD, School of Architecture

Within the last two decades, the city of Detroit has seen substantial regrowth in its Downtown and Midtown areas, but the remainder of the city continues to suffer from the issues of poverty, crime, and racial inequality that have plagued it since the mid-1900s. As cities like Detroit search for architectural and urban design solutions, their focus must be on the abandoned properties that draw life out of the city. One of the common approaches to the problem of deserted buildings—demolition followed by new construction—bears significant environmental costs. Recent conversations around energy and resource conservation have made building renovation and reuse an increasingly popular strategy, but more research is needed to solidify the case for this approach. One method of learning more about the effects of these different approaches is a life cycle assessment (LCA), a comprehensive analysis of a building that accounts for the myriad processes and materials involved in every stage of its life. The LCA strategy was used in this report to analyze and compare the hypothetical results of the following three approaches on a century-old high school in Detroit: 1) demolition and new construction; 2) a cost-effective, short-term renovation; and 3) a more intensive, costly, long-term renovation that would ensure high efficiency and long-lasting resiliency. Unsurprisingly, the demolition approach created the most waste and represented the largest environmental threat. However, beyond making a simple comparison, this report identified the contributing factors that go into all three approaches to arrive at a more complete understanding of the advantages and drawbacks of each.

(Oral Presentation)

Leaf litter colonization alters removal rates of eDNA from Common Carp and Steelhead Trout in experimental mesocosms

Authors: E.M. Curtis, J.L. Tank, E.D. Snyder, P.F.P. Brandão Dias, A.N. Pruitt, A.J. Shogren, D. Bolster, S.P. Egan, K. Bibby, G.A. Lamberti.

Abstract: Declining biodiversity is a growing crisis globally, and the field of conservation is heavily reliant on species monitoring and resultant population data. However, these data are challenging to collect and require intensive sampling along with extensive taxonomic expertise. Environmental DNA (eDNA) is an efficient and non-invasive method of monitoring organisms in aquatic habitats. However, critical knowledge gaps exist regarding controls on eDNA removal from the water column, especially in flowing waters (i.e., streams and rivers). Moreover, allochthonous organic matter inputs via autumn leaf fall is an important seasonal change in stream ecosystems, especially in smaller, headwater streams, and leaf litter accumulation (i.e., debris dams) and decomposition may modify biotic and abiotic conditions that influence eDNA retention in streams. We conducted experimental releases of Common Carp (Cyprinus carpio) and Steelhead Trout (Oncorhynchus mykiss) eDNA in recirculating mesocosms (n=24) to quantify eDNA removal rates in conjunction with varying densities and decomposition stage of submerged leaf litter. We found that leaf density had no significant effect on eDNA removal rates, but removal rates for smaller eDNA particles (0.4 μm) were 74% higher in mesocosms with biofilm-colonized leaves relative to those with "fresh" uncolonized leaves (Tukey-Kramer Test, $p < 0.001$). In contrast, we found no significant difference in removal rates between colonized and uncolonized leaves for larger eDNA particles (1.2 μm). Overall, eDNA removal rates were higher for smaller eDNA particles, but only in the presence of biofilm-colonized leaves, suggesting a biological mechanism for eDNA removal from the water column. These results suggest that seasonal leaf litter plays a role in the fate of eDNA particles, which is mediated by eDNA particle size and leaf litter quality. Understanding controls on eDNA removal has the potential to assist in the interpretation of eDNA data in natural systems.

Why are Malaria-Carrying Mosquitoes Now Biting Outside the Standard Bed Netting Usage Time?

Carmela D'Antuono, Maxwell Machani, Yaw Afrane, Samuel Rund

Anopheles mosquitoes, which are the vectors for malaria-causing parasites, have shifted their feeding behavior to bite earlier or later than the classical biting time. We have recently shown that the onset time (start of activity) of these early, late, and classical-biting mosquitoes is constant, despite the biting time-differences. As a vector for malaria, the behavior of anopheles mosquitoes has large implications for public health concerns. One of the most common practices to avoid the biting of these mosquitoes is the usage of insecticide-treated bed nets during the time in which mosquitoes are active. These mosquitoes are biting at different times in a day than the bed nets are being used and we don't know why. Two possible theories for the behavior shift, that are analyzed, are phenotypic plasticity (adaptability) in biting times, or canalization (the evolution) of specific distinct biting time niches. This research relies on new technology, BG-Counters, to investigate host seeking behavior of anopheles gambiae mosquitoes to improve public health policies. These counters will allow for the automated monitoring of numerous mosquito behaviors including house entry and a proxy for biting.

Paper Analytical Device Lane Development for Qualitative Detection of Chemotherapy Supportive Drug Mesna

Rebecca Daly

Advisor: Dr. Marya Lieberman, Department of Chemistry and Biochemistry, University of Notre Dame, Co-Authors: Rachel Roller and Max Wilfinger

The current global pandemic of falsified medicine threatens the credibility of pharmaceutical manufacturers and poses a particularly difficult challenge to developing countries. As a result, Paper Analytical Devices were developed to combat negligence in the production and distribution of pharmaceutical drugs. PAD lanes detect drug purity by targeting functional groups in pharmaceuticals through color-generating reactions [Stevenson, 2016]. ChemoPADs utilize microfluidic assays to qualitatively and semi-quantitatively analyze chemotherapy and chemotherapy-supportive drugs. Mesna, a chemotherapy-supportive drug, detoxifies acrolein to prevent hemorrhagic cystitis in patients [Reddy and Winston, 2022]. Chemotherapy patients are particularly vulnerable to the effects of substandard drugs like mesna due to their weakened immune systems. This project was developed to generate a PAD lane that would detect the presence of mesna in a sample. Mesna, sodium 2-mercaptoethane sulfonate, contains a thiol group that serves as its most prominent functional group [U.S.]. A reaction mechanism that exhibited a vibrant color change in the presence of a thiol group was explored in order to visually detect mesna. When blue-colored copper(II)-neocuproine is introduced to a reducing agent, it converts to an orange-colored copper(I)-neocuproine. A series of experiments were conducted to confirm that mesna successfully reduces the copper complex. The reagents of this study were added to a PAD to create the mesna identifying lane. Further semi-quantitative research will include how the intensity of the orange color is influenced by the concentration of mesna in order to identify substandard formulations. Additionally, other color-generating reactions that thiols can undergo will be explored.

Anti-tumor efficacy of pan-KRAS SOS1 inhibitors, BI-3406 and BAY-293, in preclinical cholangiocarcinoma models

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Cholangiocarcinoma (CCA) is a deadly disease with a poor prognosis. The current standard treatment for cholangiocarcinoma is Gemcitabine plus Cisplatin (GemCis) chemotherapy, which leads to a median survival of less than 12 months. Several oncogenic mutations play a role in cholangiocarcinoma progression and a mutation in KRAS has been linked to approximately 25% of CCA cases. We evaluated two pan-KRAS SOS1 inhibitors, BI-3406 and BAY-293, which target the Son of Sevenless 1 (SOS1) protein, an activator of KRAS in cholangiocarcinoma. CCA cell lines EGI-1 (KRAS mutant), CCLP-1 (KRAS mutant), and TFK-1 (KRAS wildtype), and normal cholangiocytes MMNK-1, were cultured and in vitro cell proliferation and protein expressions were analyzed. In vivo tumor growth inhibition experiments were performed in CCLP-1 subcutaneous xenografts. In vitro cell proliferation decreased by BI-3406 and BAY-293 treatment, and an additive effect was observed with combination treatment of these inhibitors and GemCis. Percent inhibition in cell proliferation at low concentrations (Gem 100 nm, Cis 100 nm, BI-3406 1 μM, BAY-293 1 μM) in GemCis, BI-3406, BAY-293, GemCis+BI-3406 and GemCis+BAY293 treatments was 64.57%, 35.43%, 33.06%, 72.00%, 73.80% (EGI-1); -6.65%, 18.95%, 19.10%, 12.34%, 49.42% (TFK-1); 36.8%, 13.97%, 26.05%, 49.80%, 59.39% (CCLP-1); 72.68%, 36.10%, 60.06%, 87.65%, 93.70% (MMNK-1), respectively. Immunoblot analysis revealed that treatment with BI-3406 and BAY-293 caused a decrease in protein levels responsible for cell growth and proliferation such as PS6, SOS1, p-ERK, p-MEK and p-AKT was observed, and an increase in apoptosis-related proteins such as cleaved-Caspase-3, cleaved-Parp and Bax. In vivo experiments in CCLP-1 xenografts demonstrated that net tumor growth in the control, GemCis, BI-3406, and GemCis+BI-3406 groups was 78.6 mm^3, 25.7 mm^3, 21.6 mm^3 and 6.2 mm^3, respectively. The antitumor effects of novel inhibitors BI-3406 and BAY-293 shown in both in vivo and in vitro experiments provide hope for improved treatments for the disease moving forward.

Drought-driven Changes in Terrestrial Water Use Efficiency Impact Lateral Carbon Transport

Eva Deegan, University of Notre Dame, Notre Dame, IN, United States, Ceara J Talbot, University of Notre Dame, Biological Sciences, Notre Dame, IN, United States and Stuart Jones, University of Notre Dame, Biological Sciences, Notre Dame, United States

The intensification of hydrological conditions, including drought, drives changes in net ecosystem exchange (NEE). Plant water-use efficiency (WUE) mediates these changes through the coupling of GPP and evapotranspiration (ET) and can increase as a physical adaptation in response to water stress, altering the magnitude of globally significant carbon (C) fluxes. Since WUE impacts both runoff and ecosystem carbon content, changes in WUE will likely impact lateral C transport (LCT) from terrestrial to aquatic ecosystems, a historically unaccounted-for component of NEE. Previously, we found that LCT is sensitive to model vegetation parameters, and particularly water-use efficiency (WUE) due to its impacts on both C and water cycling. However, more research is needed to determine whether accounting for short-term drought driven changes in WUE can improve predictions of LCT at the watershed scale. Here, we apply a coupled terrestrial-aquatic C and hydrology process model at the watershed scale and use a data assimilation approach to quantify the impact of dynamic WUE on LCT estimates compared to a traditional static WUE parameter. We calculate dynamic WUE from Eddy covariance flux tower data collected from the Duke Forest AmeriFlux site and compare terrestrial and aquatic model outputs to MODIS and USGS stream gauge data, respectively. We run two model scenarios for each of the three vegetation sites present at Duke Forest (grassland, hardwood forest, and pine plantation). In scenario 1, we use a static PFT-specific WUE parameter. In scenario 2, we use dynamic WUE data. Study results suggest that using dynamic WUE data is valuable for modeling LCT response to drought, and that predictability is improved yet highly depends on vegetation type. Therefore, the study indicates that dynamic WUE data has an important role in terrestrial aquatic models for accurately quantifying and predicting carbon fluxes in response to future environmental stress and change.

PrIntMap-R: An Online Application for Intraprotein Intensity and Peptide Visualization from Bottom-Up Proteomics

Simon D. Weaver, Christine M. DeRosa, Sadie R. Schultz, and Matthew M. Champion

Bottom-up proteomics (BUP) produces rich data, but visualization and analysis are time consuming and often require programming skills. Many tools analyze these data at the proteomelevel, but fewer options exist for individual proteins. Sequence coverage maps are common, but do not proportion peptide intensity. Abundance-based visualization of sequence coverage facilitates detection of protein isoforms, domains, potential truncation sites, peptide “hot-spots", and localization of post-translational modifications (PTMs). Redundant stacked-sequence coverage is an important tool in designing hydrogen–deuterium exchange (HDX) experiments. Visualization tools often lack graphical and tabular-export of processed data which complicates publication of results. Quantitative peptide abundance across amino acid sequences is an essential and missing tool in proteomics toolkits. Here we created PrIntMap-R, an online application that only requires peptide files from a database search and FASTA protein sequences. PrIntMap-R produces a variety of plots for quantitative visualization of coverage; annotation of specific sequences, PTM’s, and comparisons of one or many samples overlaid with calculated fold-change or several intensity metrics. We show use-cases including protein phosphorylation, identification of glycosylation, and the optimization of digestion conditions for HDX experiments. PrIntMap-R is freely available, open source, and can run online with no installation, or locally by downloading source code from GitHub.

Testing the Tests: Chemical Interferences and Variability in Fentanyl Test Strips

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Fentanyl Test Strips (FTS) are lateral flow competitive immunoassay testing strips. FTS works by using antibodies which selectively bind to fentanyl and some of its analogues. Through microfluidic action, the sample is absorbed into the strip where functionalized gold nanoparticles capped with a fentanyl antigen compete with fentanyl in solution to bind to two sites on the nitrocellulose membrane. Any fentanyl above a minimum concentration for detection will prevent the binding of the red gold nanoparticle to the antibodies, which means a positive test will only have one red band, compared to two. FTS are used for drug checking in on-site tests and criminal investigations, and designed for the preliminary detection of fentanyl in forensic urine samples. FTS are now being used in an off-label way as a harm-reduction based drug checking tool. With this off-label usage comes discrepancies in the limit-of-detection and potential for false positive results. In addition, production differences are seen between production lots and brands. For example, when I took apart different lots of one popular brand of FTS, I found either one or two conjugate pads where the functionalized gold nanoparticles are stored.

The goal of this research was to develop a methodology for an effective screening of fentanyl test strips and a suitable image analysis technique. I developed a method to screen the FTS which maximized the color intensity of the control and test bands of the strip through the use of a light box to collect good quality and reproducible images. I have conducted interference studies on cutting agents and other over-the-counter pharmaceuticals believed to cause false positives on FTS based on their chemical structure and occurrence in analyzed street drug samples. Common cutting agents diphenhydramine, procaine, and levamisole were found to cause false positive results in addition to methadone, a treatment for narcotic drug addiction. Around Halloween of 2022, there were alarming news headlines about fentanyl laced candy, so I tested candies to see if they could cause false positive results on an FTS. Through this, I found acidity interferes with the antibody binding occurring in the test. Citric acid was found to cause this interference with both false positives and invalid test results. Other organic and inorganic acids had the same effect.

While FTS displays a qualitative “yes or no” result, I was able to use the NIH’s ImageJ analysis software to quantify the intensities of the control and test bands. I compiled data from over 300 tests, including tests of genuine fentanyl that were run by graduate students in my group, into a histogram which I used to identify test strips with intensities outside of the standard deviation which is used for detection of tests run in incorrect solvents and temperatures. The variabilities and chemical interferences I found across various lots and brands of FTS prove the strips, although subject to certain limitations, are a useful tool for preliminary drug checking.

The relationship between neurophysiological responses and emotional memory after periods of sleep and wake

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Sleep plays a powerful role in memory consolidation (Rasch & Born, 2013), and in particular for processing emotional memories (Payne et al., 2008). Sleep-facilitated memory processing is thought to occur because the stimuli are tagged at initial exposure for later processing during sleep. One possible indicator of this tag is participants' physiological reaction to the emotional stimuli (Kim & Payne, 2020). In one study, Cunningham et al. (2014) showed that participants' skin conductance responses (SCRs), a measure of sympathetic autonomic activity, were positively correlated with memory for negative objects after a period of sleep. The data in Cunningham et al. (2014) was obtained from a university student sample. The present study aims to determine if these findings extend to a broader community sample. Thirty-eight participants from the South Bend community (age 18-59 years old) viewed scenes consisting of emotional and neutral objects superimposed on neutral backgrounds and rated them for their arousal and valence. Participants' SCR while viewing each scene was measured. After an approximately eight-hour period of either sleep or wake, participants completed a memory test where they viewed the objects and backgrounds separately and reported whether the item was the same item, a similar item, or a new item.. Negative scenes elicited more SCRs from the participants than neutral scenes. Participants showed greater memory for negative objects than neutral objects. Contrary to our predictions, we did not find significant correlations between SCRs and memory for negative or neutral scenes in either sleep or wake conditions. Further research will examine this change with age in a larger sample.

(Poster & Oral Presentation)

Palladium or Zinc Triggered Leakage from Engineered Liposomes

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1. The University of Notre Dame, Department of Chemistry and Biochemistry

Liposomes are one of the best known nanocapsules for drug delivery. Liposomal biochemistry has proved effective for the transport of intravenous chemotherapeutic agents to the site of cancer, in part because of their size and susceptibility to the enhanced permeability and retention (EPR) effect in tumors. Liposomes are often stabilized by a coating of polyethylene glycol (PEG), but the enhanced stability also makes it more difficult for encapsulated payload to leak at a specific site of disease. For some time, researchers have been exploring methods to trigger liposomal release by endogenous or exogenous stimuli. This presentation focuses on two new liposome systems. One contains a new caged phospholipid called Alloc-PE that forms stable liposomes (large unilamellar vesicles). Liposome treatment with $PdCl_2$ removes the chemical cage, liberates membrane destabilizing dioleoylphosphoethanol-amine (DOPE), and triggers liposome leakage of encapsulated aqueous contents. The second liposome system contains a structurally related phospholipid called Proloc-PE and releases its encapsulated payload when treated with $ZnCl_2$. Unlike Pd(II) with the Alloc-PE system, the Zn(II) cation does not appear to cleave the Proloc-PE head group structure, suggesting a novel alternative leakage mechanism. The liposome data includes fluorescent dye leakage assays and video movies of activated fusion of giant unilamellar vesicles. Together, the results indicate new directions for liposomal drug delivery based on triggered leakage by metal cations.

Initial Studies Characterizing Vacuoles in the Pathogenic Yeast Cryptococcus neoformans

Meghan Figueras, Peter Stuckey, Julia Marine, Felipe Santiago Tirado

C. neoformans is a major cause of illness in immunocompromised individuals, responsible for about 200,000 yearly deaths in the HIV/AIDS population alone, with an overall mortality that can be as high as 81%. One reason for such high mortality is the lack of effective antifungal treatments. The vacuole is a fungal-specific organelle that may represent a good drug target for the development of better antifungals. The role of the cryptococcal vacuole in virulence is not clear. However, in order to study the vacuole, we need a way to visualize it. This study focuses on testing and optimizing vacuolar staining protocols in the wildtype (WT) C. neoformans and two mutants, vac8 and pfa4, that are thought to have vacuolar defects. Two dyes, FM4-64 and MDY, were used to compare different staining conditions. Each C. neoformans strain was analyzed in stationary phase and logarithmic growth phase under each dye. Both dyes produced similar vacuolar visualization, however the MDY staining protocol was faster, and so it was selected as the protocol for quantification. A complication of quantification during the logarithmic growth phase is that many yeast cells are budding, and during this process the vacuole normally fragments. However, during the stationary phase, WT yeast are not budding and should have only one or two big vacuoles, making it easier to quantify and categorize the vacuole morphologies. Therefore, the MDY protocol of stationary phase C. neoformans was selected for quantification. WT, vac8, and pfa4 cells were categorized as having either normal vacuoles, abnormal vacuoles, or indeterminate staining. The WT strain showed 13.86% abnormal vacuoles, vac8 showed 49.18% of abnormal vacuoles, and pfa4 showed 72.79% of abnormal vacuoles. These results suggest differences in vacuole morphology of vac8 and pfa4 mutants, as compared to WT. This study also tested the mutant strains under various stress conditions. Vac8 had growth defects under caffeine, CFW, $NaNO_2$ at 30°C, and Congo Red conditions. Pfa4 had growth defects under caffeine, SDS, CFW, NaCl, $NaNO_2$ in 5% CO_2, H_2O_2, $NaNO_2$, RPMI at 37°C, and Congo Red conditions. This suggests that vacuolar dysfunction affects the fitness of the yeast under stress conditions.

Effects of para-substitution and protecting groups on gold-catalyzed diyne cyclization

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Use of gold catalysis to carry out alkyne transformations has been a major point of research for the development of efficient methodologies in organometallic synthesis. Gold, which has mild Lewis acid character, has been shown to form π complexes with alkynes and generate highly reactive vinyl cations, which are followed by rearrangement and irreversible protodeauration. Alkynes are the most common and most successful reaction partners for gold catalysts, which effectively increase the electrophilicity of the coordinated alkyne, aiding nucleophilic attack. The ease of gold-catalyzed alkyne transformations can be altered by stabilizing or destabilizing the cationic intermediate. Siliconbased protecting groups can also be used to improve yields by limiting side reactions. The purpose of this project was to investigate the scope of the gold-catalyzed cyclization reactions between aromatic 1,5-diynes by varying the backbone of the aromatic ring and the bulkiness of the terminal silicon protecting group. Aromatic substrates for gold catalysis were prepared by iodination of para-substituted phenols, followed by triflation of the -OH group, then two subsequent Sonogashira reactions to install the alkynes. Finally, a gold-catalyzed cyclization reaction was performed to cyclize the two alkynes. Bulkier Si groups (TIPS) were observed to produce better yields than less bulky groups (TMS) due to their ability to prevent side reactions. Furthermore, compounds with more highly electron withdrawing para-substituents saw lower yields compared to compounds with more highly electron donating substituents. These results support the application of the postulated vinyl cation mechanism to the 1,5-diyne cyclization reaction.

(Oral Presentation)

Pattern Similarity Analysis of Episodic Memory using EEG

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Abstract

Developmental amnesia (DA) is a disorder which impairs episodic memory and is caused by hypoxic-ischemic episodes during early infancy. Interestingly, this episodic memory impairment does not extend to semantic memory, which is preserved in individuals with DA. While hippocampal atrophy is commonly associated with memory impairments, the role of the hippocampus in semantic memory is not yet understood. Previous research suggests that individuals with DA exhibit cortical reinstatement (i.e. the phenomenon in which the same patterns of brain activity are present at encoding and retrieval) despite being unable to recollect these events, providing a potential avenue for semantic consolidation. More research using healthy models is necessary to establish a basis to be used in translational work with DA. Here, we hypothesized that cortical reinstatement supports learning in healthy adults. Participants aged 18-50 completed six identical blocks of an object-location associative memory task while undergoing EEG. Data were preprocessed and artifact rejection was completed using ICA and manual rejection. In order to detect if cortical reinstatement was present, a pattern similarity analysis was conducted using the EEGlab software through MATLAB. Preliminary results suggest that there is a strong correlation between neural activity during encoding and at test, consistent with cortical reinstatement and potentially indicative of learning. However, further testing is needed to confirm these findings and replicate them in a sample of DA patients. The association between cortical reinstatement and learning has real-world implications and can inform educational resources used to assist children with DA in the classroom.

Synthesis of a sidechain modified analogue of the bacterial RNAP inhibitor pseudouridimycin

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The discovery and development of broad-spectrum antibiotics is of high interest due to the widespread emergence of drug-resistant pathogens. Bacterial RNA polymerase (RNAP) is a validated bacterial drug target since viability of bacterial cells relies on RNAP-mediated transcription. Pseudouridimycin (PUM) is a naturally occurring C-nucleoside/dipeptide antibiotic isolated from Streptomyces albus. PUM inhibits bacterial RNAP in vitro in the mid-nanomolar range, with greater than 10-fold selectivity over human RNAP and does not exhibit significant toxicity to human cells. PUM also displays potent bacterial growth inhibition in vitro and in vivo. The dipeptide tail of this nucleoside analogue inhibitor is responsible for its moderate selectivity for bacterial RNAP. Our laboratory is engaged in the optimization of PUM to enhance its potency and therapeutic index. Toward this end, we have targeted modified PUM analogues incorporating natural and non-natural sidechains into the dipeptide tail. Here, we describe a convergent total synthesis of a PUM analogue where the N-terminal glycine is substituted to a L-alanine residue. This synthesis serves as a proof-of-concept to generate additional analogues for future structure-activity relationship studies. Our laboratory previously identified two intramolecular decomposition pathways that also compromise PUM's efficacy. Here, we further describe an expedited solid-phase synthetic approach toward des-hydroxy PUM analogues with enhanced chemical stability. These studies will enable PUM dipeptide tail optimization efforts and pave the way for advancement of analogues toward the clinic.

(Oral Presentation)

Biofilm colonization, nitrate, and labile carbon control nitrate removal in experimental streams

Authors: Jonathan P. Gilman, Jennifer L. Tank, Abagael N. Pruitt, Meg L. Hilbert, Anna E.S. Vincent

Agricultural intensification has led to a significant increase in global nitrogen (N) fertilizer use, and a subsequent increase in N runoff to nearby streams. As inorganic N inputs increase, retention and transformation capacities decrease, and the transport of excess N downstream can result in harmful eutrophic conditions. While controls on nitrate removal have been well-studied, the influence of labile carbon availability on reach-scale nitrate removal under varying stream conditions remains understudied. Using experimental streams, we examined how nitrate removal varied temporally (day vs. night), over a biofilm colonization sequence (e.g., early biofilm development, late biofilm, senescence), and with the addition of labile carbon (as acetate). We conducted replicated short-term nitrate additions, alone (+N) and with added carbon (+N+C), in four replicate streams from July-September 2022 (N=48 releases) during early biofilm (EB), late biofilm (LB), and algal senescence (AS). We conducted replicated releases during both day and night conditions to partition the role of autotrophs and heterotrophs on uptake. Nitrate removal was not detectable during daytime +N releases for EB and LB phases; however, we quantified significant nitrate removal during senescence (AS period; 0.1±0.04 mgN m-2 d-1). We suggest nitrate removal was stimulated by organic carbon released during algal die-off which stimulated heterotrophic assimilation. In contrast, for +N+C releases, we measured nitrate removal during both day (0.05-0.8 mgN m-2 d-1) and night (0.1-0.4 mgN m-2 d-1) conditions across all biofilm phases, suggesting that N uptake by heterotrophic biofilms was carbon limited. These preliminary results demonstrate the interplay between autotrophs vs. heterotrophs, and nitrate vs. carbon availability, in controlling nitrate removal in streams, suggesting a temporal partitioning of uptake at multiple scales. Overall, nitrate removal dynamics are complex and driven by multiple environmental controls, but understanding temporal variation in the biogeochemistry will inform efforts to improve water quality in agricultural streams.

Eyes to Ecosystems: a review and meta-analysis of phenotypic plasticity in the fish visual system

Clayton Glasgow and Julián Torres-Dowdall

Phenotypic plasticity is the capacity of a single genotype to express different phenotypes under different environmental conditions. It is a widely spread phenomenon, and it is an important mechanism by which organisms respond to environmental change. A particularly tractable system to study plasticity at different levels of biological organization is the fish visual system. It has a relatively well understood genotype to phenotype map, and it has been shown to respond plastically to environmental stimuli (Carleton et al. 2020). The number of studies investigating plasticity in the fish visual system has risen dramatically in recent years. To gauge the current state of the knowledge regarding fish visual plasticity, a literature review was conducted to identify the most commonly-studied visual traits, the impacts of the plasticity (or lack thereof) of these traits on fish evolution and ecology, and next steps in visual plasticity research. Opsin expression was the most studied trait within papers reviewed, showing high levels of plasticity across a variety of species and families, followed by chromophore usage, fish behavior, and photoreceptor cell traits. Future research should seek to link the plasticity of these visual traits to species evolution and broader ecological functions to better understand if and how environmentally-induced phenotypic variation can have population, community, and ecosystem level effects.

(Oral Presentation)

EIH Waste Management and Application of Design for Sustainability Principles in the College of Engineering

Erin Goldman

Although plastic waste is generated at the University of Notre Dame's Engineering Innovation Hub, there are currently no plastic recycling or repurposing measures in place for this waste. This waste is often sent to landfills, contributing to the larger global problem of plastic waste accumulation. The two main types of plastic waste generated, HDPE and ABS, are recyclable and plastic waste from the EIH can be greatly reduced. I proposed the reduction of the plastic waste produced by the EIH by quantifying the amount of plastic waste, implementing recycling programs, and creating resources to educate EIH users about sustainable design. After characterizing EIH waste production and the current university recycling systems, it was determined that plastic waste from the EIH would need to be recycled in a pyrolysis facility, a facility that chemically breaks down the plastics, rather than in a typical recycling facility. Therefore, the implementation of this recycling system was dependent on the ability for the University's partner pyrolysis facility to operate at the capacity needed to accept the types of plastic generated from the EIH. Although the facility does not currently have the capacity to accept these plastics, a physical implementation plan was created in coordination with EIH Staff and the Office of Sustainability for implementation of the recycling system when the facility does expand its operations. Additionally, I recognized a gap in the College of Engineering curriculum in Design for Sustainability principles. Therefore, I created Design for Sustainability resources and shared them with professors in the design track of the AME Department, as well as freshman engineering professors to reduce sources of waste. The anticipated quantifiable outcome is the physical reduction of waste by weight, and the anticipated qualitative outcome is a more sustainable culture for the College of Engineering at the University of Notre Dame.

We are looking to test the efficacy of a marketing campaign aimed at increasing reusable cup use at Au Bon Pain (ABP), the coffee shop in Hesburgh Library at Notre Dame. Currently, consumers can fill their own reusable cup with self-serve hot & iced coffee and hot tea, but an overwhelming majority of them use disposable paper and plastic cups that ABP offers. Since these cups produce a lot of plastic waste, it is important to increase the number of consumers who bring reusable cups to ABP. Our marketing campaign aims to do this with 4 measures: 1) create a promotional video for social media in which Father Pete, the Director of Campus Ministry at Notre Dame, endorses the practice of bringing a reusable cup to ABP for self-serve coffee and tea, 2) design posters which inform students of the option to bring a reusable cup to ABP for self-serve drinks and to notify students of Father Pete's endorsement of this practice, 3) hold 2 tabling events where students, faculty and staff can "spin to win" for a reusable cup if they sign up for reminders to bring a reusable cup with them out the door in the morning (however, we did not ask most students to sign up for reminders because we did not want to keep them at the table too long). After implementing these measures, we will look at how many reusable cups were used at ABP during the experimental time frame and compare it to the number of reusable cups used last year at ABP during the same time period.

Heart Rate Variability in Response to Stress: A Prospective Investigation on the Link with Depressive Symptoms

Grace Gorman

Depression is a prevalent disorder with symptoms manifesting both physiologically and psychologically. Depression is associated with autonomic nervous system dysfunctions that are linked to risk of cardiovascular diseases. Heart rate variability (HRV) is commonly used for measuring heart health, and respiratory sinus arrhythmia (RSA) specifically is an indicator of parasympathetic nervous system activity. Although depression is associated with low RSA, the association between RSA in response to stress and prospective depressive symptoms remains unclear. The present study aimed to fill this gap and examined the association between RSA post stress and prospective depressive symptoms. One hundred participants completed a laboratory session that consisted of measures of baseline depressive symptoms and RSA following stress induction. One to two months later, participants completed a follow-up online session that included measures of depressive symptoms. Linear regressions, ANOVAs and ANCOVAs were conducted on the associations between post-stress HRV and depressive symptom levels at baseline and at follow-up. When controlling for baseline depressive symptom levels, participants with high levels of follow-up depressive symptoms showed no change in RSA during the calming task and a significant decrease in RSA during one of the stress-inducing tasks. In contrast, participants with low levels of follow-up depressive symptoms showed an overall increase in RSA in the same stress-inducing task, indicating greater flexibility in response to external stimuli. These findings suggest individuals who are at risk for elevated depressive symptoms experience maladaptive response to stress. That is, RSA under stress may be a biomarker for depressive symptom elevation.

Irish Choose to Reuse: A Campaign to Reduce Coffee Cup Waste at Notre Dame's Au Bon Pain

Emma Hamilton and Rachel Gutierrez

We are looking to test the efficacy of a marketing campaign aimed at increasing reusable cup use at Au Bon Pain (ABP), the coffee shop in Hesburgh Library at Notre Dame. Currently, consumers have the option to fill their own reusable cup with self-serve hot coffee and hot tea for a $0.70 discount, but not many of them do. Since the discount alone is not incentivizing customers enough to bring their own reusable cup, it is important to find other methods that will. In this project, we look at a series of measures backed by psychology which aim to increase reusable cups rates: 1) leverage social influence by filming a video of Fr. Pete, the Director of Campus Ministry at Notre Dame, endorsing the practice of using your own reusable cup at ABP, 2) bring awareness of the opportunity to bring a reusable cup to ABP to students, faculty and staff by hanging fliers around campus which advertise the option 3) warn the ND community about the dangers of disposable cups and encourage them to take part in our mission to reduce plastic waste by holding two tabling events, 4) encourage habit formation by sending out daily reminders to students to pack a reusable cup in the morning. We looked at the impact these measures had on reusable cup rates over time and compared them to reusable cup rates in the three weeks leading up to the campaign.

Investigating the Role of *enah* in Dorsal Root Ganglia Entry into the Spinal Cord during Embryonic Development

Matthew Hicks, Bailey Brumbaugh, Crystal Lockett, Cecilia Cesa

Advisors: Dr. Dana DeSantis, Dr. Sarah Light, Dr. Sahana Srinivasan, Dr. Michelle Whaley, Department of Biological Sciences, University of Notre Dame

Dorsal root ganglia (DRG) cells establish a neuronal connection between the peripheral and central nervous systems during the embryonic development of vertebrates. The axons of DRG cells extend and navigate towards the spinal cord where they implement Ramón y Cajal's "battering ram" mechanism to penetrate the dorsal root entry zone (DREZ) and connect with the central nervous system. These processes are enabled by the structural dynamics of actin filaments within DRG cells which promote axon extension.

Using zebrafish (Danio rerio) as a model system, a genetic screen was performed which identified *enah* as a gene that affected DRG entry. The translated product of *enah* is known to facilitate the polymerization of actin in controlling cell motility and navigation but how it does so is not fully understood. As a group, we evaluated the normal functions of *enah* in relation to DRG navigation and entry into the spinal cord by utilizing CRISPR microinjection technology to knockdown *enah* in Tg(TNFα:GFP) transgenic zebrafish for a set of fluorescent-analysis experiments. Through these experiments, we examined an overall decrease in DRG entries into the spinal cord. Further experiments were performed in conjunction with the tools Lifeact and paclitaxel to understand the interaction of *enah* with actin while attempting to chemically restabilize actin filaments to promote DRG navigation and entry into the spinal cord.

This study is essential in expanding the knowledge surrounding the crucial nervous system connection process in vertebrates such that it can be applied to human development issues. Specifically, the data collected adds to the understanding of one of the many genes responsible for this process. A future direction from this study would be to analyze the various other genes associated with DRG navigation, such as *col4a5*, to further understand the nervous system network.

Game Day Farmer's Booth Pilot Project

Megan Hilbert (Environmental Science)

Regan Hultquist (Economics)

Faculty Advisor:

Dr. Phil Sakimoto (Minor in Sustainability)

Abstract

Given the Office of Sustainability's efforts to make football game days more sustainable and demonstrated student interest in a farmer's market, the aim of this project is to make arrangements with Notre Dame to host Regeneration Farms for Friday afternoon farmer's stands before home football games. Our goal is to hold a pilot farmer's booth pop-up on campus on the Friday before the Blue Gold game in order to get quantitative information on the success of the event and build a case for the continuation of similar markets in the fall. By working with local business Regeneration Farms, we aim to create an economical and environmentally friendly booth, as well as provide Notre Dame students with knowledge about where to buy sustainable food around South Bend–and how great it can be! Our project will culminate with a market on campus on Friday, April 21st. The market will serve as an educational event, an opportunity for campus community members to learn about the agriculturally rich region surrounding Notre Dame, and a first step in a relationship between Notre Dame and local, sustainable farmers. We will report on the outcomes of the event with data from student surveys at the event and sales information from Regeneration Farms. It is our hope that our project this year will create a foundation for future collaborations between members of the Notre Dame Community and Regeneration Farms.

(Oral Presentation)

Using experimental streams to understand how ammonium and labile carbon can limit reach-scale nitrification and metabolism

Authors: Megan L. Hilbert, Jennifer L. Tank, Anna E.S. Vincent, Jonathan P. Gilman, Abagael N. Pruitt

Inorganic nitrogen (N) fertilizer, generally applied as anhydrous ammonia, enhances crop yields, but runoff from agricultural fields to streams can degrade water quality. Ammonium ($NH4_4^+$-N) can be removed from the water column via assimilatory uptake by stream biofilms or can be transformed to nitrate (NO_3^--N) via the dissimilatory process of nitrification. We examined the effects of $NH4_4^+$-N and carbon (C) availability on ammonium uptake, nitrification, and reachscale metabolism using replicated nutrient additions to four experimental streams at the Notre Dame Linked Experimental Ecosystem Facility (ND-LEEF). We compared uptake and transformation rates across a biofilm colonization sequence (i.e., early and late biofilm growth, then senescence) and under varying light conditions (i.e., day vs. night). We conducted shortterm releases of $NH4_4^+$-N and $NH4_4^+$-N+C (added as acetate), and quantified reach-scale nitrification rates by documenting simultaneous $NH4_4^+$-N removal and NO_3^--N production along each stream. We also estimated reach-scale gross primary production (GPP), ecosystem respiration (ER), and gas exchange (k) using miniDOT sensors. We measured significant declines in $NH4_4^+$-N during all releases (n=48), and $NH4_4^+$-N uptake varied across biofilm colonization phases and light conditions. However, reach-scale nitrification was only detectable in 18% of releases, thus assimilatory uptake was the dominant mechanism for $NH4_4^+$-N removal. When detectable, nitrification rates were higher during the late biofilm phase (1.6±0.3 mg N m-2 h-1) compared to early biofilm (0.05 mg N m-2 h-1). There was no measurable nitrification during senescence, and both GPP and ER were significantly lower during this phase (Kruskal-Wallis $p<0.001$ and $p<0.05$, respectively). Our results suggest that biofilm constituents (both autotrophs and heterotrophs) consistently assimilate $NH4_4^+$-N, but outcompete nitrifying bacteria, thereby limiting nitrification, even when $NH4_4^+$-N availability is high. This research fills critical gaps regarding controls on stream nitrification rates and helps improve understanding about how human-impacted headwater streams respond to elevated $NH4_4^+$-N.

There's Something in the Water: The Effects of an Invasive Pondweed (Elodea canadensis) on Water Chemistry of an Alaskan Lake

Corbin Hite[1], Amaryllis Adey[1], Katherine O'Reilly[2], Gordon Reeves[3], J. Ryan Bellmore[3], Gary Lamberti[1]

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Biological invasions by non-native species into novel environments can induce ecological change that can negatively impact local communities and ecosystems. Elodea canadensis is a freshwater submerged macrophyte that has become an invasive species on four continents, including spreading from its native range in the midwestern United States through Canada and now into Alaska. Invasive and hyper-productive Elodea could have deleterious effects on Alaska's large and productive Pacific Salmon fisheries (Oncorhynchus spp.). Elodea can reduce the growth and trophic position of Coho salmon (O. kisutch) by decreasing the abundance of macroinvertebrate food populations. However, abiotic change leading to such impacts remain understudied. For example, changes to water chemistry can impact all levels of the food chain, making chemistry a crucial metric in assessing the impacts of invasive Elodea. In this study, we investigated whether Elodea affected water chemistry by placing six full water-column mesocosms ("limnocorrals") in a freshwater lake known to rear juvenile salmon. Half of the permeable limnocorrals were placed over populations of native vegetation and half were placed over populations of Elodea, and then all were there stocked with juvenile sockeye salmon (O. nerka). Over six weeks during the growing season, water chemistry samples were collected every two weeks for analysis. Our findings suggest that Elodea may modestly suppress dissolved oxygen concentrations in the surrounding system, likely due to respiration. However, Elodea did not produce detectable effects on the concentrations of water-column nutrients, dissolved organic carbon, or chlorophyll-a. These findings are a first glimpse of how Elodea might impact water chemistry, suggesting that Elodea may elicit conditions that drive ecological change in some parameters but not in others. Overall, Elodea may represent an added stressor to aquatic ecosystems in Alaska that are already threatened by ongoing climate change.

Exploring the Change in Uptake and Interatomic Distances of Ion Mixing of Uranyl Oxalate Hydroxide Hydrate with Rubidium and Cesium Counter Cations

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Uranyl Oxalate Hydroxide Hydrate [M(UO2)2(C2O4)2(OH)·2H2O (M=Na, K, Cs, Rb, NH4)] is a uranium containing compound that is of interest due to its potential application in the nuclear fuel cycle and relevance to environmental systems. Oxalates are present in nature and are used as precipitating agents in the nuclear fuel cycle. Uranyl Oxalate Hydroxide Hydrate is known to be stable under ambient conditions, and it can contain several different monovalent counter cations. Several isostructural compounds of Uranyl Oxalate Hydroxide Hydrate have been studied with different countercations, including K and NH4. These isostructural compounds contain the same 2-D anionic framework, and the structure of the layer is built by condensing the structural units through sharing oxalates to chains and connecting parallel chains by sharing OH to create the 2-D six-membered anionic framework.

Rubidium and cesium counter cations have been of particular interest due to their larger ionic radii, leading to potential substitution in the crystal lattice, and this study aims to explore the change in structure and uptake when uranyl oxalate hydroxide hydrate is mixed with different molar ratios of rubidium and cesium counter cations. The resulting compounds from the mixing are characterized using a variety of characterization methods, including single crystal X-ray diffraction (XRD), powder XRD, and inductively coupled plasma optical emission spectroscopy(ICP-OES), which will aid in determining elemental composition and crystal structure, as well as characterizing the mother liquor to determine change in cation uptake. We can hypothesize that there would be significant differences in interatomic distances and ion uptake of the newly synthesized compound when contrasted with their isostructural counterparts.

The results will examine the changes in structure due to the incorporation of varying ratios of rubidium and cesium ions, specifically interatomic distances, percent occupancy of the rubidium and cesium ions, and mother liquor composition. These findings have significant implications for the understanding of materials for nuclear waste management, where the incorporation of counter cations can improve the efficiency of environmentally-friendly processes within the nuclear fuel cycle, and for environmental processes involving uranyl oxalates in the presence of these cations.

Meta-Analysis of the Relative Influence of Landscape, Diet and Phylogeny on the Gut Microbiome of Macaques Living Throughout Asia

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Co-Authors: Benjamin Gombash, Shehani Fernando, Hope Hollocher

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A driving question in gut microbiome research is determining which external factors, such as host diet, species phylogeny, and physical landscape, are most important for governing the composition and diversity of the gut microbial community. Here, we investigate the relative influence of these factors through a meta-analysis that combines our data and previously published data. We targeted the gut microbiomes of three species of macaques (genus *Macaca*) given their varied generalist diets and the broad range of habitats in which they live. In all, 146 gut microbiome samples from four previously published studies were selected and analyzed in conjunction with our 84 samples. These data span three species of macaques (*M. fascicularis, M. fuscata, and M. mulatta*) across sites in Singapore, Japan, China, and Bali, Indonesia. The 16S rRNA data used to characterize gut microbiomes were individually downloaded from each published study and then run together through a bioinformatics pipeline to create a single dataset comprised of the amplicon sequence variants (ASVs) for each sampled individual for further analyses. The macaque diet and landscape characteristics for each collection site were categorized following a framework outlined by McKinney (2015). Factors influencing the community composition of the gut microbiome were tested using a marginal PERMANOVA, which revealed that the diet, species, and landscape variables all significantly influenced the microbiome, with landscape having the greatest effect size. Beyond community composition, an ANOVA revealed different landscape types to be significant predictors of Shannon diversity. Linear discriminant analysis effect size (LEfSe) was then used to identify the bacterial genera that distinguish the microbiomes of samples from the different landscape types. Collectively, our results point towards landscape as being a significant predictor of the gut microbiome in macaques, more so than the host diet and species phylogeny.

Age Mediates Malignant Peritoneal Mesothelioma Metastasis and the Peritoneal Microenvironment

Koryn Isa1, Kelly Julian2, Mykayla Miller3, Yueying Liu4,5, Jing Yang4,5, Kayla Nenninger4, Elizabeth I Harper4,5,6, Gena Dominique4,5, Zhikun Wang4,5, M. Sharon Stack4,5 and Tyvette S Hilliard4,5

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Malignant peritoneal mesothelioma (MPM) comprises 20% of all mesotheliomas and is a rare and aggressive form of cancer with a low five year survival rate. MPM occurs in the peritoneal membrane which lines the abdominal cavity and visceral organs. The majority of MPM patients are diagnosed at an older age with advanced stage disease that is difficult to treat. MPM has a long latency period between exposure to the carcinogen and onset of symptoms that are sometimes indistinguishable from other health conditions such as ovarian cancer, increasing the risk of missed, late, or incorrect diagnosis. Mesothelin (MSLN) is an extracellular protein expressed in mesothelial cells and highly expressed in cancer cells and may play a role in cell-cell interactions with the assistance of MUC16 which is also upregulated in several cancers. Using an engineered MSLN knockout mouse model, we examined the role of MSLN expression and age in MPM tumor metastasis. We hypothesized that MSLN knockout mice will have the least tumor burden. Murine MPM cells tagged with nuclear red fluorescence protein were injected into the peritoneal cavity of young (3-6 months) and aged (18-23 months) female MSLN wildtype and knockout mice. Tumor progression was evaluated weekly by fluorescent in vivo imaging. At endpoint dissection, abdominal organs were imaged in situ and ex vivo followed by tumor burden quantification using ImageJ. Aged mice, regardless of host MSLN expression, displayed an increase in abdominal tumor burden, with the majority of tumor burden observed in the omentum. The immune profile of tumor-free aged mice compared to young mice revealed a decrease in peritoneal natural killer cells and M1 macrophages, suggesting an influence in the regulation of MPM metastasis and the potential as targets for new immunotherapies. This study demonstrated that age, independent of host MSLN expression, increased peritoneal mesothelioma tumor growth.

Mechanistic Studies of Radical Iridium-Carbon Bond Formation in Iridium Iminoxolene Complexes and Alkyl Halides, and Synthesis of Allyl-Iridium Complex and its Characterization

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The paramagnetic iridium complex $(Diso)_2Ir$ (Diso = *N*-(2,6-diisopropyl phenyl)-3,5-di-*tert*-butyl-*o*-iminobenzoquinone) reacts with alkyl radicals, generated either by halogen atom abstraction or by hydrogen atom addition to alkenes, leading to the synthesis of alkyl iridium complexes. Various experiments with compounds containing radical stabilizing groups, such as benzyl bromide and allyl bromide, have established a reactivity with the paramagnet to form an iridium-carbon bond. Tertiary alkyl halides demonstrate limited reactivity and, instead, synthesize a hydrogen-carbon bond, forming $(Diso)_2IrH$.

The allyl iridium complex $(Diso)_2Ir(CH_2CH{=}CH_2)$ is prepared from anionic $[(Diso)_2Ir]^-$, generated *in situ* from $(Diso)_2Ir$ and cobaltocene, and allyl bromide. This product is reacted with allyl bromide to create the allyl-iridium bond.[SNB2] . The compound [SNB3] is purified and characterized using ^1H NMR, ^{13}C NMR, IR spectra, UV-VIS, CV, and elemental analysis[SNB4] . Variable temperature NMR spectroscopy in the range of 25–110 ºC demonstrates no significant change, establishing that the compound maintains an **η**1conformation and is non fluxional.

No Title Provided by the Student

No Name Provided by the Student

Malaria remains one of the most widespread and deadly diseases in the developing world. Specifically, Ghana is one of the 15 highest burden malaria countries (Severe Malaria Observatory, 2022). To end the endemicity of malaria in Ghana, concerted efforts must be made to improve malaria surveillance, testing, and the distribution of prevention tools. The success of intervention programs like these hinges on the willingness of a population to accept and utilize them. Therefore, it is critical that psychosocial research is conducted, prior to the implementation of an antimalarial procedure, to ensure that the procedure is adopted by the population. One method of collecting this psychosocial data is through the use of a Knowledge, Attitudes, and Practices (KAP) survey. This summer, I traveled to Mankranso, Ghana to administer a self-developed KAP survey related to malaria. I assessed adult residents' perceptions of malaria severity and their malaria health-seeking behaviors. My overall goal with this project is to create the opportunity for future successful and culturally relevant malaria interventions in Mankranso. At the end of my time in Mankranso, I had administered more than 300 surveys. Statistical analysis of these data, and my observations in the field, have gleaned insight into the malaria perceptions and health-seeking behaviors of adults in Mankranso. I found an overall strong level of malaria education among the respondents. However, this education did not translate to increased prevention and treatment practices. Instead, the community possessed a high level of malaria related fear.

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No Title Provided by the Student

No Name Provided by the Student

Reducing global emissions in the private sector has been a central challenge for environmental sustainability actors. One way to mitigate these externalities is for governments to implement cap and trade systems which aim to incentivize companies to reduce their carbon emissions by setting caps across industries.

The United States and European Union have both introduced cap and trade programs: the United States Regional Greenhouse Gas Initiative (RGGI) and the European Union Emissions Trading System (EU-ETS). While both share the objective of leveraging market forces to increase the cost of carbon emissions, the two programs are distinctive in how they operate and regulate those markets. The goal of this paper will be to analyze which elements of a cap and trade system are most effective towards driving its success, and to ultimately propose how such practices could be implemented in the RGGI.

Breaking the illusion between citations and impact factors of research papers

Nadim Khouzam, Santiago Schnell, Conner Sandefur

This research project's goal focuses on the impact factor scores of science journals, research papers, and individual people. An impact factor is essentially a score given to a journal, paper, or individual that assesses the influence these have on the community. For example, the impact factor of a journal is calculated by dividing the number of times the journal has been cited by the number of papers the journal has published all for a given year. Now, this impact factor scoring scale has served us well for a while. But, Dr. Conner Sandefur, Dean Schnell, and I have actually been finding some inconsistencies. We decided to put this to the test by manually calculating the impact factor of several journals ranging from high-ranking journals like LANCET to basic journals like Cell or Science. What I discovered was that my manually calculated scores, even though I used the same formula the computer generates, were either much lower than the computer-generated score or just shy of the actual score. Now, there are two problems with this: the first is that if these impact factors were true and valid, there wouldn't be this discrepancy and my manually calculated score would be almost exactly the same as the computer-generated score. The second problem is that there could be some inflation for certain journals to give them higher impact scores than they deserve. Therefore, Dean Schnell, Dr. Sandefur, and I have been attempting to standardize the impact factor scoring scale in order to get rid of these inconsistencies and to try and "even out the playing field." The current impact factor method has been what we've been using since 1975. It's been almost 50 years since this formula was invented and it clearly has become outdated. This new technique will not only help in standardizing the scores, but it will also allow for clarity on the impact a journal or paper really has. These days, a paper that has only been cited 10 times can be published in a high-ranking journal like LANCET undeservingly. This is not a good look for both the journal and the authors of that low impact paper. Therefore, weeding out the intricacies and clarifying things in this facet of science will be both beneficial for the scientific community, but more importantly beneficial to individual scientists themselves.

Mechanistic and Kinetic Studies of the formation of Alkyl Cobalt Iminoxolene Complexes

Kang-Young Kim

In a typical nucleophilic addition to a square planar organometallic complex, we normally observe a two electron oxidation state change to the metal, but in the case of an alkyl addition to organometallic cobalt species, the nucleophilic reaction oxidizes each ligand by one electron. This discussion involves a question that asks if the given reaction would proceed in an abnormal mechanism due to the unique oxidation of the ligand instead of the metal.

By utilizing the paramagnetic cobalt iminoxolene complex $(Diso)_2Co$ (Diso = N-(2,6-diisopropylphenyl)-3,5-di-tert-butyl-o-iminobenzoquinone) and its respective anion, $[Cp_2Co][(Diso)_2Co]$, are used to create alkyl cobalt iminoxolene species via an addition mechanism. The four-coordinate cobalt anion reacts with 1-iodobutane producing $(Diso)_2Co(CH_2)_3CH_3$. After the synthetic reaction was confirmed via Nuclear Magnetic Resonance (NMR) Spectroscopy, UV-Vis Spectroscopy was utilized to understand the rate in which the butyl group attaches to the cobalt species. The following data and analysis will emphasize the findings of this project.

Investigating the role of affect on creative problem solving success and intrinsic solving mechanisms

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An Effective state modifies creative problem solving. Positive mood is thought to promote solving by broadening attention and facilitating task-switching (Rowe et al., 2007, Subramaniam et al., 2009), while negative mood inhibits solving through decreasing cognitive flexibility and narrowing attention (Chiu et al., 2018, Easterbrook, 1959). However, little is known about what components of the problem solving process are impacted by affective states. When attempting a challenging problem, solvers typically generate ideas until they reach an impasse which inhibits solving until they restructure their conception of the problem and reach the solution (Wallas, 1926). The current study examines whether affect influences participants' likelihood of reaching and overcoming impasses. Forty participants attempted to solve six insight puzzles. Each puzzle compels participants to follow an incorrect solving process which must be reconceptualized to find the correct solution. Before each puzzle, participants saw a positive or negative image or video clip to induce a corresponding effect. While solving, participants spoke their thoughts aloud, allowing the researcher to score impasses and methods for solving. Preliminary results indicate the negative induction decreased effect compared to the positive induction. Future analyses will examine the effect of the induction on the frequency and character of the impasses. We predict negative affect will increase the occurrence of impasses and time elapsed before reaching the solution while positive affect will promote overcoming impasses and generating unique solution attempts. These findings will contribute to our understanding of how affective state modulates problem solving and may suggest strategies for improving problem solving success.

Investigating the Role of the CXCL5/CXCR2 Signaling Axis in PyMt Cell proliferation at the Bone Metastatic Niche

Xiaotong Alex Lin, Madeline sheeley, Courtney Flatts, Adison Steinke, Emma powers, Laurie Littlepage.

Abstract:

Breast cancer metastasis is the leading cause of death in breast cancer patients globally, and currently, there is no sufficient treatment or cure. The Littlepage Lab at the Harper Cancer Research Institute is working on discovering new therapeutics to treat breast cancer at the metastatic stage. The most common site of breast cancer metastasis is to the bone, and current therapies are ineffective at eliminating breast metastases in the bone. Recently the Littlepage Lab identified the involvement of signaling through the chemokine CXCL5 and receptor CXCR2 in promoting breast cancer cell proliferation and colonization in the bone metastatic site.Using an ex-vivo murine bone culture, the stromal cell populations that support cancer cells at the bone metastatic niche through CXCL5/CXCR2 signaling can be further investigated. Aim 1: Using an ex-vivo murine bone culture, Cxcr2-KO-PyMT mammary cancer cell as well as Scramble-PyMT mammary cancer cell proliferation in the presence of stromal CXCL5/CXCR2 presenting cells can be measured. PyMT mammary cancer cells proliferation are further quantified using luciferase luminescence by Biorad plate reader. Aim 2: Using femur and tibia from Cxcr2 KO mice, to investigate the effects of absent stromal CXCL5/CXCR2 signaling axis on PyMT mammary cancer progression, proliferation is then also measured using luciferase luminescence. These results will contribute to the Littlepage Lab project on bone metastasis and will influence the design of therapeutics targeting the CXCL5/CXCR2 signaling axis as a means of treating breast to bone metastasis.

Palladium Promoted Isomerization of Fatty Acid Double Bonds: A New Approach to Bioorthogonal Chemistry

Graeme Marshall and Joseph Hagerty

Abstract:

Bioorthogonal modification of various biologically relevant molecules such as proteins and nucleotides has been of increasing interest over the past years. Modification of phospholipids in particular are popular, however they are almost exclusively upon the phospholipid head. Modification of the double bonds present on the unsaturated chains has remained relatively unexplored. In this paper we describe the results of isomerization studies of oleic acid as catalyzed by Pd (II) species in conjunction with bis(2,6dimethylphenyl)acenaphthenequinonediimine (BIAN). In particular it was found that PdCl2 alone isomerized oleic acid's double bond, while PdCl2 in concert with BIAN did not. Further, Pd(OAc)2 alone failed to isomerize oleic acid's double bond, while Pd(OAc)2 in concert with BIAN succeeded in isomerizing that bond.

Quantifying Leaderless Translation Efficiency in Mycobacterium Tuberculosis

Anna McCartan

Mycobacterium tuberculosis is a bacterium responsible for the human disease tuberculosis. It is responsible for more than 1.6 million deaths annually. Tuberculosis employs a complex regulatory mechanism to evade the human immune system and affect disease. Previous annotation of the Mycobacterium tuberculosis genome has identified open reading frames (ORFs) based on canonical features such as the presence of a 5' UTR. As a result, it has been ineffective in identifying ORFs that proceed through non-canonical mechanisms. One such mechanism is 'leaderless' translation, in which mRNAs are translated in the absence of a 5' UTR and a Shine-Dalgarno ribosomal binding sequence. Ribosomal profiling suggests this translation initiation mechanism is active in Mycobacterium tuberculosis. However, the details of the mechanism itself are poorly understood.

This study aims to computationally quantify the efficiency of the 'leaderless' mechanism in M. tuberculosis. We utilize existing RNA-Seq and Ribo-Seq datasets, which measure global transcription and translation in the cells. This is accomplished in a Python coding environment. Examples of leaderless translation are identified by comparing a list of transcription start sites (TSS) against the genome reference sequence and extracting bases where the TSS aligns with a start codon. In these cases, ORFs are generated. Across each ORF, the ratio of ribosomal footprint signal (Translation) to the RNA-seq data (Transcription) is hypothesized to be representative of translation efficiency. Thus, these relative intensities are calculated and normalized based on ORF length and a ratio is determined for each ORF. ORFs are trimmed with functions accounting for overlap with annotated genes. The resulting data yields examples of high-ratio protein-RNA leaderless transcripts. Identification of these high-efficiency transcripts reinforces previous work showing the activity of leaderless translation in M. tuberculosis. Characterizing these cases will inform future studies investigating potential mechanisms for leaderless translation.

Invertebrate Diversity in Great Lakes Coastal Wetlands

Authors: Ben McCarthy, Amaryllis Adey, Sarah Klepinger, and Gary Lamberti

The coastal wetlands of the Laurentian Great Lakes are crucial habitats for supporting and sustaining the overall health of the Great Lakes. Invertebrates are among the most numerous and diverse groups of animals in wetland ecosystems and are particularly important as they serve as an essential link between autotrophs and higher consumers in coastal wetland food webs. Additionally, invertebrate feeding habits contribute to controlling algal blooms, processing detritus, and helping to suppress some fish and invertebrate pest populations. Great Lake wetlands are currently confronted with invasive and non-native monocultures of wetland vegetation, such as Typha (cattail) and Phragmites (common reed), which can aggressively displace native plants that support wetland biodiversity. The Great Lakes Coastal Wetland Monitoring Program (CWMP) has annually sampled invertebrate communities in coastal wetlands from 2011-2021, and we used these data to evaluate invertebrate biodiversity in Great Lake coastal wetlands as it relates to vegetation type as a potential driver. We assessed invertebrate biodiversity, both spatially and temporally, using taxa richness (i.e., alpha and gamma diversity) and the Shannon diversity index to examine relationships between invertebrate biodiversity and coastal wetland vegetation type. Wet meadow vegetation zones had the highest mean alpha diversity and highest mean Shannon diversity, whereas water lily and submerged aquatic vegetation zones supported the lowest diversity. Wet meadows were most abundant in

Lake Huron, which also had the highest alpha and Shannon diversity among the lakes, whereas Lakes Ontario and Erie had the lowest diversity, lacked wet meadow habitats, and were composed largely of lily and submerged vegetation zones. Wet meadow habitats of the Great Lakes should be a priority for conservation and restoration efforts for enhancing invertebrate diversity and therefore maintaining the ecological health of the Great Lakes.

Automated well-to-well MALDI spotting and analysis using lower cost robotics and custom 3D-printed hardware

Garrett McFadden

Advisor: Sadie Schultz and Dr. Matthew Champion

MALDI-MS is an indispensable tool for rapid characterization of biological samples including protein therapeutics and microbial samples for strain detection. Many analyses utilize individual sample preparation. Hand-spotting of samples on MALDI plates is tedious, error prone, and impractical for higher throughput. Existing efforts to automate this process primarily focus on MALDI based imaging, which is incompatible with the individual sample analysis described. To automate these tasks, we automated preparation, spotting, and matrix application using robotics and custom 3D-printed adapters. We designed and created a 3D-printed adapter for the MALDI plate which is compatible with the Andrew+ robotic interface. The adapter positions the MALDI plate so that a drop of sample from the Andrew+ robot can be deposited via the hanging-drop method. Spectra from protein digests, reduced and intact model therapeutic antibodies (SigmaMAb) were acquired on a Bruker Ultraflex MALDI-TOF instrument in linear and reflected modes. These data were analyzed using peptide-mass-fingerprinting and custom Python scripts. A tryptic digest of Serum Albumin (BSA) was spotted on half of a 384-well MALDI target using the robot, while the other half of the plate was spotted manually as a control. Full plate tests of intact BSA, reduced/oxidized SigmaMAb were performed. Samples spotted with automated methods exhibited similar scores, protein coverage, and number of peptides. Acquired spectra resulted in peaks at 66,430 Da for intact BSA and 146,558 Da (intact), 50,395 Da (reduced heavy chain), and 22,938 Da (reduced light chain) for SigmaMAb. Ultimately, the combination of robotics and 3Dprinted hardware has performed similarly to manual spotting while improving the practicality of plate preparation, making it an exciting new option for MALDI analysis. This strategy can be expanded into other analytical pathways in the future, such as MALDI-based preparation and data acquisition of microbial pathogen detection.

Philadelphia Toxics Profile: A Review of the Neurologic Risks Posed by Chemical Releases

Kaitlin McGowan

Advisor: Anthony Serianni

It is well known that many pollutants produced by chemical plants have public health effects, and specifically neurological effects, but few comprehensive local analyses have been performed to assess the health risks from the exposure experienced by a specific community. AdvanSix Resins and Chemicals, LLC, is a large chemical intermediate producer in northeastern Philadelphia, situated squarely within the residential neighborhoods of Bridesburg and Frankford. It releases large enough quantities of pollutants to require reporting to the EPA's Toxic Release Inventory (TRI), and is regulated by the Clean Water Act (CWA) and Clean Air Act (CAA), both of which it has a history of violating. The specific toxic pollutants released from this facility in 2021 are as follows: phenol (107,705 lbs), cumene (72,698 lbs), cumene hydroperoxide (60,987), methanol (41,157 lbs), acetophenone (8851 lbs), acetaldehyde (2053 lbs), formaldehyde (1481 lbs), propionaldehyde (108 lbs), ethylbenzene (76 lbs), formic acid, polycyclic aromatic compounds, and chlorine. This review utilizes the TRI, published correlational studies in humans regarding disease and pollution, and randomized controlled studies in animals to attempt to identify the full scale of potential neurotoxic effects of these chemicals in light of the pounds released. Additionally, this review investigates the accumulation of toxic chemicals in the local water, soil, etc. to identify potential progressive health and environmental hazards.

Assaying Salinity Tolerance of a South Michigan Zooplankton Daphnia Pulicaria Population

Neil McAdams, Bret Coggins, Michael E. Pfrender

Acknowledgement: Carbon, nitrogen, and ion analysis was performed at CEST and advised on by Mike Brueseke and Jon Loftus.

Anthropogenic salinization by road salt runoff has been linked to disruptions in trophic cascades causing population declines in zooplankton and threatening regional aquatic ecosystems. Increased salinity has been directly linked to the rapid evolution of salinity tolerance in the microcrustacean Daphnia pulicaria. As part of a collaborative effort in the Great Lakes region I collected samples of local D. pulicaria and performed 48-hour LC50 assays for chloride tolerance. I sampled two freshwater lakes in southwestern Michigan, '3-Lakes' and 'Pine Lake'. I used horizontal and vertical tows through the water column to sample the zooplankton. Bathymetric data, and water samples were collected from each site for elemental analysis. Total organic carbon and total nitrogen values were obtained with Shimadzu TOC-L/TNM. Cation analysis was performed by atomic emission spectroscopy using Perkin Elmer Optima 8000 ICP-OES. Salinity was measured using a benchtop meter. Both lakes had similar salt profiles with negligible differences. D. pulicaria from 3-Lakes were isolated and were maintained in culture for several generations. One genotype was chosen for the LC50 experiment and acclimated in a medium containing 18mgCl/L. A 48 Hour LC50 performed on neonates (<24h) from the 3-Lakes population determined that the 48h LC50 = 1619 mgCl/L. Chloride measurements from 3-Lakes varied between 220 mgCl/L and 280mgCl/L depending on depth of draw. 3-Lakes D. pulicaria had >80% survival at 1200mgCl/L. Given the presently low chloride levels in 3-Lakes, this broad range of tolerance to acute salinity exposure may indicate that this population has the capacity to survive moderate future changes in salinity caused by road salt runoff. This data alongside that of regional collaborators will allow us to identify trends in salinity tolerance across a broad geographic range, this improves predictions about keystone zooplankton's survival in response to future changes in lake salinity.

Synthesis of a substituted amino-furanyl

Gabe McKenna

Department of Chemistry and Biochemistry

CXCR1 and CXCR2, when activated by chemokines, are implicated in a broad range of inflammatory responses associated with cancer. This project investigates a potential synthesis of a potential CXCR antagonist fragment, 4-isopropylfuranyl amine. The original 8-step synthesis reported by Chao et. al (2007) was adapted for optimal synthesis. This presentation reports changes made to the synthetic pathway with NMR and LCMS to confirm the intermediates, and analyzes the efficacy of each synthetic step. Finally, we explore future directions for this synthesis that would overcome the fallbacks of the current procedure.

Chemiluminescence as a Mechanism to Test for Artesunate in Solution Using Luminol and Hemin in Basic Media

Diane Medina Batista

Artesunate and its derivatives are sesquiterpene lactones that incorporate an endoperoxide linkage trigger, activated by iron-reduced reduction in the malarial parasite that begin a cascade of reactions eventually leading to the parasite's death. This molecule, along with other antimalarial drugs, such as dihydroartemisinin, are included in medicines shipped to countries where citizens are prone to malaria. However, the genuine dose of medicine is often mixed in with counterfeit drugs packaged to look like the real medicine in the same shipment. Cases have, thus, arisen from patients who were thought to have received the appropriate medicine but died due to lack of treatment from these counterfeit pills. This study worked to design a sensitive chemical test to find artesunate in small amounts in solution using luminol and hemin dissolved in sodium hydroxide. Iron ions of hemin cause the generation of reactive oxygen species from artesunate, while luminol works as the chemiluminescent agent that transfers energy in chemical reactions and releases it in the form of light. The reaction kinetics rely on this cleaving rate of the endoperoxide linkage of artesunate to generate reactive radicals. It was found that the optimal portions of reagents used are 100 μL of 0.112 mg/mL luminol and 0.96 mg/mL hemin in 0.25 M sodium hydroxide with 100 μL of 3.50 mg/mL artesunate in methanol. Pure forms or artesunate were used in all reactions, though recent tests have successfully detected artesunate and dihydroartemisinin in pharmaceutical pills used in Laos and Ghana. Future studies will work to move this test to a paper-based medium, as opposed to the current liquid medium used, though obstacles have arisen from this process as the dry hemin-luminol solution yields no glowing when dry.

Roles of Extracellular Vesicles in the Aging Microenvironment and Epithelial Ovarian Cancer Progression: Cell Adhesion and Proteome Profiling

Joshua Mijares, Reihaneh Safavisohi, Christopher Barile, Yueying Liu, Jeff Johnson, Ceming Wang, Xiaoye Huo, Hsueh-Chia Chang and M. Sharon Stack

Most cases of epithelial ovarian cancer (EOC) are diagnosed in women above the age of 60. Our lab investigates the role and molecular mechanisms of aging in ovarian cancer. The goal of this project was to examine the age-differential effects of exosome-mediated tumor-host communication. Exosomes (sEVs) secreted by tumors can reprogram the cells in the tumor microenvironment to contribute to metastatic processes. To determine whether there is differential exosome-mediated communication with aging, we isolated sEVs from peritoneal lavages obtained from aged (A, 22 months) and young (Y, 24 weeks) healthy (tumor naïve) mice. We then treated ovarian cancer (OVCAR5) cells with these sEVs and tested the ability of these cells to adhere to a layer of LP9 mesothelial cells to model early adhesive events in EOC metastasis. We found that cells treated with sEVs isolated from aged mice were more adhesive than cells treated with sEVs isolated from young mice. To investigate why the age of the host affects exosome-mediated tumor-host communication, the sEVs were lysed, and their proteome was analyzed via high-resolution mass spectrometry (HR-MS). Our results indicate vesicular proteins that are overexpressed in aged samples may play a significant role in cell adhesion. Furthermore, our data highlight a list of proteins as potential candidates for EV proteins in the aged host, which provide valuable insights into EV pathways in ovarian cancer metastasis.

(Poster and Oral Presentation)

Investigating Drug-Induced Inhibition of VRK1-Mediated Phosphorylation as a Novel Cancer Therapeutic Approach

Katherine Minton, Kathryn Morris, Kevin T. Vaughan

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Cellular senescence is a process in which cells permanently exit the cell cycle and enter a state of dormancy. Due to the anti-proliferative nature of senescence, our lab is interested in investigating the potential of inducing this mechanism to treat cancer. In the premature aging disease Hutchinson-Gilford Progeria Syndrome (HGPS), cellular senescence is activated following the induction of a "nuclear blebbing" defect characterized by a disorganized, incomplete nuclear envelope. In HGPS, the nuclear blebbing phenotype is caused by a mutation in the Lamin A protein that prevents its phosphorylation and subsequent interaction with the phospho-Barrier to Autointegration Factor (phospho-BAF) protein. The absence of this interaction prevents the proper formation of the nucleus, alerting the cell to enter a senescent state. Within the context of cancer, this anti-tumor effect makes the induction of nuclear blebbing incredibly appealing. Hence, our lab has become interested in identifying compounds that induce the nuclear blebbing phenotype by preventing the interaction of phospho-Lamin A and phospho-BAF.

Vaccinia-related kinase 1 (VRK1) is responsible for the phosphorylation of BAF. We have previously discovered that treating cells with Luteolin, a competitive VRK1 inhibitor, is sufficient to induce nuclear blebbing. However, Luteolin is effective at clinically irrelevant doses. In an effort to identify more clinically applicable VRK1 inhibitors, we developed a kinase assay that measures VRK1 inhibition by converting phosphorylation activity to a luminescent signal. The assay consists of 3 steps: a phosphorylation reaction, ATP depletion, and kinase detection. First, VRK1 is added to phosphorylate a substrate and produce ADP from ATP. Second, an ATP depletion reagent is added to deplete unused ATP and convert ADP back into ATP. Third, a kinase detection reagent is used to convert ATP to luminescence measured by a microplate reader. Initial tests of the assay revealed that the specific substrate used, substrate concentration, and VRK1 concentration each affected luminescence output. Recombinant BAF protein resulted in much higher luminescence than the original recommended VRK1 substrate, native cow casein protein. Additionally, higher concentrations of BAF and VRK1 resulted in higher luminescence. Following initial optimization, the assay was used to measure the ability of various molecules to inhibit VRK1 phosphorylation. Resulting luminescence seemed to correlate with the ability to induce nuclear blebbing. Future steps involve using this assay in collaboration with Purdue University to complete a high throughput screen of a kinase inhibitor library in order to identify potent inhibitors of VRK1. Following this screen, the ability of potential inhibitors to induce the nuclear blebbing phenotype and cellular senescence will be tested in vitro.

Poop in the Pool: How Shrimp Fecal Pellets Affect Nitrogen Flux in the Great Salt Lake

Kevin Murphy, Andrea Stumpf, Gary Belovsky

Department of Biological Sciences, University of Notre Dame

The South Arm of the Great Salt Lake consists of an upper brine layer and a deep brine layer. The major biotic components of the Great Salt Lake ecosystem – including algae, brine shrimp, and brine flies – live within the upper brine layer. The deep brine layer, an anoxic layer of higher salinity, is approximately six meters below the surface. It is a site for decomposition of detritus that falls into it, potentially holding those nutrients until water turnover occurs. Turnover with the upper brine layer occurs every four to 20 years when the salinities approach one another and high winds are present. Brine shrimp are abundant and produce fecal pellets as they graze on phytoplankton, so I was interested in assessing how abundant these pellets are, how quickly they sink into the deep brine layer, and how rapidly they decompose. This is important as nitrogen is the limiting resource for phytoplankton production in the lake, and its potential deposition in the deep brine layer may reduce primary production. Brine shrimp fecal pellet output was analyzed through counting pellet production at different levels of phytoplankton provided for grazing. Pellet sinking rate was measured in a cylinder containing brine levels found in the lake's upper brine layer. Pellet decomposition was measured as the disappearance of chlorophyll a (a marker in the pellets from consumption of phytoplankton) over time. I found that pellets decompose very slowly (greater than three months to decompose 90%) and fall into the brine layer in approximately one day. Based on lake bathymetry, 24% of pellets enter the deep brine layer and their nitrogen is lost there until turnover occurs. Based on brine shrimp abundances, phytoplankton availability, and the fact that over 1000 pellets are deposited per cm^2, pellets constitute a major loss in nitrogen to the deep brine layer.

(Poster and Oral Presentation)

An Ecological Study Linking County-Level Demographic and Political Affiliation Characteristics to COVID-19 Cases and Vaccinations in Indiana

Keo Pangan

Advisor: Marie Lynn Miranda, Ph.D.

Department of Applied & Computational Mathematics & Statistics

During the COVID-19 pandemic and the subsequent vaccine implementation, the effects of the pandemic varied by social and racial groups, partly explained by already existing disparities in health insurance coverage and economic status. Groups that were more likely to be affected negatively by COVID-19 included those who lived in crowded conditions, could not work remotely, and had lesser access to COVID-19 testing and vaccinations. The purpose of our ecological study is to determine if and how county-level demographic, socioeconomic, and political affiliation characteristics differentially affected patterns of COVID-19 cases and vaccinations in the state of Indiana. 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 cases and vaccination counts from the Indiana State Department of Health. We then conducted statistical analyses with linear regression models that used combinations of specific variables – in particular, the median household income, the proportion of the county population that identified as Republican, and the proportion of the county population who had at least a Bachelor's degree. The models were compared, using their AIC (Akaike Information Criterion) and their adjusted R-squared values, to find the best model fit to the COVID-19 case and vaccination patterns in Indiana. The inclusion of the proportion of the county who possessed a Bachelor's degree, the county proportion who identified as Republican, and the county median household income improved the models' adjusted R2 values for COVID19 cases and vaccinations by 1.53 and 2.00-fold, respectively. For the case patterns, the county population that is 40-59 years old had a positive, statistically significant association with cases, and the county-level median household income had a negative, statistically significant association with cases. For the vaccination patterns, there was a positive, statistically significant association with the county proportion of adults who possessed a Bachelor's degree, the county population of adults aged 40-59 years old, and the county population proportion of those who identify as Non-Hispanic White. The Republican county proportion had a negative, statistically significant association with vaccinations. Linking county-level demographic, socioeconomic, and political affiliation characteristics with COVID-19 cases and vaccinations improved model fits. Different pathways likely account for the differential associations in COVID-19 cases and in COVID-19 vaccinations due to sociodemographic characteristics. Nonetheless, there are inequities and health disparities that merit further investigation to help close these health gaps.

Happy Planet Hygiene

Ana Peczuh

Faculty Advisor Tom Gallagher (Mendoza College of Business)

A greater effort to reduce the amount of packaging, especially single-use packaging, is crucial in response to the climate crisis. One industry that can make a large impact is the personal care industry. Hygiene products have the potential to greatly decrease the amount of packaging they are sold in because they can be purchased via refill stations where consumers bring their own reusable containers to stores to be refilled with product. This project aims to create a business model for a hypothetical shampoo and conditioner company with in-store refilling stations. This will be achieved by researching storefronts and brands with existing personal care refill stations and using this information to develop a sustainable supply chain and financial model for the hypothetical company.

Delineating the Role of Iroquois 5b in Kidney Development

Madeline Petrikas

Faculty Advisor Dr. Rebecca A. Wingert

Cilia are short hair like structures which are found on the surface of many different types of cells. They are particularly notable in kidney cells, where they are thought to function as sensors to detect the level of fluid flow through the lumen of renal tubules. Cilia are created in a process known as ciliogenesis, which includes the production of both primary and motile cilium. Cilia are extremely important for normal kidney function, and defects in cilia can damage how kidneys monitor and control ligand-gated ion channels. Cilia can be found in single ciliated cells or multiciliated cells (MCCs). MCCs come together to form complexes of cells which can synchronize the beating of their cilia in order to create a current to generate fluid flow or move particles along. Zebrafish provide a tractable model to study MCC development. Knowledge about MCC development and function is essential for the study of many tissues, but it is also specifically applicable to various kidney pathologies. Interestingly, MCC formation has been found to occur in several kidney diseases, but researchers are not yet sure why or how. MCCs are thought to form in these instances to produce a current to encourage greater fluid flow in blocked kidneys. Here, we report that the Iroquois 5b (Irx5b) transcription factor is essential for proper MCC development. We found that irx5b transcripts are expressed in renal progenitors, and thus hypothesize irx5b is necessary for MCC specification. In future studies, we will elucidate how Irx5b influences MCC fate choice. Understanding the mechanisms that contribute to the formation and function of renal MCCs is applicable to the mechanisms of organogenesis and various diseases.

Expression and Localization of Arrestin 1, Arrestin 2, and Aaop1 in Wh Aedes aegypti During Light Transitions

Mikayla Copley, Jake Fuehrmeyer, Emme Hemmerich, Finn Mahoney, Caroline Potts

The *Aedes aegypti* mosquito is a principal vector that transmits deadly diseases such as dengue and yellow fever. The visual system is critical to its host seeking ability. This study focuses on two particular proteins within the visual system: Aaop1 and Arrestin2. Aaop1 is a rhodopsin protein that undergoes a conformational change upon excitation from light to activate the phototransduction cascade. Arrestin proteins are responsible for resetting the phototransduction cascade and the endocytosis of rhodopsin. Genes in the *Drosophila* visual transduction system are evolutionarily conserved, allowing us to use a well-characterized model in *Drosophila* to propose a model of the *Aedes* vision system. Our goal is to determine if both organisms have a similar localization of proteins through the use of immunofluorescence imaging. Aaop1 transitions from the membrane-rich rhabdomeres at night to the cytoplasm upon experiencing low light conditions at dawn, which is consistent with its crepuscular behavior. To characterize Arrestin2 movement, we sacrificed animals at time points during the dawn period when Aaop1 undergoes endocytosis. In comparing the position of the two proteins at the same time points, immunofluorescence images show that there is colocalization of Arrestin2 and Aaop1. This colocalization suggests that there is an important interaction between the two proteins during rhodopsin endocytosis. This cellular mechanism could be exploited as a target for interrupting mosquito host-seeking behavior.

Irish eating green: student sentiment and motivations towards sustainable dining at the University of Notre Dame

Brooke Puccini and Kaela Reisch

The United States food system faces several widespread challenges including unnecessary food waste, high carbon costs, and overuse of single-use plastics. College dining programs, including those at the University of Notre Dame (ND), are not immune to these issues. Sustainable dining campaigns have the potential to counteract these negative effects of food consumption, but the success of a sustainability program largely depends on the motivation of its target population to engage in sustainable action. Several sustainable programs from ND Campus Dining have experienced mixed results due to limited participation, low awareness, and high inconvenience to the customers, indicating a gap in current understanding of consumer motivation. This project aimed to understand how ND students perceive sustainable action and how motivated they are to participate in sustainable dining programs. Results showed that the average student at ND places a higher importance on meal price and quality over carbon footprint. Personal ethics and concern for environmental health were the top motivators for sustainable action from the average ND student, whereas price and inconvenience were the top inhibitors. These findings suggest that a successful sustainable dining program that is tailored to ND students will emphasize high quality, lower prices or discounts, and ethical contribution to sustainability. The results of this project are the first step towards the creation of a successful, long-standing sustainable dining program at ND.

Does Geography and English Fluency Matter? Measuring Cognitive Vulnerability to Depression in African, European, and U.S. Samples

Brian M. Ram, Ciara E. Lawlor, Lindsay K. Barrow, & Gerald J. Haeffel

According to the hopelessness theory (Abramson et al., 1989), some people are at high risk for developing depression because they have a "cognitive vulnerability." When faced with stress, these people tend to generate overly negative inferences about their future and self-worth. Specifically, an individual with cognitive vulnerability is likely to: (a) attribute the event to stable and global causes; (b) view the event as likely to lead to other negative consequences; and (c) construe the event as implying that he or she is unworthy or deficient. Research shows that people who generate these three types of negative inferences are at a greater risk for depressive symptoms and depressive disorders than people who do not generate these types of inferences (Haeffel et al., 2008).

However, a limitation of research on the cognitive vulnerability hypothesis is that studies have focused almost exclusively on college students from the United States. It remains unclear if the results of this work generalize to more diverse samples. Indeed, do our measures even work in other areas of the world? To begin to address this gap in the literature, we tested the generalizability of the measure used to assess cognitive vulnerability to depression (the Cognitive Style Questionnaire; CSQ). Specifically, we investigated if geography and English fluency affected its reliability and validity. To this end, we conducted a 2 (Fluency: 1st language vs Fluent) x 3 (Geography: United States, Europe, and Africa) correlational design. Participants (N = 575) were recruited via an online participant platform (Prolific) and administered the CSQ and a measure of depressive/anxious symptoms (MASQ).

Results showed a significant effect of geography ($p < .001$), but not English fluency ($p = .06$), on cognitive vulnerability scores. Participants from African countries reported significantly lower vulnerability (and depressive symptom) scores than participants from the United States and Europe.

Sustainability capstone project: My Friend, The Lake

Christina Randazzo

A culture is formed by the stories passed on between generations. These stories shape beliefs, values, and the way that society interacts with and treats the Earth. To create a sustainable future, people need to understand sustainability and develop a sustainable mindset starting at a young age. Many children have limited ability to interact with nature (if at all) and develop their own stories centered around a healthy relationship with the Earth. Since these personal narratives are what would typically compel them to care about and take action to protect the environment, the stories need to be able to go to them. For this project, I have built off of my previous research and personal narratives about Lake Erie—her importance, impact, and the problems that face her today (specifically toxic algae blooms)—and put them into a picture book titled My Friend, The Lake, targeted toward early childhood readers. The story is enriched by colorful photographs that tell a story while providing material for visual learning. The book is self-published and accessible online and in select libraries/nature centers. This project acts as a piece of ecologically-conscious media for children to read and engage with and will allow them to increase awareness of problems facing the Earth; specifically, Lake Erie.

Investigating CB1 Receptor-Mediated Mechanisms in Fragile X Syndrome Patient-Derived Induced Neurons

Emily Rao, Cameron MacKenzie, Camden Arnold, James Chrisman, James Knopp, Katharyn Hutson, Christopher Patzke

Advisor: Dr. Christopher Patzke

Department of Biological Sciences, University of Notre Dame

Fragile X Syndrome (FXS) is the most common inherited form of autism spectrum disorder (ASD) and results in developmental and learning disabilities in patients. The trinucleotide CGG repeat mutation in the Fragile X Messenger Ribonucleoprotein 1 (FMR1) gene, which codes for the protein FMRP, is the sole known cause of FXS. Studies have revealed that the loss of FMRP, a translational repressor of mRNAs in the nervous system, is responsible for various neuronal defects in mouse models of FXS. Currently, FXS research has focused primarily on mechanisms in the postsynaptic neuron, while there is little known about the role of presynaptic processes. In this study, we investigated the role of the CB1 receptor (CB1R) in FXS neurons using the endogenous cannabinoid reporter GRABeCB2.0 and found that CB1R activity was reduced in FXS compared to wild-type neurons. We then measured the levels of cyclic AMP (cAMP) and phosphorylated PKA (phospho-PKA), two key presynaptic proteins downstream of the CB1R, as well as the numbers of synaptic vesicles recruited to the presynaptic terminal. We observed an increase in cAMP and phospho-PKA and a subsequent decrease in the recruitment of vesicles in FXS neurons. Together, these results unveil a CB1R-mediated mechanism in FXS neurons that lead to reduced vesicle accumulation through the cAMP/PKA pathway. Our findings serve as a foundation for a new potential drug target, which would enable the future development of better treatments for FXS.

Distribution of Per- and Polyfluoroalkyl Substances (PFAS) in the Great Lakes Ecosystem: A Review

Therese Reisch, Juan Flores, Kaitlin Mohlenkamp, Alison Zachritz, Daniele Miranda, and Gary Lamberti

Department of Biological Sciences

Advisor: Gary Lamberti

Per-and polyfluoroalkyl substances (PFAS) are a large group of synthetic chemicals that are widely used in everyday products ranging from cookware to cosmetics to water-resistant clothing because of their surfactant properties. However, PFAS have entered the environment where they are highly persistent because of their strong carbon-fluorine bonds. These chemicals are linked to numerous wildlife and human health problems such as increased cancer risk, lower fetal birth weight, and altered immune responses. In the environment, PFAS have been studied for their distribution in various ecosystem compartments and biomagnification in terrestrial and aquatic organisms. We assembled the published literature on the distribution and concentration of PFAS in organisms in the Great Lakes watershed to understand the extent to which PFAS have penetrated the biota. A thorough literature search targeting primary publications produced 34 papers spanning 1979 to 2019 that contained data on PFAS concentrations in aquatic and riparian biota. These papers predominantly considered perfluorooctanesulfonic acid (PFOS), but contained data on other PFAS such as perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), and perfluorobutane sulfonate (PFBS). These compounds were analyzed mostly using whole fish homogenates and avian eggs, among other tissue samples, and were extracted from a variety of fish, bird, invertebrate, and plant species. We are currently performing a meta-analysis of these data to assess the distribution and bioaccumulation of PFAS in the Great Lakes watershed. This analysis will be crucial to our understanding of the distribution of PFAS in the Great Lakes watershed and inform efforts to regulate and remediate PFAS in the environment.

Challenges Resulting in Low System Effectiveness of Reactive Case Detection Strategies for Malaria Control in the Ashanti Region of Ghana

Madeline Reynders

Effective strategies for malaria treatment and control in endemic areas are essential to reduce transmission and disease burden. We aimed to evaluate the operational logistics and feasibility of a reactive case detection program (RACD) in the Ashanti region of Ghana. RACD programs are designed to detect subclinical asymptomatic infections related to a single symptomatic malaria case, often detected at a health center. Individuals are followed to their households where members of the index case and neighboring households are screened and treated for malaria [4]. RACD programs aim to reduce peri-domestic transmission by asymptomatic carriers and target subclinical cases to eliminate parasite reservoirs [5]. The effectiveness of an RACD system critically depends on accurate diagnosis of index cases in the clinical setting. Therefore, we evaluated the sensitivities of various field diagnostic tools for clinical and subclinical cases, including rapid diagnostic tests (RDTs), expert microscopy by WHO-certified microscopists, and field microscopy. Through the implementation of a pilot program, we identified two major limitations to an effective RACD program in this area: the low sensitivity of diagnosis of index cases at the health center and asymptomatic community members, and a low level of receptivity to RACD-style follow ups among study participants. With operational improvements, such as the use of RDT as the initial diagnostic tool, and increased community receptivity, an RACD program will be effective in detecting a significant portion of asymptomatic infections in this area. However, we found that the prevalence rate among asymptomatic individuals in this area is extremely high (63.95%), which suggests that uniformly applied interventions such as mass drug administration may have a greater clinical impact than an RACD program. Due to low system effectiveness and the endemic nature of the disease setting, we concluded that an RACD system is not a feasible option for malaria control in this region.

Evaluation of The Effect of SREBP1 Inhibitor With Chemotherapy As A Potential Combination Therapy Against Obese Ovarian Cancer

Emily Richardson[1, 2], Sophia Santoso[1, 3], Jing Yang[1, 4], Yueying Liu[1, 4], and M. Sharon Stack[1, 4]

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Ovarian cancer (OvCa) is the fifth most common cancer among women, and the most fatal gynecological malignancy, largely attributable to its late diagnosis, widely disseminated intra-peritoneal metastasis and resistance to chemotherapy. Obesity is a prevalent pandemic-level health issue worldwide. Epidemiological studies show 66% of U.S. women are overweight and >35% are obese. Meta Analysis showed that obesity and the accumulation of adipose tissue increase the risk of OvCa incidence and progression. We recently demonstrated that diet-induced obesity (DIO) leads to enhanced tumor burden. Tumors grown in mice on a western diet (40% fat) exhibit increased intracellular lipid content and overexpress sterol regulatory element binding protein 1 (SREBP1). SREBP1 is a master transcriptional regulator of de novo lipogenesis that can induce lipogenic reprogramming of tumor cells. SREBP1 is synthesized in the endoplasmic reticulum and transported to the Golgi via SREBP cleavage-activating protein (SCAP), wherein it undergoes regulated proteolysis to release the active transcription factor that translocates to the nucleus. In this study, we aim to evaluate SREBP1 as a potential novel therapeutic target for OvCa in the obese host. Experiments use conventional standard-of-care chemotherapy (paclitaxel/carboplatin) in combination with an inhibitor of SREBP1 (Nelfinavir) to treat pre-clinical murine models of OvCa and DIO. Nelfinavir inhibits SREBP1 maturation through inhibition of site-2 protease activity, which leads to suppression of regulated intramembrane proteolysis. Total and organ-specific tumor burden were imaged and quantified longitudinal and end point. Tumor sections were characterized by immunohistochemistry for expression of SREBP1, PCNA, iNOS, and CD206. Immune cell population in peritoneal lavage or ascites fluid were quantified. Our results reveal that this combination therapy yields a lower tumor burden in DIO obese OvCa preclinical models. Overall, these innovative analyses will identify mechanisms through which host obesity can affect treatment response and reveal new targets for therapeutic intervention.

(Oral Presentation)

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

Brooke Rodriguez[1], Michele Adams[1], John P. Grieco[1], Benedicte Fustec[1] and Nicole L. Achee[1]

[1]Department of Biological Sciences, Eck Institute for Global Health, University of Notre Dame

In recent years, outbreaks of emerging zoonoses are increasing in frequency worldwide and more are foreseen in the future. Disease surveillance typically targets a select cohort of biological samples and tests for known pathogens. Many sites where samples originate lack the capacity to rigorously process and/or test material, resulting in requirements for samples to be sent to other laboratories delaying outputs and alerts to potential outbreaks. The REDI-NET is a long-term, phased initiative built upon a Consortium of global networks intending to overcome these and other barriers to detect, predict, and contain emergent zoonoses. REDI-NET's strategy is to strengthen domestic and international capacity to effectively implement bio-/xeno-surveillance in Belize, Florida and Kenya by leveraging partner expertise in disease surveillance and metagenomics using Next-Generation Sequencing (NGS) with Oxford nanopore technology (ONT). The Biomeme Franklin™ Real-Time Polymerase Chain Reaction (PCR) Thermocycler is a portable, battery-operated mobile device designed for testing samples in remote field settings for fast and targeted pathogen detection where zoonotic threats may exist. Through experiments that will be conducted during May-August 2023, we will evaluate the added benefit (or not) of introducing Biomeme Franklin™ testing of tick samples in Belize within the REDI-NET surveillance pipeline. Specifically, we will use ONT MinION sequence outputs to guide targeted testing of tick samples with Biomeme Franklin™ to quantify 'hits' of tick-borne pathogens. Findings are anticipated to strengthen current pathogen datasets for our predictive risk models, trouble-shoot field-friendly PCR methodologies and guide development of future pathogen surveillance task forces.

An Analysis of the Effects of Experience and Training on Mental Health and the Ability for Mexican Physicians to Cope During the COVID-19 Pandemic

Authors: Kate Brandin, Kayla Bucci, Elizabeth Horwitz, Julia Ruelle

Advisor: Vania Smith-Oka, Ph.D.

Department of Anthropology

Abstract:

The COVID-19 pandemic has had significant impacts on all members of society, especially doctors and other healthcare workers, causing increased stress as a result of heavier workload and the severity of the emergency. Scholars suggest that younger doctors experience rising rates of stress and burnout; this stress can be exacerbated by the COVID-19 pandemic. This poster is based on a survey of doctors at public and private hospitals in Puebla, Mexico carried out in 2020 that investigated their stress levels within the pandemic. Results showed that older physicians tended to report a greater ability to cope with the difficulties brought about by the pandemic than middle aged and younger physicians. Secondly, the results showed that completing a residency does not have a clear relationship to the stress level and coping ability like age does. This investigation reveals the complexity of the effects of the COVID-19 pandemic and prompts further research into how to quell these effects.

Knockout of the ABC transporter, *SCARLET*, leads to altered behavior and differential gene expression in *Daphnia magna*

Jose Salazar Saavedra

Advisor: Trenton C Agrelius, PhD

Department of Biological Sciences

Daphnia are freshwater microcrustaceans that have been heavily studied in the fields of ecology, ecotoxicity, evolution, genomics, and, more recently, epigenetics. *Daphnia* have short maturation times and produce large clutches of parthenogenic eggs resulting in genetically identical offspring. Manipulation of gene expression and gene knock-in/out technology are now possible for *Daphnia* through RNA interference, the CRISPR-Cas system, and transcription activator-like effector nucleases (Ebert 2022). These possibilities for gene alteration combined with its other characteristics make *Daphnia* a spectacular model for studying certain pathways that have yet to be elucidated in other organisms. The **A**TP-**B**inding **C**assette (ABC) *Scarlet* is an eye pigment transporter that mediates the transport of a tryptophan metabolite, 3-hydroxykynurenine (3HOK), into a specialized lysozyme-like organelle in *Daphina magna*. *Scarlet Drosophila melanogaster* mutants have been shown to have age-dependent progressive loss of dopaminergic neurons, increases in reactive oxygen species levels, shortened lifespans, and decreased climbing indices (Zhuravlev et al. 2020). Furthermore, the accumulation of 3HOK within the nervous system has been observed during neurodegenerative disorders, such as Alzheimer's, Parkinson's, and Huntington's diseases. We hypothesized that the knockout of the *Scarelt* gene in *D. magna* would result in the loss of eye pigmentation as well as the accumulation of 3HOK, leading to altered locomotive behavior. To accomplish this, we generated sgRNAs targeting the *Scarlet* gene in *D. magna* and mutated the gene using the Cas9 nuclease. We conducted behavioral assays and used RNAseq to quantify changes between our mutant and wild-type *Daphnia*. We observed age-dependent changes in swimming patterns that progressed over time and increased expression of more than 30 genes with **G**ene **O**ntology terms relating to oxidative stress, transport, and damage.

Capillary Isoelectric Focusing – Fraction Collector System to Examine Electrophoretic Mobility of Bacteria

Olivia Schneider, Caitlin Kerr, Bonnie Huge, and Matthew Champion

Department of Chemistry and Biochemistry, University of Notre Dame, Notre Dame IN 46556

Microbiomes of bacteria are plentiful in the natural world, but because so many different types of bacteria exist, it is difficult to be able to separate and identify the different species. Bacterial microbiomes have been separated using techniques such as capillary zone electrophoresis, providing information about bacterial mass and charge. However, capillary isoelectric focusing is a separation technique that has rarely been used to separate bacteria, but can provide new information about bacterial species, specifically regarding its isoelectric point. A significant step in separations is optimizing the protocol needed for bacterial separations. This was completed by conducting capillary isoelectric focusing on proteins in conjunction with a laser induced fluorescence detection instrument to determine a protocol that would improve separations while also not harming the bacteria. The results from the research conducted this summer revealed a protocol that separated proteins most efficiently, including what catholyte plug, anolyte plug, voltage, and pressure to use. The optimized protocol can then be applied to the capillary isoelectric focusing of bacteria in conjunction with a fraction collector to separate bacterial microbiomes.

(Oral Presentation)

Challenge on the Horizon: Tensions between Human Use and Natural Value at Mount Rainier

Piper Shine

Advisor: Annie Gilbert Coleman, Ph.D.

Department of Sustainability, University of Notre Dame

This capstone explores the development of Mount Rainier National Park (MORA), defining how its change over time raises issues of sustainability. I will answer the question of how personal experiences, park management, and advocacy groups impact land attitudes, use, and sustainability of access to Mount Rainier National Park (MORA).

Sustainability perspectives and practices in Mt. Rainier have been formed since its entrance into the American identity. Desires to recreate on the land precariously balance between honoring its intrinsic value as a living body that is often disturbed by human activity. Learning to love a place often involves experiencing it, but the ethical approach to this is difficult to learn and practice. Historical and present rhetoric informs practice, which shapes how individuals value, see, and use the land. Historical narratives set precedents of use, but present advocacy is striving to change the conversation to intrinsically valuing and respecting the land. Regulatory bodies inform how the public approaches land; sustainability is a cyclical education between park management and people. Mt. Rainier contextualizes this tension.

Applying a Generalized Joint Attribute Model to the Historical Vegetation-Environment Relationship in the Midwestern United States

Ian N.C. Shuman

As ecosystems become increasingly destabilized by anthropogenic activities such as climate change, urbanization, and deforestation, the need for informed predictions of vegetation's response to environmental change is becoming critical. An understanding of the historical relationship between vegetation and the environment is essential to these predictions, but the ecological mechanisms of this relationship remain contentious. While some assume a "one to one" interaction existed between vegetation and environmental conditions, such as climate, soil characteristics, and topography, others argue that a complex network of both environmental and biotic processes shaped the vegetation distribution, allowing for the persistence of multiple stable states of vegetation. To disentangle these two competing hypotheses, a Generalized Joint Attribute Model was used to characterize the relationship between 12 environmental drivers and the presence of 15 taxa, reconstructed from the 19th Century Public Land Survey notes of Illinois and Indiana. Across more than 78,000 observations, environmental drivers, particularly climate conditions, explained 30.3% of the variation in historical ecosystem presence. Beyond that explained the environment, it was found that negative biotic interactions also worked to maintain distinct prairie, savanna, and forest ecosystems. As a result, we argue that both environmental conditions and biotic interactions, which give rise to multiple stable states, should be considered when predicting vegetation's response to changing conditions and developing future land management strategies.

(Oral Presentation)

Exploring Gravitational Wave Data for Binary Neutron Star Systems

Cameron Sprauge

A new area of physics research exploded following the first detection of gravitational waves from a binary black hole system merger in 2015. Thus, Research into gravitational waves is a growing field, and there are many groundbreaking discoveries that will inevitably occur in the near future. This presentation will explore the open data from gravitational waves emanating from binary neutron star systems using the Bilby library engineered by LIGO. Specifically, this presentation will deal with parameter estimation using raw strain data to more accurately determine attributes of the source. The process of ascertaining reliable source parameters is essential to the study of the actual astrophysical events being recognized at the interferometers on Earth.

Cxcl5/Cxcr2 as Potential Therapeutic Targets in Breast Cancer Bone Metastasis.

Adison Steinke, Courtney Flatt, Madeline Sheeley, Emma Powers, Alex Lin, and Laurie E. Littlepage

Metastatic breast cancer is the most advanced stage of breast cancer and kills patients at significantly higher rates than primary tumor growth. Bone is the most common location for metastasis of breast cancer cells with 65-75% of metastatic breast cancer patients having bone metastases at death. No current treatments cure metastatic breast cancer. Previous studies in our lab have identified the chemokine Cxcl5 and its receptor, Cxcr2, as sufficient in promoting proliferation and colonization of breast cancer cells in bone. Furthermore, inhibition of the receptor Cxcr2 has demonstrated sufficiency in reducing colonization and proliferation, giving emergence to potential therapeutic options that target the Cxcl5/Cxcr2 signaling axis to impede breast cancer metastasis. Currently, we have utilized genetically modified cell lines to understand the contributions of Cxcl5/Cxcr2 expression in proliferation, adhesion, and cell death. Cxcr2 knockdown cell lines have demonstrated reduced proliferation and adhesion, consistent with Cxcr2 promoting tumor growth and metastasis. We are currently investigating Cxcl5 knockdown and overexpression cell lines, and in the future, plan to generate Cxcr2 overexpression cell lines to further explore the role of Cxcl5/Cxcr2 expression in breast cancer metastasis. Additionally, using in vivo and ex vivo techniques, we are investigating the therapeutic efficacy of the Cxcr2 antagonist, Repertaxin, in the colonization and treatment of breast cancer bone metastasis. The use of an ex vivo co-culture system previously developed by the Littlepage Lab to grow cancer cells in mouse bones allows the assessment of the effects of Repertaxin on cancer cell proliferation in healthy or cancer-primed bones ex vivo. The therapeutic efficacy of Repertaxin has then been further evaluated in vivo through injection into mouse models of bone metastasis to test the effect of the Cxcr2 antagonist. Cell proliferation, tumor burden, and bone degradation are currently being quantified to determine the sufficiency of Repertaxin on the impediment of metastatic breast cancer in vivo. These investigations will generate preliminary data for the use of Repertaxin as a potential clinical option in the treatment of metastatic breast cancer and shed further insight into the effectiveness of Cxcr2 inhibitors in preventing and reversing proliferation and colonization of breast cancer metastases.

Senescence-associated secretory phenotype induces pyroptotic cell death in normal mammary epithelial cells

Seunghoon Sun

Cellular senescence is a state of permanent cell cycle arrest which occurs in response to different damaging stimuli. An important aspect of senescent cells is the ability for these cells to influence the surrounding microenvironment through the senescence-associated secretory phenotype (SASP). While previous studies have examined the role of the SASP in the context of cancer cells, the impact of the SASP on normal epithelial cells is not well understood which serves as the focus of this study. Our results show that when normal mammary epithelial cells are exposed to conditioned media from senescent fibroblasts, these cells undergo cell death. Furthermore, this cell death phenotype is maintained across different senescence-inducing stimuli such as the overexpression of the oncogene H-Ras and treatment with bleomycin, a DNA damaging agent. The data suggests that the cell death induced by the SASP is pyroptotic and involves inflammasome, caspase, and gasdermin activation. Taken altogether, this study demonstrates a novel relationship between the SASP and induction of pyroptotic cell death in epithelial cells.

The Development of Small-Molecule Inhibitors of Glycogen Synthase to Treat Cori Disease

Ian Tibbals

Advisor: Dr. Richard Taylor, Dept. of Chemistry and Biochemistry, University of Notre Dame

Glycogen storage disease type III, Cori disease, is an inherited disorder that results in the buildup of structurally abnormal glycogen in the body's cells. Caused by a mutation in the AGL gene that encodes the glycogen debranching enzyme, the disease is typically detected during infancy through symptoms such as an enlarged liver and low blood sugar levels. With current treatment options confined to dietary modifications, research has explored the potential of inhibiting glycogen synthase, and in turn reducing total glycogen accumulation, as a new therapeutic strategy. Collaborators at the Indiana University School of Medicine recently discovered a diaryl pyrazole that demonstrates strong inhibition of glycogen synthase in vitro, yet lacks the pharmacokinetic properties necessary for in vivo studies. Using a combination of two synthetic routes, over a dozen analogues of this lead inhibitor have been synthesized, with particular emphasis on altering substituents susceptible to metabolic oxidation. In addition, these analogues have attempted to strengthen the binding affinity of the lead compound through the installation of new hydrogen bond acceptors. Initial biological testing has revealed promising inhibitory potential for certain analogues in vitro, however, no compound has yet to show inhibition in cellular assays. Future work will look to add additional functionality to the lead compound in hopes of forming new enthalpic interactions within the binding pocket of glycogen synthase.

The Feasibility of Solar Technology in Dschang, Cameroon

Joyce Tipe, Architecture

Advisor: Prof. John Odhiambo Onyango Ph.D, School of Architecture

University of Notre Dame

The city of Dschang, Cameroon is one filled with many natural resources, including plentiful sunlight. However, solar energy is currently underutilized in the region, despite growing energy needs throughout the country. I have studied the feasibility of utilizing solar technology in Dschang, Cameroon and found that the western region of Cameroon, where Dschang is located, is optimal for the use of solar panels. I have researched the cost of electricity in the area, and found there to be potential for a solar photovoltaic system to be incorporated into the electricity system for a building in the area. I found the best solar technology that could provide the energy needs of a school design I created. I researched the initial costs and the space required to implement the solar technology I have selected. I then analyzed the challenges of utilizing solar technology in a rural area, where resources are limited and funding is typically inadequate. Ultimately, I found that while initial costs will always be a deterrent, the utilization of solar technology in Cameroon is a valuable investment that will provide reliable energy that will allow for residents of Dschang to be self-sufficient.

Sulfur Insertion into Tris(pyrazolylborate) Zinc Thiolate Complexes

Victor Tsang, W. T. Michael Seo, Emily Tsui

University of Notre Dame

Zinc thiolate motifs play both structural and functional roles in biological systems. Elemental sulfur (S0) can insert into a metal-sulfur bond to form metal polysulfanides; these unique species can participate in redox signaling processes related to homeostasis and disease. A major goal of this study is to study energetic factors governing sulfur insertion into 5-coordinate zinc thiolate complexes. A working hypothesis is that these reactions are governed by both metal coordination geometry and ligand ring strain. Zinc thiolate complexes supported by substituted tris(pyrazolyl)borate ligands were synthesized and characterized spectroscopically and structurally. The sulfur reactivity of these compounds were studied, and sulfur insertion products were characterized crystallographically.

Traditional Adobe Construction: A Future Sustainable Building Practice

Savannah Valerio, Architecture Major

Prof. John Odhiambo Onyango Ph.D

Abstract

Energy consumption is becoming an important issue in architecture, engineering, and construction. In recent years, there has been a transition away from traditional construction and towards more lightweight construction with added insulation. Modern construction relies more heavily on HVAC systems that consume a lot of energy. To reduce carbon emissions and meet current sustainability initiatives, people are looking for ways to design cost-effective, low-carbon homes. This proposal will compare the thermal behavior of traditional adobe construction with modern wood-frame construction in New Mexico. To assess thermal behavior, greenTEG technology will be used to measure the R-value of two different wall types in New Mexico. In addition, the thermal mass of the walls will be analyzed by building a simple model of the walls in a lab and running tests using the guarded hotbox method. The data collected onsite will be verified using an online IES Virtual Environment simulator. These three different methods will provide an overall idea of adobe's ability to regulate the indoor thermal environment. The results will be compared to the ASHRAE-55 standards for human comfort. A life cycle sustainability assessment will be conducted to evaluate the environmental, social, and economic impacts of each construction method.

(Oral Presentation)

Father-Adolescent Attachment and Adolescent Anxiety: A Multi-Informant Growth Curve Analysis

Savannah Vetterly, Applied and Computational Mathematics and Statistics

Advisor: Dr. E. Mark Cummmings and Sarah Hoegler, Department of Psychology

Abstract:

One of the biggest developmental contributors to the emergence of anxiety is the family context, including insecurity in the parent-child attachment relationship. Evidence suggests that attachment security may serve the purpose of buffering the child from feelings of anxiety. Given that early to mid-adolescence is marked as a time of stressful transitions, a secure parent adolescent relationship has the potential to buffer the adolescent from the stress of these transitions. However, little is known about the effects of father-child attachment on anxiety, especially in early to mid-adolescence. The present study addresses parental influences on the development of adolescent anxiety in a sample of 295 mother, father, and adolescent triads studied across three years. Two growth-curve models were specified: one for mothers and the other for fathers. Results indicated that linear increases in changes in adolescent reports of secure attachment with their fathers were predictive of linear decreases in changes in adolescent reports of anxiety ($b = -0.344$, 95%CI[-0.670,-0.018]).

Although previous studies have extensively underscored the ways that mothers contribute to their child's emotional security by providing comfort during distress, the present study contributes to a growing body of research that likewise highlights the importance of the father child relationship. In particular, recent work suggests that the father-child relationship may serve a function of encouraging positive social skills and helping adolescents navigate other developmental challenges in early to mid-adolescence. Given that fathers particularly help their adolescents meet these challenges – and that these challenges relate to subsequent anxiety– this could be a possible explanation for why attachment with fathers (but not mothers) was predictive of linear decreases in adolescent anxiety. While the results highlight fathers' effect on adolescents' anxiety, future research should continue to elucidate the unique roles that fathers play in adolescent development and other internalizing symptomatology.

(Oral Presentation)

Guiding Sustainable Ecosystem Management and Riparian Development Through Climate Informed Flood Modeling of the St. Joseph River

Nathan Voss, Applied and Computational Math and Statistics

Faculty Advisor: Dr. Alan Hamlet, Department of Civil and Environmental Engineering and Earth Sciences

Abstract:

Climate change is at the forefront of environmental policy. However, lawmakers, developers, and landowners often do not have the proper tools to assess the growing environmental risks associated with a changing climate. One such risk is flooding, not only in coastal regions, but every inland area within river floodplains as well. Riparian developments, both public infrastructure projects (bridges, sewers, etc.) and private homes, farms, and businesses, are increasingly in the crosshairs of devastating floods that may be due to climate change. However, developers lack the necessary tools needed to predict the growing frequency and intensity of such events. This project used hydrological and climatological data from the United States Geological Survey and a Non-Stationary Monte-Carlo flood model that accounts for different future climate scenarios, is to assess the risk of the infrastructure developments for the St. Joseph River Watershed in South Bend, Indiana. The results of this statistical analysis were shared with academics and professionals in the South Bend community to help understand increased flooding in the context of current floodplain development strategies, and climate change adaptation strategies leading to the development of more sustainable, flood-resistant/resilient infrastructure projects, as well as more sustainable ecosystem management strategies for agricultural lands.

Optimization of Tryp-N for Pyroglutamic Acid Avoidance and Design of a Novel Colorimetric Substrate for N-Terminal Proteases

Authors: Amanda Waelde, Daniel Hu, Matthew M. Champion

Abstract

Mycobacterium tuberculosis is a leading cause of death worldwide, leading to about 1.8 million deaths from tuberculosis each year. Post-translational modifications of proteins, including N-terminal acetylation (NTA) of proteins, is a major means by which *M. tuberculosis* regulates its virulence. Our lab has developed a method for efficient quantification of NTA that can be used in *M. tuberculosis* research. The method uses trypsin, a common protease that cleaves C-terminal to lysine and arginine residues, to digest proteins into individual peptides. However, if the first amino acid residue after a trypsin cleavage site is glutamine or glutamic acid, the N-terminus exposed after tryptic digestion can undergo a cyclization reaction into N-terminal pyro-glutamic acid (pyro-Glu), yielding a contaminant in our NTA quantification method. The pyro-Glu can be removed, but the procedure is extremely time consuming and alters the amino acid sequence itself, making computation-based sequencing of the peptide more difficult. We are evaluating Tryp-N, an N-terminal protease that cleaves before arginine and lysine, yielding peptides beginning with one of those two residues. Since the resulting N-terminal amino acid residues cannot be glutamine or glutamic acid, their cyclization into pyro-Glu and the resulting contamination will be eliminated. The digestion conditions for Tryp-N were unknown prior to this work and are not readily investigable due to the lack of model substrates for N-terminal proteases. Most common proteases have colorimetric substrates which facilitate rapid optimization of enzymology and determination of steady-state kinetic parameters. Here, we show the optimization of Tryp-N using a dye-bound protein-substrate and the design and synthesis of a novel colorimetric substrate specific for N-terminal proteases. Establishing digestion conditions for Tryp-N will enable us to demonstrate its ability to prevent pyro-Glu formation and use it in our NTA quantification, preventing contaminants, eliminating the need for pyro-Glu removal, and aiding *M. tuberculosis* research.

Ecosystem contamination by PFAS – the DDT of our Generation

Josh von Werder, Kristin Schaars, Alison Zachritz, Heather Whitehead, Daniele Miranda, Graham Peaslee, and Gary Lamberti

Per- and poly-fluoroalkyl substances (PFAS) are a class of highly fluorinated man-made compounds used in many industrial and domestic applications. Release of PFAS into the environment has led to their detection in the atmosphere, land, and water. These chemicals are also highly resistant to chemical breakdown by both abiotic and biotic processes, which has led to their reference as "forever chemicals". Because recent research has linked PFAS to various human health problems such as kidney cancer, immune suppression, and endocrine disruption, PFAS have become an ongoing public and environmental concern warranting further investigation. Once taken up by the biota including plants and animals, PFAS can bioaccumulate and magnify their concentrations in upper trophic level organisms. Furthermore, PFAS can circulate in ecosystems and be transported to animal movements such as by fish spawning migrations. Furthermore, eating organisms (e.g., sportfish) contaminated with PFAS can expose humans to PFAS intake, such as those who participate in sustenance fishing or hunting. Our project has two major objectives: (1) assess the extent to which PFAS is being transported to tributaries to Lake Michigan by spawning salmon and (2): evaluate if the PFAS concentrations in salmon harvested from Lake Michigan relate to health guidelines currently established for the Great Lakes region. We will use stable isotopes of N and C to characterize fish trophic positions with isotope ratio mass spectrometry (IRMS) and quantify PFAS compounds in more than 150 biotic and abiotic samples using liquid chromatography with tandem mass spectrometry (LC-MS/MS). Data from this project will provide resource managers with a better understanding of the risks associated with PFAS in the Great Lakes fishery. We will also contribute data to better understand PFAS transport to streams and to improve health recommendations regarding consumption of Lake Michigan sportfish.

Out With the Old Enemy, In With the New Enemy: Foundational Methodology To Explore Neuroendocrine-to-Luminal Redifferentiation as a Treatment Direction in Neuroendocrine Prostate Cancer

Rachel Whitehead

Abstract

Neuroendocrine prostate cancer (NEPC) is a rare but highly aggressive subtype of prostate cancer that has increased in prevalence over the past two decades due to the wide clinical use of androgen receptor inhibitors (ARi). NEPC cells have developed pathways that are independent of the androgen receptor (AR) and can resist ARi treatments. Effective treatment methods for NEPC remain elusive; a pressing need exists for advanced diagnostic and therapeutic directions. Recent evidence points to the lineage plasticity hypothesis, which postulates that luminal cells develop into neuroendocrine cells through downregulation of luminal-defining factors and upregulation of master drivers of the neuroendocrine phenotype. We hypothesize that a certain FDA-approved drug can reverse the molecular effects of luminal-to-neuroendocrine transdifferentiation and can reactivate AR signaling and PSA expression, thus redeveloping AR dependency and sensitivity to ARi. We have developed a model using lentiviral transduction of an NEPC cell line along with a AR-independent CRPC cell line and an adenocarcinoma cell line for methodology validation and relative controls. The reporter lentiviral vector in the model induces expression of mCherry fluorescence in live cells and GFP fluorescence in cells that express activated AR. We have validated the function of the reporter vector using western blot, flow cytometry, and immunofluorescence microscopy techniques. We have also generated a positive control with a lentiviral vector that induces exogenous AR expression. We have proven that the vector evokes GFP fluorescence in cells that have the reporter vector along with sufficient levels of androgen production and/or exposure to activate AR. We have further run flow cytometry on NEPC cells that have been exposed to the EZH2 inhibitor tazemetostat as a preliminary drug trial with the reporter vector to examine the possibility of AR-resensitization by the inhibition of EZH2, a master epigenetic regulator of the neuroendocrine presentation that is shown to be highly upregulated in NEPC cells. In this project, we have generated a foundational methodology and initial direction of optimizing protocols in preparation for a drug screening across an entire FDA-approved drug library as a crude examination of possible candidates for resensitization to AR signaling on a mass scale.

Analyzing The Impact of norpA Exon 4/4a CRISPR-Mediated *Aedes Aegypti* Mutants on Phototransduction and Arrestin Localization in Photoreceptor Cells in Light Transitions

Jessica Williams, Luzmarialena Flores, Brian Johny, Jordan Lam, Britney Solis
Michelle Whaley, Joseph O'Tousa

The importance of the norpA gene in the phototransduction pathway of Aedes Aegypti cannot be overstated. As a protein of central importance in phototransduction, this gene operates in tandem with other sensory pathways to influence the insect's host-seeking behavior, which ultimately determines its ability to act as a vector for numerous major diseases. Alternative splicing of the NORPA phospholipase-C beta (PLCβ) transcript reveals two subtypes. Further, Northern blot analysis of tissue suggests that Subtype 1 contains NORPA exon 4 and is likely linked to retinal-specific function. Subtype 2 is linked to broader reproductive function and contains exon 4A instead of exon 4. Our aim is to genetically characterize *norpA* Subtype 1 and 2 mutants through Single animal genomic DNA isolation, polymerase chain reaction (PCR), and capillary electrophoresis, followed by fast cloning and DNA sequencing. We will also conduct genetic crosses to achieve homozygous lines for subsequent physiological and light avoidance behavior studies. Also in the cascade, arrestin proteins are activated and regulate the deactivation of rhodopsin. Previous *Drosophila* studies have identified arrestin isoforms in *Aedes aegypti, arr1* and *arr2*, and our lab aims to gain a deeper understanding of its mechanism and of the necessity of each isoform on rhodopsin recycling and localization in *Aedes aegypti*. In doing so, we will carry out western blot analysis on arrestins 1 and 2 of white-eyed *Aedes aegypti* in differing dawn/dusk time points. We will also perform indirect labeling for the two protein isoforms at dawn and dusk time points for a subsequent immunofluorescence assay on retinal tissue. With these directions, we hope to gain insight into altering the vector competence of *Aedes aegypti.*

Mechanistic Studies and Characterization of Radical Iridium-Carbon Bond Formation in Iridium Iminoxolene Complexes

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The paramagnetic iridium iminoxolene complex (Diso)2Ir (Diso = N-(2,6diisopropylphenyl)-3,5-di-tert-butyl-o-iminobenzoquinone) reacts with 1-bromoethylbenzene through bromine abstraction to form (Diso)2Ir(CHMePh). Rates of bromine atom abstraction can be measured by UV-vis spectroscopy, and rates of iridium-radical combination can be measured by competition with TEMPO as a radical trap. (Diso)2IrH, formed from (Diso)2Ir and molecular hydrogen, reacts with styrene to give exclusively the secondary alkyl (Diso)2Ir(CHMePh) as a mixture of diastereomers. These diastereomers can be prepared from the well characterized compound (Diso)2IrCl and crystallized from methanol. The diastereomers decompose in the presence of light into ethylbenzene radical and (Diso)2Ir, which can then form styrene, ethylbenzene, and (Diso)2IrH. The weak Ir–H bond (BDFE = 57.3 kcal mol-1) allows the hydride to react with styrene by a radical mechanism; this is confirmed by its diastereoselectivity, which is the same as observed in reactions with PhCH(Me)Br.

Spirit of Science Presenters—3:30 pm to 4:30 pm

The below Middle School students are the awardees of **The Northern Indiana Regional Science and Engineering Fair (NIRSEF)** that is open to schools in the counties of Elkhart, Fulton, Marshall, and St. Joseph, LaPorte, Porter, and Lake. They will be presenting their data at COS JAM.

Brynleigh Oakes and Ellie Foster from Kankakee Valley Middle School Project Titled "Mirror Magic"

Matthew Huemmer from Mishawaka Catholic School Project titled “How High does a Marble have to start to complete a double loop-the loop on a track”

Eleanor Niemier from Schmucker Middle School "How does habitat impact stream water quality? Comparing chemical and biological indicators across four habitats along Juday Creek”

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.

“Platinum Induced Gene Expression Yields Mechanistic Insights to Chemotherapy Resistance”

May Weston, Marian High School

Abstract:

Cancer cells grow at an uncontrollable rate and evolve and change easily. When treated, cancer cells can be inherently resistant or develop resistance overtime. Therefore, it is crucial to understand resistance and the mechanisms that contribute to it. In the 2017 study, Identification of Novel Protein Expression Changes Following Cisplatin Treatment and Application to Combination Therapy by Stark, et al., the cisplatin induced expression of over 250 proteins in LCL cells was analyzed to see the relationship between gene expression and chemotherapy resistance and sensitivity. The research conducted in this project analyzes four of these genes (ADPGK, ZNF326, LSR, ENC1) to see their correlation to chemotherapy resistance in cancer cells. The genes were selected based on common patterns, and qPCR was performed to quantify the genes. I hypothesized that all of these genes would play a role in resistance and change in expression based on their expression in blood cells. All of the genes showed that they contribute to chemotherapy resistance or sensitivity in some way. Many of the genes mimicked the trends in their expression identified in blood cells suggesting their roles in resistance. However, the genes also showed that they play a complex role in resistance in some cancers like HCT116 (oxaliplatin) due to their increasing and decreasing expression. These genes have the potential to become biomarkers for chemotherapy resistance due to their distinct roles in resistance. Overall, understanding the relationship between gene expression and chemotherapy resistance will help to improve treatment outcomes.

“The Effect of APC loss on Response to Chemotherapy in Ovarian Cancer Cells”

Lucinda Flanagan, St. Joseph High School

Abstract:

Hypothesis: APC knockdown in ovarian cancer cells (APCKD cells) using CRISPR will result in decreased chemotherapy-induced apoptosis.

Description of procedure: Protein was isolated from non-targeted control lines (NTCs) and APCKD OVCAR5 cells. To confirm APC knockdown, APC/Actin western blot analysis was performed. APCKD cell lines with lower APC expression than the NTCs were selected for further evaluation, and treated for 24 hours with either DMSO, 1uM PTX, H20, or 8uM DOX. DMSO and PTX treated cells were collected after incubation, stained with AnnexinV/PI, then analyzed using flow cytometry to determine the number of cells in early or late apoptosis. H20 and DOX treated cells underwent protein isolation and the lysates analyzed using Cleaved Caspase 3 (CC3)/Actin western blots. Three independent experiments were performed.

Statement of results: The level of apoptosis in the drug-treated APCKD cells were compared to the non-targeted controls for each sample. APCKD cells saw a decrease in DOX and PTX-induced apoptosis in comparison to NTC cells.

Conclusions: The results of our study suggest that APC may be a prognostic marker to determine chemoresistance in ovarian cancers.

“Identification of Contaminant Proteins in Food”

Madelyn Samuels, Marian High School

Abstract: I conducted a study to identify proteins in some food products with the intention of helping consumers be more aware of what they are putting into their bodies. This information may also inform people living a vegan lifestyle about consuming an item that may contain animal proteins. While FDA regulations specify label listings on foods, some contents may be unknown to FDA and to the manufacturer. I began by choosing nine common protein enriched products which included 3 for a vegan diet, 3 for a non-restrictive diet, and 3 for either diet. Proteins extracted from the various foods were identified using a standard bottom-up proteomics approach, which included the following steps: 1) the enzyme trypsin converted proteins to peptides, 2) peptides separated via liquid chromatography, 3) mass spectra and tandem mass spectra of eluting peptides obtained with a mass spectrometer and 4) bioinformatics software was used to search a database to identify proteins based on their peptide mass spectra. Contaminant proteins were identified as those not originating from the primary protein source in the food item.

“Identification of amino acid residues required for dimerization of the transferrin receptor”

Luke Reynolds, Marian High School

Abstract:

Novel research in the field of cancer cell biology suggests the use of the transferrin receptor as a possible indicator of ferroptotic cell death. The transferrin receptor controls the influx of iron sent to a cell—fittingly, ferroptosis is a form of iron-dependent cellular death. This project focuses on the formation of transferrin receptor (TfR1) dimers during ferroptosis (dimers are, simply put, molecular complexes consisting of two identical molecules). In other terms, this project highlights the amino acids necessary to form TfR1 dimers, as well as the general importance of these dimers in their novel, ferroptosis-indicator usages. The original hypothesis speculated that specific amino acids would be critical to the formation of these dimers—more specifically, the hypothesis suggested that the removal (or mutation) of the amino acid cysteine would prevent the formation of these dimers—cysteine plays an important role in the formation of disulfide bonds, which led to this hypothesis. To test the hypothesis, this project consisted of two main steps. The project began by conducting site-directed mutagenesis to alter specific amino acids within TfR1. Specifically, the procedure replaced four cysteine receptors (C62, C67, C89, and C98) with serine amino acids. This interrupted the formation of disulfide bonds, which were hypothesized as the major contributing factor in this dimer formation. The second major step was to introduce the mutated TfR1 into mammalian cell lines and determine whether or not TfR1 dimers still formed upon ferroptotic cell death. This was measured via Western Blot. This hypothesis proved true, and formation of the TfR1 dimer in cells treated with the mutated receptor was much lower than the formation in cells treated with the original receptor.

“Measuring the Magnetic Field of a Superconductor using a Kitchen Scale”

Sophie Pairitz, Marian High School

Abstract:

Superconductors can be a great benefit in the future. Many people see superconductors as a way to store more energy, like in energy generators, or even help reduce the carbon dioxide emission from cars or other forms of transportation. The interaction between a magnet and a superconductor needs to be understood before progress can be made. This experiment used a container to hold weights on top of a levitating magnet so that the magnetic field of a superconductor could be measured. By adding marbles into the container and recording the added weight, the magnetic force could be measured. The change in distance between the magnet and superconductor was recorded to see the relation of the magnetic force and change in distance. The data showed that as the change in distance decreased, the magnetic force increased. As the force got stronger the ability to move the magnet closer to the superconductor grew smaller.