2023

Festival of Research Abstracts, 2023

College of Science and Mathematics

1 Shreya Akunapuram akunapuram.3@wright.edu

Research Advisor: Dr. Weiwen Long

Regulation of ERK3 by KRAS signaling and role of ERK3 in cell growth of NSCLC

Co-author(s): Weiwen Long

Extracellular signal related kinase 3 (ERK3) is one of the atypical mitogen activated protein kinases (MAPK). It is expressed ubiquitously and plays a role in a variety of cellular processes, including cell growth and differentiation. ERK3's role in promoting migration and invasion in various cancers has been well established. ERK3 is upregulated in non-small cell lung cancers (NSCLCs) and has been shown to promote NSCLC tumor growth and progression. However, the regulation of ERK3 in lung cancers remains largely unclear. A recent study indicates that ERK3 phosphorylation at S189, an indicator of ERK3 activity, is upregulated by KRAS in NSCLCs. KRAS is one of the most frequently mutated oncogenes in lung cancers. To study the KRAS dependent regulation of ERK3, knockdown of KRAS was performed and it resulted in a remarkable reduction in phopho-ERK3 as well as total ERK3 protein level confirming the regulation of ERK3 by KRAS. Further, I found that the regulation of ERK3 by KRAS may be through the transcription factor c-Jun that is well-known to be activated by KRas/ERK1/2 signaling. Given the discrepancy in the role of ERK3 NSCLC cell growth, I have investigated the role of ERK3 in cell growth by knocking down ERK3 using different siRNAs in a variety of NSCLS cell lines with different KRas mutation status and differential dependence on KRas. To further understand the regulation of ERK3 by KRAS, cell models with KRas overexpression are to be developed and the effect of ERK3 inhibitors on the cell growth of NSCLCs with KRAS mutations are to be evaluated.

2 Venicia Alhawach alhawach.2@wright.edu

Research Advisor: Dr. Michael Leffak

ATTCT Pentanucleotide Repeats Induce Instability in Human cells.

Microsatellites are unstable, short repeats of DNA that can impede replication by their ability to form non-B-DNA structures which stall the replication fork leading to its collapse. If unrepaired, they can lead to double stranded DNA breaks. We are studying the ATTCT pentanucleotide whose expansion has been correlated with the neurodegenerative disease spinocerebellar ataxia 10 to monitor its effects on replication and repair using flow cytometry, inverse PCR, and sequencing. Our lab has demonstrated that ATTCT repeats, when at sufficient length, are able to cause chromosome instability in human cells.

3 Cassidy Alspaugh alspaugh.8@wright.edu

Research Advisor: Dr. Shulin Ju

Investigation of ALS-Associated TDP-43 Toxicity in Budding Yeast

Co-author(s): Shulin Ju

Amyotrophic lateral sclerosis (ALS) is a neurodegenerative disease where motor neurons deteriorate. This disease causes loss of movement, eventually death, and has no cure. In 97% of ALS patients, a protein, TDP-43, mislocalizes and aggregates in the cytoplasm. We modeled ALS-associated TDP-43 in yeast to assess why cell death occurs. Genetic screens identified 50 human genes that suppressed TDP-43 toxicity. We found that suppressors did not lower TDP-43 protein levels, affect aggregation, or

physically interact with TDP-43. The next step is to identify cellular pathways involved in suppression, which could lead to the discovery of future drug targets.

4 Keisha Barnes

barnes.224@wright.edu

Research Advisor: Dr. Andrew Voss

Analysis of Synaptic Fidelity in Huntington's Disease Mouse Neuromuscular Junctions

Co-author(s): Katherine A. Trittschuh, Steven R.A. Burke, Abhyudai Singh, and Andrew A. Voss

Huntington's disease is a genetic disorder associated with cognitive and motor decline. Previously, we discovered ion channel defects that cause muscle from the transgenic R6/2 mouse model of Huntington's disease to be hyperexcitable, as well as evidence of decreased quantal content at the neuromuscular junction. In this study, we used voltage-clamp electrophysiology to investigate the time course over which the changes develop and computational modeling to estimate vesicle refilling rates. Our results suggest that membrane hyperexcitability occurs as early as 8 weeks, while quantal content is reduced only at late stages. Furthermore, at 12 weeks, vesicle mobilization is greatly reduced.

ASK (Applying Scientific Knowledge)

5 Smriti Bastakoti

bastakoti.2@wright.edu

Research Advisor: Dr. Abinash Agrawal

Distribution and Fate of Select Non-Point Source Pollutants in the Dayton Streams and Tributaries: Effect of Land Use in an Urban Watershed

Co-author(s): Abinash Agrawal

The proposed study aims to investigate the distribution and fate of nutrients (nitrogen, soluble-phosphorus), pesticides (glyphosate, diazinon), and emerging contaminants (ACE-K, caffeine) in Beavercreek Sub-watershed (BCS) and Little Beavercreek sub-watershed (LBS), Dayton Ohio. The surface water in this area is impacted by point-source and non-point-source pollutants (NPS), due to human activity. So far, there is a limited study that examined the sources of NPS pollutants in surface water that may recharge the local aquifer. NPS pollutants, including lawn fertilizers, pesticides, and micropollutants in treated wastewater, have contaminated urban water bodies and groundwater, posing risks to surface water quality and drinking water, and endangering human health and the environment. The study will involve collecting water samples from various sites in LBS and BCS sub-watersheds, which will be analyzed for select NPS pollutants mentioned above. The GIS-based tools will be utilized to identify sites for field measurements and water sampling at least once a month. The LBS and BCS sub-watersheds' surface water flow patterns (in intermittent vs. perennial streams) will be modeled using Arc Hydro. The chemical analysis of the samples in the WSU lab will be helpful to produce maps to understand spatial and seasonal trends. The correlations between the concentrations of NPS pollutants and the geospatial information (land use, vegetation cover, soil type, and impervious surface) will be examined. The results of this study should be useful to assess the impact of NPS pollutants in the study area and potentially develop strategies to protect human health and the environment.

WestRock Scholar

6 Hannah Baumgardner baumgardner.20@wright.edu

Research Advisor: Dr. Megan Rúa

Culturing Microorganisms from Toledo Harbor and Lorain Harbor Dredged Sediments

Co-author(s): Dr. Megan A. Rúa

Microorganisms have evolved to inhabit nearly every environment, including environments with extreme temperatures ('thermophiles'). Recent high-throughput sequencing identified thermophiles in Toledo Harbor and Lorain Harbor dredged sediments despite their moderate temperatures. To better understand why these microorganisms are present, we cultured and morphotyped microorganisms from dredged harbor sediments at ambient and elevated temperatures. Overall, the ambient temperature had a greater diversity than the elevated temperature. Additionally, more gram-positive bacteria were isolated from the elevated temperature than the ambient temperature. These cultures provide an important first step in determining what thermophiles are doing in dredged sediments.

7 Sankhadip Bhadra bhadra.3@wright.edu

Research Advisor: Dr. Yong-jie Xu

Role of TTT complex in regulating DNA replication checkpoint in fission yeast

Co-author(s): Saman Khan

Replication stress and DNA damage in a cell activates the checkpoint pathway controlled by ATR and ATM of the phosphatidylinositol-3-kinase (PI3K) family of protein kinases. Their maturation and stability are regulated by TTT (Tel2-Tti1-Tti2) protein complex. We are taking a genetic approach to analyze the functions of Tti1, the largest component of the TTT complex in fission yeast. Our preliminary data show that it is likely that new separation- of-function mutants of tti1 in the DNA replication checkpoint and the DNA damage response have been identified which suggests that the TTT complex might also regulate the downstream checkpoint signaling pathway.

8 Miliben Anandbhai Bhakta bhakta.4@wright.edu

Research Advisor: Dr. Courtney Sulentic and Dr. Thomas Brown

AhR activation differentially alters the expression profile of IGH constant regions

Co-author(s): Dr. Courtney Sulentic

Xenobiotics binding the aryl hydrocarbon receptor (AHR) inhibit antibody production in animal models. However, we identified differential effects on the antibody profile following AHR activation using a human B-cell line. IgG and IgE were significantly inhibited, an effect reversed by an AHR antagonist (AHRA). IgM and IgA were unaffected. The AHR transactivation domain had no impact on IgG and IgM expression but did significantly impact the effect of the AhRA on IgA and IgE transcription. These results suggest that AhR activation differentially regulates the expression of Ig isotypes and exposure to xenobiotics that alter AhR activity may alter immunocompetence.

9 Mia Williams Burnett

burnett.44@wright.edu
Research Advisors: Dr. Saber Hussain and Dr. Courtney Sulentic

MIC's Carbamoylation Problem

The goal of this research is to better understand the effects of MIC exposure in the formation of carbamoylated urine proteins as potential biomarkers. The hypothesis is environmentally relevant Methyl Isocyanate exposure causes protein modification in urine. Aim 1 is to establish a profile of proteins in urine that are modified by methyl isocyanate in vitro. Aim 2 is to determine that the modified urinary proteins are present in the urine of mice exposed to MIC. Aim 3 is to determine that exposure to MIC causes release of cytokines, enzymes, and other proteins into the urine of mice.

10 Mia Williams Burnett

burnett.44@wright.edu
Research Advisors: Dr. Saber HUssain and Dr. Courtney Sulentic

A novel approach to investigate the molecular interaction between inhaled contaminants and the human lung surfactant system

Co-author(s): Captain Bryan Mayville, Dr. Jayme Coyle, Dr. Christie M. Sayes, Dr. Saber Hussain

Long-term cultivation of A549 type II alveolar cells at the air-liquid interface, results in increased secretion of surfactant at the apical surface of a co-culture assembly using Transwell® inserts. The surfactant produced has not been adequately characterized, leaving significant gaps in understanding this cell model assembly. The purpose of this study is to characterize the surfactant produced by this cell-based in vitro system and create an in vitro model that will assess the changes that occur in surfactant following exposure to airborne particulates. We intend to use lipidomics and proteomics to investigate the compositional changes following exposure to inhaled particulates.

11 Parker Cadigan

cadigan.2@wright.edu
Research Advisor: Dr. Don Cipollini

The Allelopathic Impact of *Alliaria petiolata* on Native Legumes

Co-author(s): Dr. Don Cipollini

Alliaria petiolata (garlic mustard) is an invasive plant that produces allelopathic secondary metabolites with negative impacts on root microbiomes. Here we studied the competitive impacts of *A. petiolata* on native legumes, which benefit from a symbiotic relationship with nitrogen-fixing bacteria called rhizobia. It was found that legumes grown with *A. petiolata* grew more slowly in height over twelve weeks, had a lower average final biomass, and generally suffered higher mortality than the control group. These findings suggest a negative impact of *Alliaria petiolata* on native legumes that may partly be mediated by allelopathic effects on rhizobia.

ASK (Applying Scientific Knowledge)

12 Thomas Chapman chapman.128@wright.edu

Research Advisor: Dr. Ivan Medvedev

Rotational spectroscopy of urea up to 500 GHz: The ground and eight excited vibrational states

Co-author(s): Daniel J. Tyree, Ivan R. Medvedev, Zbigniew Kisiel

Urea has an important role in the nitrogen cycle of organisms and is produced at large scales industrially for food production. Its significance in the formation of complex prebiotic molecules has made it an appealing target for astronomers searching for precursors to life in space. Assignment of the ground and eight lowest vibrational states of urea, (NH2)2CO, was performed over a spectral range between 210-500 GHz. Intensities of the excited state lines were calibrated by the ground state and excited state intensities to determine relative vibrational energies. These findings support the detection of urea in the interstellar medium.

13 Kevin Chitsaz chitsaz.3@wright.edu

Research Advisor: Dr. Jeffrey Peters

A narrow zone of hybridization between North American and Eurasian subspecies of a common dabbling duck.

Co-author(s): Emily Murphy, Jeffrey Peters

Eurasian and North American subspecies of a duck, the Green-winged Teal, interbreed in a hybrid zone on the Alaska Peninsula. Samples from Southwestern Alaska were sequenced for mitochondrial DNA (mtDNA) and the Z-sex chromosomes (zDNA) to determine the geographic extent of interbreeding. Individuals from Cold Bay, Alaska had North American mtDNA but mostly Eurasian zDNA. In contrast, individuals from Kodiak and Kotzebue had mtDNA and zDNA only found in the North American subspecies. These results show that the hybrid zone does not extend far outside of Cold Bay, providing insight into the complexities of speciation.

ASK (Applying Scientific Knowledge)

14 Ryanne Antonette Cimatu cimatu.2@wright.edu

Research Advisor: Dr. Silvia E. Newell

What a Waste: Nitrogen Runoff in the Maumee River

Co-author(s): Myers, J.A., and S.E. Newell

An abundance of nitrogen comes from farmland runoff. In excess, it overstimulates cyanobacteria, causing harmful algal blooms (HABs). Our research aims to improve land management practices and fertilizer usage based on Soil and Water Assessment Tool (SWAT) model predictions. However, the in-river nutrient transformations in the SWAT model are based on outdated data from the 1970s. We aim to address this knowledge gap by providing real data and directly measuring nutrient transformation rates to apply to the model. To achieve this goal, we measure nutrient concentrations and rates of biological activity in the Maumee River. We (1) quantify ammonia, nitrite, nitrate, and chlorophyll concentrations bimonthly, (2) analyze rates of nitrogen turnover, nitrification, and bacterial respiration,

(3) and correlate these rates with ambients and environmental parameters. Rates of potential uptake and regeneration of ammonia were exceptionally high, in line with hypereutrophic lakes, correlating with high chlorophyll even in November 2022. This model will aid management decisions in response to HABs by promoting appropriate farmland management, accounting for farmer willingness to implement, and contribute to the development of future government policies.

15 Daniel Cline cline.74@wright.edu

Research Advisor: Dr. Chuck Ciampaglio

Marine Vertebrate Fauna of the Conemaugh Group (Carboniferous, Kasimovian – Gzhelian) of Ohio

Co-author(s): Ryan Shell, Charles Ciampaglio, Jamie Cheshire, and Lauren Fuelling

The rocks of the Conemaugh Group were deposited by a series of marine transgressions and regressions in the Appalachian Basin that occurred in the late Carboniferous Period (307.0 – 298.9 million years ago). Exposures of the Lower Brush Creek Limestone, Portersville Shale, and Skelley Limestone units within the Conemaugh Group of southeast Ohio contain fossils from numerous marine vertebrates. Chondrichthyan taxa are especially diverse in these units, with genera such as *Petalodus, Denaea, Deltodus, Glikmanius,* and *Cooleyella* reported in abundance by previous studies. Other genera, such as the piscivorous *hybodontiforms Ossianodus* and *Diablodontus*, have been identified only by recent investigations.

16 Tristan Coffey coffey.38@wright.edu

Research Advisor: Dr. Christopher Barton

Groundwater Flow Simulation in Discrete Fracture Networks in Bedrock Beneath the Mirror Lake Watershed, Woodstock, New Hampshire

Groundwater flow is being modeled in crystalline bedrock beneath the steep 0.85 km^2 Mirror Lake watershed within the Hubbard Brook Experimental Forest, Woodstock, NH. Groundwater flow takes place through networks of intersecting fractures which is dependent on the properties of fracture networks and of the individual fractures that comprise them, both of which vary with rock type.

Modeling of the fracture networks is done using the computer program FracMan®, to model stochastic 3-D discrete fracture networks (DFN) which explicitly represents the properties of each individual fracture.

Flow simulation is performed using PFLOTRAN, an open-source nonlinear differential equation solver computer code that calculates the fluid flow pathways and rates through the fracture networks.

17 Jared Compaleo

compaleo.4@wright.edu
Research Advisor: Dr. Abimbola O. Kolawole

Novel cell penetrating peptides with anti-adenovirus properties

Co-author(s): Suvechha Bhandari

The strong interaction between a pathogen and its appropriate receptor is vital for infection to occur. We developed a novel peptide that could interrupt adenovirus binding to its receptor (CAREx8) on the cell surface and, consequently, attenuate adenovirus infection.

We then synthesized five different cell penetrating peptides at the N-terminus of the newly developed molecule for easy delivery into cells. In comparison to a scrambled control peptide, at least two cell penetrating peptides significantly reduced CAREx8 expression levels and adenovirus-5 transduction in MDCK cells that stably expressed human CAREx8. Our data suggest that the peptides may serve as novel anti adenovirus compounds.

18 Lindsey Cruse

cruse.7@wright.edu
Research Advisor: Dr. Abimbola O. Kolawole

Developing RT-qPCR multiplex systems for wastewater-based epidemiology

Co-author(s): Abimbola Kolawole

Wastewater-based epidemiology has become very popular in determining early virus infections before major outbreaks. There are a large variety of viruses that can be released in stool and into the wastewater. We therefore developed multiple RT-qPCR multiplex systems that allowed the measurement of multiple viral genomes at the same time from a single nucleic acid template. We then used the systems to successfully amplify fourteen different human enteric viruses. Our data suggest that wastewater surveillance of multiple enteric viruses can show yearly trends, predominant viruses, and whether there could be potential mixed infections occurring, therefore serving to detect possible outbreaks.

19 Christopher Dupont

dupont.4@wright.edu
Research Advisor: Dr. Mark Rich

Mechanisms Contributing to Muscle Dysfunction in Hyperkalemic Periodic Paralysis

Co-author(s): Chris Dupont, Murad Nawaz, Andrew Voss, Mark Rich

Hyperkalemic periodic paralysis causes temporary episodes of muscle weakness/paralysis and stiffness (myotonia) due to mutations in Nav1.4 sodium channel. The channel dysfunction lead to increased inward sodium current, resulting in muscle depolarization. It is unclear why normal potassium levels lead to weakness, and why high levels are needed in the mouse model. This study found that weakness is due to failure of muscle activation at the neuromuscular junction and myotonia is caused by two mechanisms: myotonic discharges and prolonged elevation of intracellular calcium levels, independent of action potentials. These novel findings could pave the way for new therapeutic targets.

20 Joshua Eduful

eduful.2@wright.edu
Research Advisor: Dr. Abimbola O. Kolawole

Human astroviruses exit infected cells through extracellular vesicles

Co-author(s): Salina Daniels; Abimbola O. Kolawole

Viruses are released from infected cells and spread to neighboring cells either through lytic pathway (by rupturing cells), non-lytic pathway (such as the use of extracellular vesicles), or both. Human astroviruses (HAstV) cause viral gastroenteritis in children, the elderly, and immunocompromised patients. Here, we investigated how HAstV are released in infected Caco2 and Huh 7.5 cells. Our data showed no cell lysis in HAstV-infected cells. However, we observed an association between the level of extracellular vesicles produced by virus-infected cells and the released HAstV particles. This suggests that HAstV egress is non-lytic and may involve the use of extracellular vesicles.

21 Taylor Eitel

eitel.5@wright.edu
Research Advisor: Dr. Megan Rúa

Dredged Sediment Condition Changes Fungal Colonization of Corn Roots

Co-author(s): Ashley Julian

Sediments mechanically removed from waterways, dredged sediments, can be used as a soil amendment to improve soil function in modern agriculture. However, little is known about how dredged sediments affect belowground microorganism communities, which are vital for plant growth. To determine how dredge amendments affect belowground fungal communities, we quantified colonization of arbuscular mycorrhizal fungi (AMF) and dark septate endophytes (DSE) using corn grown in varied applications of two dredged sediment conditions (weathered/fresh). Overall, we saw greater DSE colonization in fresh dredge amendments and greater AMF colonization in weathered dredge amendments. Our research aids in improving modern agricultural practices.

22 Cierra Ellington

ellington.15@wright.edu
Research Advisor: Dr. Sherif M. Elbasiouny

Similar Expression of SK2 and SK3 Channels in C9orf72 Mouse Model of ALS

Co-author(s): Brielle Gatrell, Kalin Gerber, Oliva Mace, Teresa Garrett, Sherif Elbasiouny.

The C9or72 genetic mutation is the most common mutation found in patients diagnosed with familial and sporadic Amyotrophic Lateral Sclerosis (ALS) and Frontotemporal Dementia (FTD). These neurodegenerative diseases primarily effect motor neurons, causing loss of motor function. Little is known to how the C9 mutation affects ALS/FTD disease progression. Previous data collected in SOD1 mice models that focused on calcium activated potassium channels (SK2&3) (which are responsible for regulating neuronal excitability) indicate that downregulation of these channels influence the neurodegeneration found in ALS/FTD disease states. By using immunohistochemistry methods, similar inactivation of the SK2 and SK3 channels was found in the C9orf72 mouse model.

23 Elaine Eppolito eppolito.2@wright.edu

Research Advisor: Dr. Michael Hennessy and Dr. Patricia Schiml

Effects of Astressin, a peripheral CRF-R1 & R2 blocker, on depressive-like behavior in infant guinea pig pups

Co-author(s): Tisha Sharma, Dr. Patricia Schiml, Dr. Michael Hennessy

Early life stress (ELS) is associated with many psychiatric disorders such as depression. Guinea pigs provide an excellent model for examining physiological impacts of ELS because they share biologically similar stress responses with humans and exhibit depressive-like behavior. To investigate the role of peripheral levels of the stress hormone CRF in depressive-like responses, we administered Astressin to infant guinea pigs thirty minutes before a three-hour maternal separation. Astressin is a CRF R1 and R2a/b antagonist that does not cross the blood-brain barrier. We hypothesize that blocking CRF receptors will reduce the onset of depressive-like behaviors. Data are currently being collected.

24 Marvena Fahmy fahmy.2@wright.edu

Research Advisor: Dr. John Stireman

Diversity of Lady Beetles in Prairies of the Dayton Area

Co-author(s): Juan M. Perilla Lopez

Lady beetles (Coccinellidae) are commonly known for their role as biological control agents in crops, and act as indicator species for the health of ecosystems. The diversity and composition of coccinellids was surveyed using net and flight interception traps during the Summer of 2021-2022 to determine the effect of prairie size in native and restored prairies of the Five Rivers Metroparks. Eight coccinellid species were found throughout the prairies studied in the Dayton area, of which three are non-native to North America. Further studies need to be done to determine the effects of prairie management practices on their community structure.

WestRock Scholar

25 Fatemeh Ghezelsofla ghezelsofla.2@wright.edu

Research Advisor: Dr. Abinash Agrawal

Assessing Vulnerability of the Miamisburg Buried Valley Aquifer System by Drinking Water Pollutants including Chlorinated Solvents and Arsenic

Co-author(s): A. Agrawal

The Buried Valley Aquifer System (BVA) is a Sole Source Aquifer serving as the main source of drinking water for the residents of Dayton, Ohio. Due to its shallow depth, the aquifer is vulnerable to contamination from various sources, including spills, accidents, and agricultural activities, as well as recharge from the Great Miami River carrying various pollutants, including pesticides, nutrients, chlorinated solvents, pharmaceuticals, and personal care products. The proposed study aims to (i) examine the redox processes in the aquifer through seasons and (ii) assess the distribution, mobility, and fate of select pollutants including chlorinated hydrocarbons (CHC), arsenic and manganese, in the Miamisburg BVA system, through field sampling and three-dimensional flow and pollutant transport

modelling. The study will develop a predictive model for a better understanding of the hydrologic processes and identify potential plume flow direction, natural attenuation, and fate of observed pollutants. The project objectives include evaluating the relationship between the Great Miami River and drinking water quality in the Miamisburg BVA and providing information about hydraulic and geochemical processes in the local aquifer through a grid of monitoring wells. The findings of this study should aid in the effective management of the BVA system in the area and reduce the health risk to ~30,000 area residents who depend on the public water supply.

WestRock Scholar

26 Breonna Gillespie gillespie.44@wright.edu

Research Advisor: Dr. Quan Zhong

Rescue of cells from death induced by a Parkinson's disease-causing protein

Co-author(s): Roselle Bea Almazan, Annabel Vivian Almazan, Pooja Shirahatti, Rajalakshmi Santhanakrishnan, Ishita Haider, Zoe Paxhia-poppaw, Eric Manishimwe, Shulin Ju, Quan Zhong

A pathological hallmark of Parkinson's disease is the formation of Lewy bodies due to abnormal misfolding and accumulation of the disease-causing protein, α-synuclein. It has long been speculated that proteins associated with Lewy bodies may interact with α-synuclein and alter its ability to misfold, accumulate, or cause cell death. Using a novel yeast model, we identified a conserved family of signaling proteins known to be present in Lewy bodies protecting cells from death induced by abnormal accumulation of α-synuclein. Intriguingly, such protective effects correlate with the health of mitochondria. Future work will focus on understanding the underlying mechanisms.

27 Hailey Glascoe glascoe.5@wright.edu

Research Advisor: Dr. Don Cipollini

Optimal defense theory amid artificial herbivory within *Alliaria Petiolata*

Optimal defense theory predicts that the most valuable tissues in plants will be most highly defended with chemical defenses. Tests of this theory require examinations of tissue value to the plant. We examined the value of young and old leaves, as well as roots to growth in *Alliaria petiolata*, an invasive weed of North American forests. Removing 50% of the area of leaves resulted in decreased growth as expected, but removal of 50% of roots resulted in increased growth, a surprising result. This result indicated that while leaves are clearly valuable, plants appeared to overcompensate for root tissue losses.

ASK (Applying Scientific Knowledge)

28 Delaney Grant grant.95@wright.edu

Research Advisor: Dr. David Ladle

Altered Proprioceptor Sensory Afferent Morphology After Sciatic Crush Injury

Co-author(s): Delaney Grant, Nick Greene, & Dr. David Ladle

Traumatic peripheral nerve injuries (PNI) are caused by various injuries, including motor vehicle accidents and combat-sustained injuries. Recovery is slow, and complete recovery requires reinnervation by somatosensory and motor axons; however, there are often persistent deficits in sensory function after recovery. The recovery of proprioceptive sensory afferents and the mechanisms underlying their impaired function after injury remains largely unexplored. We demonstrated that after a sciatic nerve crush injury, the muscle spindle afferents supplied by the sciatic nerve exhibited altered morphology, characterized by a decrease in axonal width and an increase in inner rotational distance, compared to the uninjured leg.

29 Madeline Greene greene.166@wright.edu

Research Advisor: Dr. Megan Rúa

Quantifying Root Traits and their Effects on the Soil Microbiome

Co-author(s): Dr. Megan Rúa

The root microbiome serves as a complex system and contains several thousand fungal and bacterial taxa. These microorganisms interact directly with plant roots by promoting growth, defending against pathogens, and cycling nutrients. Despite their importance, a key missing link is understanding how changes in the microbial assemblage of the root microbiome are driven by variation in root trait expression. Using a greenhouse experiment, we will measure changes in microbial composition and diversity as a function of changes in fine roots and carbon concentrations. These results will improve our understanding of plant adaptability and reforestation efforts for economically important species.

30 Ava Hall hall.527@wright.edu

Research Advisor: Dr. Steven Higgins

Removal of Per- and Polyfluoroalkyl Substances (PFAS) in Water Supplies using Clay Minerals

Co-author(s): Dr. Sushil Kanel, Dr. Steven Higgins, Dr. Daniel Young and Avianna Gay

Per- and Polyfluoroalkyl substances (PFAS) are in many industrial products from non-stick cookware to chemical fire retardants. These “forever chemicals” cause concern because they are toxic in relatively low concentrations and are now found in significant concentrations in natural waters worldwide. To cleanup this environmental contamination, PFAS needs to be separated from water sources for disposal. To assess the potential for soils to serve as a filtration medium for PFAS contamination, kinetic experiments of the adsorption of perfluorooctanoic acid (PFOA) were performed to determine if specific clay materials are effective filtration media.

ASK (Applying Scientific Knowledge)

31 Akshay Hira hira.2@wright.edu

Research Advisor: Dr. Madhavi P. Kadakia

TIP60 mediated regulation of ΔNp63α is associated with cisplatin resistance

Co-author(s): Andrew J. Stacy, Jin Zhang, Mike Kemp and Madhavi P. Kadakia

ΔNp63α, member of the p53 family of transcription factor, is overexpressed and considered oncogenic in non-melanoma skin cancer where it promotes cell survival, proliferation and inhibits cell apoptosis. TIP60, a histone acetyltransferase (HAT) mediates cellular processes such as transcription and DNA damage response (DDR). We discovered that ΔNp63α and TIP60 levels are significantly increased and correlates with cisplatin resistance. We hypothesize that TIP60 mediated acetylation of ΔNp63α regulates its transcriptional activity thereby modulates chemoresistance. Our findings will provide critical insights into the mechanism linked to chemoresistance and may lead to strategic treatment for resistant tumors with increased efficacy.

32 Katherine Holderby holderby.3@wright.edu

Research Advisor: Dr. J. Ashot Kozak

Using tetraethylammonium for inhibition of TRPM7 channels in intact cells

Co-author(s): J. Ashot Kozak

Tetraethylammonium (TEA) is a quaternary ammonium compound well-known for its ability to block various potassium channels, such as Kv1, KCa1 and KcsA. For many potassium channels, TEA block occurs from the outside and represents open channel blockade. It is less known that TEA can also block transient receptor potential channels, such as TRPM7 (Kozak et al, 2005, J Gen Physiol). Intracellular TEA at millimolar concentrations blocks TRPM7 current in the outward but not inward direction. Since TRPM7 is a strongly outwardly rectifying conductance, such voltage-dependent block may be useful for studying the function of this channel in various cell types. Using whole cell patch clamp, we found that incubating cells overnight in the presence of TEA results in the complete blockade of endogenous TRPM7 outward currents. The blockade is reversible upon washout of intracellular solution.

33 Ashley Julian julian.9@wright.edu

Research Advisor: Dr. Megan Rúa

Cropping strategy has mixed effects on soil properties when coupled with dredged sediment applications on agricultural soils.

Co-author(s):Dr. Megan Rúa

Crop rotation is a common strategy in agriculture to increase soil productivity, while applying dredged sediments as an amendment has only recently gained traction. Combining these field management strategies is still largely unexplored. To determine their potential when combined, we performed a greenhouse experiment manipulating dredged sediment applications across two growing seasons using a rotation strategy to quantify changes in soil properties of amended agricultural soils. Soil physical and chemical properties improved following the second growing season, which highlights how dredged

sediment addition is a viable agricultural management strategy; however, rotation did not always drive these soil property improvements.

WestRock Scholar

34 John Karanja Kamau kamau.4@wright.edu

Research Advisor: Dr. Hongmei Ren

A Novel Role of Lipin1 in Cardiac Function

Lipin1 has dual functions acting as phosphatidic acid phosphatase required for lipid synthesis and as a transcriptional coactivator. Our recent study showed that lipin1 plays an important role in maintaining plasma membrane integrity. Since plasma membrane integrity is crucial for cardiac muscle viability and functions, we evaluated the role of lipin1 in cardiac function using a novel mouse model, cardiac-specific lipin1 KO mice. We found that lipin1 deficiency in cardiac tissue leads to cardiac muscle membrane instability, increased inflammation, necroptosis, and fibrosis. These findings suggest a critical role of lipin1 in cardiac function.

35 Amina Khatun khatun.4@wright.edu

Research Advisor: Dr. Abimbola O. Kolawole

The prevalence of murine noroviruses in laboratory mice

Co-author(s): Riya K. Khadgi, and Dr.Abimbola O. Kolawole

We investigated the prevalence of murine noroviruses in mouse research facilities between April 2022 and January 2023. To achieve this objective, we screened for the presence of murine noroviruses in fecal samples collected from the bedding of 50 different contact-sentinel mouse cages. We detected viral genomes by RT-qPCR in 10% of the samples. Interestingly, 20% of the samples contained viruses that successfully infected RAW264.7 cells. Our Sanger sequencing data confirmed that the infectious viruses were murine norovirus type 1. This study highlights the importance of updating health monitoring practices and developing tools to monitor emerging viruses in mouse research facilities.

36 Ellen Lee lee.413@wright.edu

Research Advisor: Dr. Hongmei Li-Byarlay

Examining parent-of-origin effects on transcription and RNA methylation in mediating aggressive behavior in honey bees (*Apis mellifera*).

Co-author(s): Sean Bresnahan, Lindsay Clark, Rong Ma, Juliana Rangel, Christina M. Grozinger, Hongmei Li-Byarlay

Genes are passed from parent to offspring in differential patterns. These patterns determine the phenotype of the offspring, including their behavior. Africanized honeybees (*Apis mellifera*) have been known to show aggressive patterns of behavior. Here we have examined their RNA and methylation (epigenetic) patterns to determine whether their parent's genes have an effect on their behavior. Here we show that there are higher paternal (father) alleles present in the RNA, and their aggression is linked to increased maternal (mother) and paternal allele-biased transcription. However, it was not found that methylation patterns played a role in aggressive behavior.

37 Ellen Lee lee.413@wright.edu

Research Advisor: Dr. William Romine

Avian Flu Flies: (H5N1) epidemic patterns reflect migratory bird paths.

Spread of the Avian flu (H5N1) has been linked to migratory bird patterns (ducks, for example) during previous outbreaks (Webster, et al. 2007). In 2022 more than 58million cases of H5N1 were reported in commercial and wild foul to the WHO (CDC.gov). This has led to the reduction of available edible eggs across the country, spiking the cost of eggs in grocery stores. A more concerning consequence may be in the works. H5N1 may be morphing into a more mammalian pathological virus, which threatens human lives (Kupferschmidt, 2023).

38 Mitchell Link link.73@wright.edu

Research Advisor: Dr. Katie Hossler

Microplastics in Wetlands of West–Central Ohio: Concentration and Distribution

Co-author(s): Tyler Retherford, Olivia Steeves, and Katie Hossler

An emerging global contaminant—microplastic (plastic pollution < 5 mm)—may be degrading wetland ecosystems. This study will identify where microplastics are accumulating in wetlands, and what wetland characteristics correlate with microplastic distribution. Soil samples were collected from 30 wetlands in west–central Ohio. Microplastics were isolated by density separation and digestion, then quantified by mass and count. Preliminary results suggest a mean microplastic concentration of 0.35 g/kg soil (SD=0.37 g/kg), with higher concentrations in smaller wetlands on sloped landscapes (R^2=0.41, p=0.007). These results will provide a foundation for understanding the ecological consequence of this anthropogenic contaminant.

39 Bhavitha Madala madala.21@wright.edu

Research Advisor: Dr. Courtney Sulentic

The Role of Exosomes as Biomarkers in the Diagnosis of Alzheimer's disease

Alzheimer's disease (AD) is a progressive and degenerative brain disorder that affects an individual's ability to think, remember, and function. It is the most common cause of dementia in the elderly and affects millions of people worldwide. Biomarkers can help detect AD in its early stages long before overt symptoms appear. This early detection can lead to earlier treatment and potentially better outcomes. We have reviewed the literature, which shows evidence in favor of exosomal-based biomarkers as diagnostic tools for AD. Exosomes have been found to contain abnormal levels of beta-amyloid and tau, two proteins that are central to the pathogenesis of AD. These exosomal biomarkers can be used to diagnose AD. Data collected from various human subjects support a diagnostic role of exosomes as biomarkers in AD. An enhanced understanding of the role of exosomes as biomarkers in AD is a rapidly evolving area of research with great potential for improving diagnostic and treatment strategies and could improve patient quality of life.

40 Marion Morel marion.morel@wright.edu

Research Advisor: Dr. Weiwen Long

The F-box protein FBXL16 upregulates IRS1 signaling and promotes cell growth in lung adenocarcinomas with KRAS mutation

Co-author(s): Weiwen Long

FBXL16 is an F-box protein that was shown to upregulate major oncoproteins such as C-MYC and SRC-3 by antagonizing the activity of another F-box protein, FBW7. In this study, we found that FBXL16 and IRS1 are both upregulated and highly correlated in lung adenocarcinomas harboring KRAS mutations. Further, we found that FBXL16 upregulates IRS1 stability and thus IGF-1/IRS1/PI3K-AKT signaling. Moreover, FBXL16 depletion inhibits IGF-1 dependent cell proliferation and migration whereas FBXL16 overexpression promotes anchorage-independent cell growth in vitro and cell invasiveness in vivo. Taken together, our findings reveal FBXL16 as a potential target for treating LUADs with KRAS activating mutations.

41 Josie Marshall marshall.232@wright.edu

Research Advisor: Dr. Volker Bahn

Bat Habitat Use in Wright State Woods

Bats play in important ecological role by consuming large amounts of insects. Riparian, edge, and interior habitats are preferred by different species. I tested how bat species are distributed among habitat types and habitat uses among nights and throughout the season. Using three stationary acoustic monitors a week, I collected bat calls over 4-night periods at edge, riparian, and interior sites within the Wright State Woods. Species classification was done after the data collection from May 31, 2022, to August 20, 2022, using Wildlife Acoustic software. I concluded that the edge habitats were seen to have most bat activity. The whole forest must be preserved to support the survival of bats within the area.

42 Anthony McLaughlin mclaughlin.59@wright.edu

Research Advisor: Dr. Megan Rúa

Identifying the taxonomic composition of soil viral communities in response to elevated phosphorus and pH

Co-author(s): Jared L. DeForest Ph.D.

Climate change and other environmental stressors impact soil chemistry and nutrient cycling. Stressors in temperate forest cause shifts in soil biogeochemical processes and microbial communities. Soil viruses are abundant but neglected member of microbial communities, influencing biogeochemical nutrient cycling and regulating microbes. Understanding these relationships provides insight into nutrient cycling changes soil viruses cause. To assess changes in soil viral assemblage, we will quantify viral community composition and associated traits in a long-term study manipulating soil pH and phosphorus in a forest. Results from this work will elucidate the role soil nutrients play in structuring and influencing soil virus composition.

43 Dakota Mcmeans mcmeans.5@wright.edu

Research Advisor: Dr. Shannon Romer

Effects of exposure to impulse noise and jet fuel inhalation on hearing-related injury in a rodent model

Co-author(s): Sonner, M.J., Dirr, E.W., Brune, J.M., Howes, R.L., Hanandeh, N.A., Gut, C.P., Schaal, N.C., Keebaugh, A.J., Romer, S.H.

Hearing-related injury (HRI) is one of the most common Military-connected disabilities. Personnel aboard U.S. Naval aircraft carriers can be exposed to elevated noise in both on- and off-duty areas as well as ototoxicants, including components of jet-fuel. The effects of combined JP-5 jet-fuel exposure and noise are not well understood. Long-Evans rats were exposed to combinations of occupational and extended duration noise exposure with and without JP-5. HRI was assessed by measuring distortion product otoacoustic emission thresholds and auditory brainstem response thresholds. Rats exposed to non-occupational extended duration impulse noise had increased auditory thresholds and loss of cochlear hair cells.

44 Kelia McMichael mcmichael.9@wright.edu

Research Advisor: Dr. Clintoria Williams

The Epithelial Na^+ Channel is a Zn^{2+} Sensitive Renal Na^+ Reabsorption Pathway that Mediates Zn^{2+} Deficiency-induced Hypertension

Co-author(s): Tara-Yesomi Wenegieme, Aston M. J. Waite, Adaku C. Ume, Danielle N. Adams and Clintoria R. Williams

We reported that Zinc deficiency induces hypertension by promoting renal sodium reabsorption. We hypothesize that ENaC mediates zinc deficiency-induced hypertension. To this end, wild-type mice were placed on a zinc-adequate or zinc-deficient diet. A subset of Zinc deficient mice was treated with an ENaC inhibitor. Invitro, western blot analysis performed showed that TPEN-induced ZnD stimulated both αENaC and βENaC protein expression. Immunohistochemical staining of kidneys from zinc-deficient mice revealed αENaC protein increased compared to zinc-adequate mice. Our findings reveal that ENaC is a Zinc sensitive renal sodium reabsorption pathway and ENaC mediates ZnD-induced hypertension.

45 Arian Mcneil mcneil.19@wright.edu

Research Advisor: Dr. David Ladle

Repeated occupational-level exposure to the pesticide malathion leads to peripheral neuropathy

Co-author(s): Martha Sonner, Shannon Romer, David Ladle

Environmental exposure to organophosphate (OP) pesticides, such as malathion, is a risk factor for neuropathy and neurodegeneration. Toxic levels of OPs irreversibly inhibit acetylcholinesterase (AchE) activity, leading to acute paralysis and even death as the neurotransmitter acetylcholine accumulates at cholinergic synapses. In addition, there is compelling evidence that repeated low-level "occupational-like" exposure to OPs is associated with somatosensory defects but the cellular mechanisms for this

effect are unclear. We show sensory neuron cell size in the dorsal root ganglia is significantly reduced in rats exposed to occupational level malathion. However, co-administration of a reversible AchE inhibitor, galantamine, prevented this effect.

Considine Scholar; ASK (Applying Scientific Knowledge)

46 Kaitlyn Miller miller.1591@wright.edu

Research Advisor: Dr. Shannon Romer

Repeated Exposure to the Organophosphate Insecticide Malathion Underlies Motor Performance Changes in Rats

Co-author(s): Sonner, M.J., Procopio, H.M., Stricker, J.L., Warwick, H.I., Phillips E.A., McMeans, D.R., McInturf, S.M., Spencer, M.A., Romer, S.H.

While organophosphates are known neurotoxicants, they remain in use as flame retardants, additives to lubricants, and insecticides. Malathion is a commonly used organophosphate insecticide. Despite known cognitive impacts, there is less data available regarding how repeated exposure to low levels of malathion impacts motor performance. To examine this, we exposed male and female adult Sprague Dawley rats to 50 mg/kg of malathion via subcutaneous injections daily for 4-weeks total. Motor behavior was assessed 1-week following exposures and included open field activity, rotarod/accelerod and grip strength. We found significant alterations in motor performance differentially in male and female rats.

ASK (Applying Scientific Knowledge)

47 Brooklyn Morris morris.330@wright.edu

Research Advisor: Dr. Hongmei Ren

Explore the potential drug treatment to elevate lipin1 expression in dystrophic muscle

Co-author(s): Rajsi Thaker and Hongmei Ren

Our previous studies on lipin1 in Duchenne Muscular Dystrophy (DMD) showed that increasing lipin1 levels in dystrophic muscle improved sarcolemma integrity, suppressed necroptosis and led to improved muscle function. In this study, three different FDA approved drugs were tested in primary cell culture, and we found that dexamethasone elevated lipin1 mRNA and protein expression levels, and suppressed the expression levels of necroptotic markers. We will further evaluate whether the effects of dexamethasone on dystrophic muscle phenotype were through the elevation of lipin1. This study will expand the current understanding of the effects of this drug on DMD.

ASK (Applying Scientific Knowledge)

48 Daniel Myers myers.393@wright.edu

Research Advisor: Dr. Suzanne Lunsford

Electrochemical Detection of Phenol Utilizing Working Electrode Modified with Green Synthesized Nanoparticles

Co-author(s): Riley Rush, Nicholas Shonkwiler, Ryan Shuler, and Suzanne Lunsford

Phenols and phenol derivatives are harmful to many living organisms, making their detection efficiently and safely important. Common methods use nanoparticles, though the creation of such nanoparticles can involve chemicals that are also not safe for the environment. Via the use of cyclic voltammetry and differential pulse voltammetry, our research group devised a method to synthesize nanoparticles and detect phenol at varying pH levels.

49 Israel Oluchukwu Odoh odoh.2@wright.edu

Research Advisor: Dr. Audrey McGowin

Using artificial sweetener acesulfame (ACE-K) to trace septic leachate into Nutter Center Pond

Co-author(s): Dr Audrey McGowin

Artificial sweeteners are resistant to biodegradation so they are potential tracers for tracking leachate from septic systems. On the Wright State Campus, Nutter Center Pond is potentially in the flow path of groundwater coming from septic systems in Bath township on the east side of Highway 844. Acesulfame (ACE-K) is an artificial sweetener that is highly resistant to biodegradation. It tastes sweet but does not metabolize, which is why it is resistant to biodegradation. Samples of surface water were collected over several months from a stream that flows under Highway 844 to the west into Nutter Center Pond. Samples were prepared using solid-phase extraction on an Oasis HLB cartridges and analyzed using liquid chromatography – mass spectrometry. Water quality data, including ion chromatography of chloride, fluoride, bromide, nitrate, phosphate, and sulfate were also measured along with dissolved oxygen, temperature, and conductivity.

50 Shreya Jitendrakumar Patel patel.789@wright.edu

Research Advisor: Dr. J. Ashot Kozak

The role of TRPM7GOF in mouse embryo development

Co-author(s): Dr. J. Ashot Kozak, Jananie Rockwood

Transient Receptor Potential Melastatin 7 (TRPM7) functions as both an ion channel and an atypical S/T kinase. In our present study, we investigated embryo development using a unique genetically engineered mouse that has a single gain-of-function mutation in TRPM7. In transfected cells, this mutation reduced the inhibition of this channel to cytosolic Mg^{2+}, spermine and acidic pH {Zhelay, 2018, JBC}. To investigate the germline transmission of TRPM7GOF, we examined embryo development stages that follow mature placenta formation (*i.e*. E11.5, E15.5, E18.5). We measured the weights and lengths of embryos to identify intra uterine growth restriction (IUGR) due to modified TRPM7 function. We observed embryos that were resorbed, had smaller placentas, were shorter and weighed less, which

indicate IUGR. In conclusion, we found strong evidence, that supports the hypothesis that the GOF homozygous mutation TRPM7 is post-placental lethal.

51 Teresa Paul paul.85@wright.edu

Research Advisor: Dr. Abimbola O. Kolawole

Detection of coronavirus infection through wastewater epidemiology

Co-author(s): Prasiddhi Rimal and Lindsey N. Cruse

We investigated the spread of coronavirus infections across WSU Dayton and Lake campuses by tracking SARS-CoV-2 genome in dormitory wastewater. Our data showed sporadic detection of coronavirus genomes in wastewater samples obtained from different sampling points. There was an increase in SARS-CoV-2 positive wastewater samples when students returned to campus for both fall and spring semesters. Additionally, SARS-CoV-2 variants were detected in sequential order: Alpha, Delta, Omicron, Mu, Epsilon, Eta, Zeta, and Lambda. We shall continue to monitor wastewater at both Dayton and Lake campuses for the next year to inform student COVID-19 testing and University response efforts.

52 Cassandra Poeppelman poeppelman.42@wright.edu

Research Advisor: Dr. Lynn Hartzler

Effects of Chronic Hypercarbia on Morphological and Ventilatory Development in Crayfish

Co-author(s): Josh Hivner, Lynn Hartzler

Instances of abnormally high CO_2 levels are becoming increasingly common in freshwater ecosystems undergoing eutrophication, causing a long-term increase in CO_2 (chronic hypercarbia). Higher CO_2 partial pressure is believed to increase the ventilation and metabolism of aquatic organisms and hinder their morphological development in acute doses. To quantify the degree to which chronic hypercarbia alters the ventilation and morphology of freshwater organisms, crayfish have been reared in chronic hypercarbic water equilibrated with 5% CO_2. The morphological effects of chronic hypercarbia on crayfish are shown with body mass, length, and width measurements, while ventilatory rate measurements exhibit the impact on ventilation.

WestRock Scholar

53 Neil Pohl pohl.22@wright.edu

Research Advisor: Dr. Steven Adams

Optical Diagnostics of Nanosecond Repetitive Pulse Discharges in Air

The objective of this project was to determine the electron temperature at different times after a pulsed discharge in air by analyzing the ratio of two tungsten emission lines. The plasma was delivered as a 10 ns pulse of high voltage across two tungsten electrodes separated by a 2mm gap of air. We observed the spectrum of light during the post-discharge emission. The ratio of tungsten line intensities at 400.9 nm and 401.5 nm provided enough information to determine the relative electron temperature. Using laser Thomson scattering, we can determine the absolute electron temperatures from our ratio of tungsten lines.

54 Venkata Sailaja Rachakonda rachakonda.9@wright.edu

Research Advisors: Dr. Courtney Sulentic and Dr. Thomas Brown

Effects of Chemicals on Antibody Expression

Co-author(s): Dr. Courtney Sulentic

B lymphocytes are important immune cell that provides protection against pathogens, and they produce antibodies, which bind and help clear the body of pathogens. However, exposure to environmental, dietary, or pharmaceutical chemicals may dysregulate antibody production from B lymphocytes. Previous animal studies identified effects on immune function by jet-fuel, poly-fluoroalkyl substances (PFAS), and 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), and the asthma drug terbutaline. Since the gene that makes antibody is very different in humans compared to animals, the objective of this project is to evaluate the effect of these chemicals on antibody production from a human B cell line. Our cellular model incorporates some of the genetic differences which humans have which will allow us to determine the impact of genetics and the environment on antibody production. If the genetic differences we are evaluating lead to altered chemical sensitivity, this will lead to improved risk assessment and identification of at-risk populations.

55 Gabriella Ramos ramos.27@wright.edu

Research Advisor: Dr. Don Cipollini

Assessing the Systemic Acquired Resistance of Garlic Mustard (*Alliaria petiolata*) Against Black Rot (*Xanthomonas campestris*)

Co-author(s): Don Cipollini

When threatened by pathogens, most plants deploy a defense mechanism called systemic acquired resistance (SAR) that limits infection. This defense mechanism was examined in garlic mustard plants in response to black rot disease. Different chemical elicitors of SAR were applied to either younger or older leaves of each plant and the spread of the infection was measured over 5 weeks. Older leaves proved to be more susceptible than younger leaves to the disease, and younger leaves that were exposed to a combination of the elicitors showed the least amount of infection. Garlic mustard appears to prioritize defense of its younger leaf tissues.

ASK (Applying Scientific Knowledge)

56 James Retherford retherford.12@wright.edu

Research Advisor: Dr. Katie Hossler

Assessing the Health of Wetlands using Soil Properties; Evaluating Bulk Density and Compaction for Improving Rapid Assessment Method's

Co-author(s): Katie Hossler, Mitchell Link, Meghan Deis, Davis Taylor

The objective of this study was to evaluate soil bulk density (BD) and penetration resistance (PR) for improving wetland rapid assessment methods to better reflect wetland health. 45 wetlands in Ohio were sampled for BD and PR (static cone penetrometer (SP) and pocket penetrometer (PP)). BD and PP were determined in the lab and SP readings were obtained in the field. Statistical analysis showed, SP

correlated with BD, r = 0.76 (R2 = 0.58, p < 0.001). PP correlated with BD, r = 0.67 (R2 = 0.44, p < 0.001). SP is the most time-efficient and correlates strongest with BD.

WestRock Scholar

57 Prasiddhi Rimal rimal.7@wright.edu

Research Advisor: Dr. Abimbola O. Kolawole

Correlating state policies with SARS-CoV-2 cases in the United States of America

Co-author(s): Teresa Paul, Abimbola O. Kolawole

SARS-CoV-2 pandemic in the United States has widely different policies which were designed to curtail the spread of COVID-19 virus outbreak. Some of state policies include total lockdown, self-quarantine, mask mandate and social distancing. We collated list of all policies from each state including directives and extent of such policies. Summarized average monthly reported cases per state with special focus on the periods of each policy. Compared the outcomes in states with comparable populations, states with different policy mandates and states with similar policy mandates. We saw reduction in cases in states that adhered strictly to mask mandate and social distancing than those with relaxed policies. Vaccination made vast reduction in number of cases in the entire country. However, level of reduction was influenced by type of vaccine mandate implantation per state. Our data suggest that policy making that involves thorough science and effective implementation could provide tools needed to combat future outbreaks.

58 Makalia Robinson robinson.368@wright.edu

Research Advisor: Dr. Abimbola O. Kolawole

Human Astroviruses infection modulates aquaporins production in cells

Co-author(s): Salina D. Daniels and Abimbola O. Kolawole

Human astroviruses (HAstV) are RNA viruses that cause diarrhea in children, elderly, and immunocompromised patients. However, the mechanism underlying HAstV-induced diarrhea is unknown. Aquaporins (AQPs) are integral membrane proteins that regulate water transport across the cell membrane in response to osmotic gradients. In this report, we showed that astrovirus infection significantly increased the expression of certain types of AQPs in Caco2 and Huh 7.5 cells, suggesting that AQPs may play a role in HAstV-induced diarrhea. However, their specific roles require further investigation due to the variability in cellular expression of AQPs.

59 Jananie Rockwood rockwood.5@wright.edu

Research Advisor: Dr. J. Ashot Kozak

Induction and evaluation of hypomagnesemia in C57BL/6 laboratory mice

Co-author(s): Taku Kaitsuka, J. Ashot Kozak

Human blood contains several divalent metal cations that play a crucial role in biochemical and physiological processes. Two main divalent are Ca^{2+} and Mg^{2+}, present in the millimolar range. Hypomagnesemia, or magnesium deficiency, is likely to occur in 25% of US population and is even higher

in hospitalized patients. It is caused by gastrointestinal and/or renal disorders and may lead to severe neuromuscular, immune and cardiovascular clinical manifestations. TRPM7 is a dual ion channel/protein kinase expressed in various tissues, including the heart, brain and cells of immune system, lymphocytes and macrophages. It conducts both Ca^{2+} and Mg^{2+}, as well as trace metals zinc, cobalt and manganese. Prolonged reductions in extracellular Mg^{2+} levels result in the potentiation of TRPM7 channel activity. Here, we report the optimization of magnesium deficiency induction in C57BL/6 mice using magnesium-deficient diet, and its effects on behavior and TRPM7 expression and function.

60 Riley Rush rush.45@wright.edu

Research Advisor: Dr. Suzanne Lunsford

Green Synthesis Technique to Modify Working Electrode with Nanoparticles to Detect Neurotransmitters

Co-author(s): Mark Crockett

The electrochemical behavior of 1,2-dihydroxybenzenes such as catechol and dopamine is responsible for many important functions in the brain. Due to many nondegenerative diseases resulting in catecholamine disruption, identification of the cause of disruption among neurotransmitters such as catechol is very important to the early diagnosis. Electrochemistry has become a fundamental sensing method for monitoring neurotransmitters in live patients. Green synthesized nanoparticles deposited onto working electrodes are studied in the detection of catechol in the presence of common interferences such as ascorbic acid (AA). The use of Differential Pulse Voltammetry as an electrochemical technique to study the reactivity in potential differences between the common neurotransmitters in the presence of AA interference will be utilized without the need for prior separation with the modified nanoparticle working electrode.

ASK (Applying Scientific Knowledge)

61 Isabella Salinas salinas.10@wright.edu

Research Advisor: Dr. Sherif M. Elbasiouny

Motor deficits in the C9orf72 Mouse Model of ALS

Co-author(s): Cierra Ellington, Teresa L. Garret, Sherif M. Elbasiouny

Amyotrophic lateral sclerosis (ALS) is a neurodegenerative disorder affecting upper and lower motor neurons that develop muscle weakness and paralysis. The most common genetic mutation in sporadic and familial ALS patients is the C9orf72 gene due to the hexanucleotide repeat expansion. Using a C9orf72 transgenic mouse model that recapitulates phenotypic mutations like ALS, longitudinal behavioral assessment was conducted using neuroscoring, forelimb and hindlimb grip strength, and accelerated rotorrod. Our data suggest that C9orf72 mice display similar progressive motor deficits as seen in ALS patients.

LSAMP Scholar

62 Kalpana Sampath

sampath.8@wright.edu

Research Advisor: Dr. Kuppuswamy Arumugam

Development of Tetrathiafulvalene (TTF) fused N-Heterocyclic compound for the Redox Flow Battery (RFB) Applications

The development of battery technology is an essential catalyst to unlock the growth and advances in sectors such as electric vehicles (EVs), electronic devices, and battery storage for renewable energy. All modern devices including mobile devices use batteries, which makes them a vital part of our modern society. The need for new sustainable battery technology with improved device performance is pivotal. Hence, researchers around the world are focusing on the development of sustainable and more environmental benign battery systems. The use of redox-active organic materials enables sustainable practices and greener fingerprints in battery technology. This research aims to develop organic based redox-active electrolytes for Redox Flow Batteries (RFB). Tetrathiafulvalene (TTF) is one such stable sulfur-containing heterocyclic organic compound capable of undergoing multiple one electron reversible redox transformations. TTF is having its unique structural and electrochemical properties and it can be subjected to various structural modifications. In this work, we aim to synthesize TTF-based imidazolium salts and it is expected to behave as an excellent electrolyte, having the properties of both a redox active mediator and an ionic liquid. TTF plays a major role in batteries to overcome limitations such as reaction kinetics and energy density, which eventually help to achieve better efficiencies in RFB.

63 Savannah Seals

seals.25@wright.edu

Research Advisor: Dr. Valerie Shalin

Long form analogies generated by chatGPT lack human-like psycholinguistic properties

Co-author(s): Valerie Shalin, PhD

Psycholinguistic analyses provide methods for large language model (LLM) output and making systematic comparisons to human-generated text. These methods can be used to characterize the psycholinguistic properties of LLM output and illustrate areas where LLMs fall short in comparison to human-generated text. In this work, we apply psycholinguistic methods to compare analogies generated by participants enrolled in introductory biochemistry courses to analogies generated by chatGPT. Results illustrate a high clustering performance for student and chatGPT-generated analogies. We use a hierarchical cluster analysis to evaluate which features that contribute to model performance. Results illustrate several linguistic differences between the groups.

64 Grant Shaffer

shaffer.88@wright.edu

Research Advisor: Dr. Adrian Corbett

Step-Specific Montoya Staircase Analysis in Demyelinating Events

Co-author(s): Michael Bottomley and Adrian Corbett

Montoya staircases are apparatuses used to objectively test right and left forelimb function of rats simultaneously. If the animals are given this test pre-injury, their function can be normalized, and a functional deficit can be determined for each limb post-injury. Previous studies suggest the first three steps might be accessible to the mouths of the rats, implying that they aren't an accurate depiction of

forelimb functional deficit following injury. We color-labeled sucrose pellets in each step of the staircase and analyzed the post-injury deficit. We found statistical evidence showing the first three steps can be omitted from further functional analyses.

65 Rahul Shah shah.260@wright.edu

Research Advisor: Dr. Shulin Ju

The Influence of ALS-Associated Matrin-3 Toxicity on Cell Size in the Yeast Model

Co-author(s): Widad El-zein, Dr. Shulin Ju, and Dr. Quan Zhong

Amyotrophic Lateral Sclerosis (ALS) is a fatal neurodegenerative disease affecting motor neurons. MATR3 is a gene that leads to cytotoxicity when mutated in motor neurons. It codes for Matrin-3, a nuclear matrix protein that binds to DNA and RNA. When mutated, it mislocalizes from the nucleus to the cytoplasm and forms aggregates. Using a yeast model to study MATR3, we found an increase in cell size with increasing Matrin-3 toxicity. To determine the association of cell size with Matrin-3 toxicity, we are using suppressor genes that rescue toxicity and seeing whether they reverse the cell size increase as well.

66 Resha Shrestha shrestha.39@wright.edu

Research Advisor: Dr. Michael Leffak

Genome instability at (CAG)102 microsatellites in human cells

Microsatellites are tandem repeats of short nucleotide sequences that can pose obstacles in the replication process leading to double strand breaks. These replication-induced breaks are repaired via a highly mutagenic mechanism, break induced replication (BIR). We focus on the trinucleotide repeats of CAG units capable of forming hairpin structures which stall the replication fork, eventually causing its collapse. The use of flow cytometry, inverse PCR, and sequencing on our engineered dual fluorescent HeLa cells allows us to study effects of these repeats on replication and chromosomal instability by monitoring subsequent recombination, mutations and translocations generated from the BIR repair mechanism.

67 Ryan Shuler shuler.15@wright.edu

Research Advisor: Dr. Suzanne Lunsford

Detection of Heavy Metals Utilizing Synthesized Green Nanoparticles

Co-author(s): Nicholas Shonkwiler and Greta Reed

Heavy metal detection proves a great challenge and there is need to develop a user-friendly, rapid analysis method for its detection. Square Wave Anodic Stripping Voltammetry (SWSV) and Cyclic Voltammetry (CV) are electrochemical methods with low detection limits and can be used to detect heavy metals. The modification of the bare carbon working electrodes with green synthesized silver nanoparticles from beet juice were utilized to detect lead and cadmium simultaneously without the need of prior separation. The sensor developed has shown overall success utilizing SWSV and CV, which will be displayed.

ASK (Applying Scientific Knowledge); WestRock Scholar

68 Mariah Slaughter slaughter.31@wright.edu

Research Advisor: Dr. Megan Rúa

Quantifying changes in root architecture and microbial communities in response to changes in soil pH and phosphorus

Co-author(s): Dr. Megan Rúa, Dr. Jared DeForest

Alterations to soil biogeochemistry from anthropogenic influences can establish new community dynamics in forest ecosystems, which can affect the growth potential of economically important species. Over time as soil chemistry and nutrient availability change, we expect to see shifts in the plant and microbial communities. To evaluate these shifts, we will quantify changes in root architecture and microbial colonization of two focal tree species in response to elevated soil pH and P within a long-term study in the unglaciated Allegheny Plateau. These results will predict changes to forest communities that will inform forestry management decisions in the decades to come.

69 Mariah Slaughter slaughter.31@wright.edu

Research Advisor: Dr. Volker Bahn

Community recovery of forest understories are sensitive to increases in deer density

Co-author(s): Dr. Volker Bahn and Dr. Alex Royo

Sustained white-tailed deer overabundance throughout eastern North America has altered forest understory vegetation communities leading to dominance of browsing tolerant plants. We determined if landscape-wide reductions in deer density initiates understory plant recovery by sampling vegetation of the Allegheny plateau from 2001 to 2021. During this time, deer densities were reduced via hunting incentives until 2016 but then allowed to rise again. Overall, we found that landscape-wide deer reductions are effective for understory recovery, but these changes can be quickly reversed if deer densities increase. These findings indicate long-term deer density management is vital to promote and sustain understory recovery.

70 Joel Spenny spenny.2@wright.edu

Research Advisors: Dr. Michael Hennessy and Dr. Patricia Schiml

Role of Prostaglandin PGE-2 in Inflammatory-Mediated Depressive-Like Behaviors

Stress experienced in early life appears to sensitize neuroinflammatory signaling mechanisms generating a phenotype with increased vulnerability to depression and other stress-related mental disorders. We examined the role of the inflammatory molecule prostaglandin-E2 in this process using a guinea pig model. In Experiment 1, central infusion of prostaglandin-E2 increased depressive-like behaviors of isolated pups. In Experiment 2, isolated pups showed significant though limited upregulation of gene expression of the prostaglandin-E2 synthesizing enzyme COX-2 and receptors in stress-related brain regions. These results provide support for the role of prostaglandins as part of the mechanism mediating early-life stress and later depression.

ASK (Applying Scientific Knowledge)

71 Davis Taylor taylor.836@wright.edu

Research Advisor: Dr. Katie Hossler

Wetland ORAM Testing

Co-author(s): Mitchell Link, James Retherford

This study is meant to evaluate soil bulk density as a metric to include in assessments of wetland condition. This was conducted by traveling to 45 wetlands in west-central Ohio and collecting soil samples. The wetlands had previously been scored for condition quality using the Ohio Rapid Assessment Method (ORAM). In the laboratory, the soil samples were weighed and dried for moisture content to determine soil bulk density. Preliminary results show a significant relationship between soil bulk density and ORAM score (R^2=0.28, $p<0.01$). The presence of outliers suggests that incorporating a soil-based metric would help improve the ORAM assessment.

LSAMP Scholar

72 Daniel Tyree tyree.14@wright.edu

Research Advisor: Dr. Ivan Medvedev

Detection of Asthma Inhaler Use via Terahertz Spectroscopy

Co-author(s): Michael Brothers, Ivan Medvedev, Steve Kim

We report on the use of terahertz (THz) tabletop chemical sensor to quantify breath concentration of HFA 134a, a common propellant in medical inhalers. The sensor utilizes rotational absorption spectroscopy to quantify HFA 134a at physiologically relevant levels in relatively short timescales. Samples of exhaled human breath were collected prior to and post (5,15, and 30 minutes) use of an asthma inhaler. HFA 134a was successfully detected in all post inhaler samples and demonstrated an exponential return to baseline. This method of screening holds a lot of promise for flagging illicit inhaler use and highlights the capabilities of THz chemical sensing.

73 Amelia Whorton whorton.10@wright.edu

Research Advisor: Dr. David Ladle

ETV1 it's Binding Sites and Where to Find them

Co-author(s): David Ladle

Changes to the gene that encodes ETV1, an ETS family transcription factor, have been linked to prostate cancer, loss of facial muscle integration, and impairment of the monosynaptic reflex. Despite these and other detriments, little is known about target genes regulated by ETV1. This project aims to predict binding sites of ETV1 in the promoter regions of putative target genes using computational tools. Elucidating possible gene targets of ETV1 may lead to insight into the gene expression programs involved in the development of the monosynaptic reflex.

74 Dilsha Samanali Wickramasinghe Wickramasinghe Mudiyanselage

wickramasinghemudiyanselage.2@wright.edu
Research Advisor: Dr. Kuppuswamy Arumugam

Functionalized Naphthoquinone based Nitrogen Heterocyclic Carbenes (NHC)s for Gold (Au) complexation studies as cancer therapeutics.

Gold-based complexes gained immense attention as feasible replacements for platinum-based cisplatin due to their less toxicity and improved selectivity. Complexation of gold with functionalized biologically active molecules such as naphthoquinone which has cytotoxic properties owing to its reversible redox features can make this drug multi-targeted. Solubility and redox properties of NHC annulated quinones can be tuned through the substitution of various functional groups. In this work, two isomers of naphthoquinone annulated N-heterocyclic carbenes were synthesized with nitro functionality for gold complexation studies. Newly designed NHCs were ligated to Iridium to study their solubility and electrochemical properties. Synthesis followed by characterization is achieved by using NMR, mass spectrometry, X-ray diffraction, cyclic voltammetry, and FT-IR spectroscopy.

75 William Romine, PhD

william.romine@wright.edu

The Impact of Study Strategies on Knowledge Growth and Summative Exam Performance in the First Year of Medical School

Co-author(s): William Romine, Molly Simonis, Jeff Peters, Volker Bahn, Amber Todd

In July of 2017, the incoming class of first year students (graduating class of 2021) at an allopathic medical school in the Midwestern United States (120 students) were given a survey at the beginning of medical school (August of 2017) to evaluate their study habits. We examined the relationship between the study strategies students reported to use and their academic performances measured by their success on the CBSE and Step 1 exams. Data suggest that students use a collective of deep processing strategies with an emphasis on contextualization to achieve greater gains on the CBSE examinations and increase scores on the USMLE Step 1 exam.

76 Sri Meghana Yerrapragada

yerrapragada.2@wright.edu
Research Advisor: Dr. Mike Kemp

Characterization of adduct-containing DNA release from cisplatin-treated cells

Co-author(s): Carpenter MA, Gingu MR, Kemp MG

On a daily basis, the human body is exposed to various genotoxins. Chemotherapeutic agents are one of them. Cisplatin is one of the most efficient and widely used chemotherapeutic agents for a variety of cancer types. The platinum atoms in cisplatin bind covalently to DNA and forms DNA adducts. These DNA adducts are potentially mutagenic and lethal to cells if not removed by the repair machinery. The final fate of these DNA-adducts is not yet known. However, we have found cisplatin adduct-containing DNA to be enriched in smaller extracellular vesicle (SEV) fractions. Furthermore, we have found that the loading of these cisplatin DNA adducts into SEVs can be reduced by caspase-3 inhibitor treatment. Because the content of SEVs can be transferred to other cells, transfer of damaged DNA via SEVs to

bystander cells may activate the DNA damage response in recipient cells throughout the body to contribute to the systemic effects of cisplatin chemotherapy regimens. Further research in this direction can help us understand the role of SEVs containing cisplatin-DNA adducts in the toxicity caused by cisplatin treatment in the kidney and brain and developing a targeted drug delivery system to limit the side effects of cisplatin regimen.

77 Anthony Young young.549@wright.edu
Research Advisor: Dr. Eric Bennett

A Missing Factor Leading to Gross Cardiac Dysfunction following a Reduction in Hybrid/Complex N-Glycosylation

Co-author(s): Andrew R. Ednie, and Eric S. Bennett

In this work, we characterized a novel mouse model that develops a non-lethal form of heart failure (HF) triggered via a reduction of cardiomyocyte (CM) complex/hybrid N-glycosylation using a tamoxifen-dependent, cre-lox knockout of GlcNAcT1 (iMgat1KO). These mice developed HF with significant electromechanical dysfunction- 35% reduction in ejection fraction (mechanical), and 11% prolongation of QTc (electrical). Interestingly, isolated iMgat1KO CMs do not demonstrate typical physiologic remodeling associated with progressive HF such as action potential prolongation and aberrant calcium transients/contractility. With this model we hope to identify the missing link between direct changes in CM N-glycosylation and gross cardiac dysfunction.

78 Ari Zakroff zakroff.2@wright.edu
Research Advisor: Dr. John O. Stireman, III

Do non-native shrubs support arthropods in eastern North America?

Co-author(s): Dr. John O. Stireman, III

Invasive shrubs are replacing native plant communities in North American woodlands. Despite this wholesale ecosystem transformation, little research has focused on their effects on arthropod communities and food webs. To assess these impacts, I compared arthropod communities on two non-native shrubs—Amur honeysuckle and border privet—to two native plants: blackhaw and ash in southwestern Ohio woodlands. I found that invasive honeysuckle hosted a much poorer arthropod community than blackhaw; however, the arthropod community on privet was more abundant and diverse than on ash. Assessing the effects of non-native plants on arthropods will help us understand the broader consequences of biological invasion.

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