UNIVERSITY of WASHINGTON

Undergraduate Research Symposium May 17, 2019 Mary Gates Hall

Online Proceedings

SESSION 1O

MCNAIR SESSION - POLITICAL DIVIDES: QUESTIONS ABOUT IMMIGRATION, CLIMATE CHANGE, AND REPRESENTATION

Session Moderator: Gabriel Gallardo, Geography
MGH 288
12:30 PM to 2:15 PM
* Note: Titles in order of presentation.

A Museum's History: Constructing Homelands through the Suquamish Musuem
Racquel Augusta (Racquel) West, Senior, Geography, History: Race, Gender, and Power
Mary Gates Scholar, McNair Scholar, UW Honors Program
Mentor: Josh Reid, History & American Indian Studies

Hybrid landscapes are the colonial, regulated plots of land (like reservations), that Native peoples have adapted to ultimately create new senses of Indian self-hood, through their ability to survive and thrive, despite the colonial process that displaces them to those regulated lands. The vanishing Indian narrative is one example of the colonial violence enacted through those regulated spaces as Western institutions and discourses confine Native peoples to notions of the past and primitivity, to ultimately claim that they have vanished in the wake of modernity. And while Western museums have helped perpetuate the vanishing Indian narrative, tribal museums have combated this harmful narrative. Museums, as institutions that present knowledge to the general public, are sites that can present counter-narratives and tribal communities can use these spaces to present proper representations of themselves. One such tribal museum is the site of my research project. The Suquamish Museum is located on the Port Madison Indian Reservation and opened in 1983. This research is interested in how this museum has made, and continues to make, a difference for the Suquamish community and particularly analyzes the Museum's relationship to the reservation. Over several months I have spent time in the Museum and researched the Museum's history through its grants, reports, programs, and exhibits. I argue that, as an institution that has continued to adapt to the community's needs, the Suquamish Museum has facilitated the construction and continued development of the reservation as a hybrid landscape through owned representation as a means of confronting the vanishing Indian narrative, thus perpetuating Native agency and sovereignty. This research is important because looking at the Suquamish tribe as its own entity, with their own representations, addresses the colonial violence that treats all Indigenous peoples as homogenous, unadaptable peoples from the "past," ultimately highlighting their agency as placemakers.

POSTER SESSION 2

Balcony, Easel 111
1:00 PM to 2:30 PM

Using *C. elegans* to Understand the Mechansims Linking Mitochondrial Function and Alzheimer's Disease
Beeta Sadat Heydari, Senior, Biochemistry
UW Honors Program
Bahar Sadat (Bahar) Heydari, Senior, Biochemistry
UW Honors Program
Mentor: Josh Russell, Pathology
Mentor: Matt Kaeberlein, Pathology

Alzheimer's disease (AD) is characterized as an irreversible, progressive brain disorder that gradually destroys memory and thinking skills, and eventually the ability to perform simple everyday tasks. Despite many decades of research focus on AD, the cause and mechanistic understanding of the progression remains enigmatic. Identification of amyloid beta plaques and hyperphosphorylated Tau in post-mortem analysis of brain biopsy is viewed as definitive for diagnosis of AD. Dr. Su-in Lee's lab has developed a machine learning method that integrates brain tissue pathology metrics with gene expression analysis from the same patient samples. Their analysis identifies genes and pathways that are statistically-associated with the concordance of pathological AD phenotypes. Working with researchers in the Kaeberlein lab, we are using the nematode *C. elegans* to directly test the impact that these genes have on the progression of human tau-induced neuronal dysfunction and death. The Kaeberlein lab previously identified a subset of genes in complex I of the electron transport chain (ETC) that are highly correlated with human amyloid beta-induced paralysis. We are now extending that work by examining the relationship of these ETC genes in the lifespan and healthspan of human Tau-

model nematodes. Our preliminary results suggest that reduction of Complex I activity increases the lifespan of human tau-models nematodes. We are conducting further studies to determine the replicability of these findings as well as disrupting ETC function with RNAi from other genes. Through directly testing nematode orthologs of human genes that are statistically-associated with AD neuropathology we will generate a better understanding of the cellular mechanisms that influence normative aging and Alzheimer's disease.

POSTER SESSION 2

MGH 241, Easel 153

1:00 PM to 2:30 PM

Inhibition of FKBP51 in the Dorsal Raphe Using SAFit2 Has Antidepressant Effects

Emily K Vo, Senior, Biochemistry
UW Honors Program
Mentor: John Neumaier, Psychiatry
Mentor: Kevin Coffey, Psychiatry and Behavioral Science
Mentor: Russell Marx

Polymorphisms in the gene, FKBP5, and its resulting protein, FKBP51, are associated with stress-related disorders. Although FKBP51 inhibitors may have antidepressant-like effects, the relevant brain regions mediating this effect are still unknown. We found that FKBP51 expression is elevated in serotonin neurons of the mouse dorsal raphe nucleus (DRN) after stress, so we tested whether FKBP51 inhibition in the DRN by the novel FKBP51 antagonist, SAFit2, has antidepressant-like effects. First, we implanted guide cannulas into the DRN of wildtype mice stereotaxically, then we habituated the mice to 2.5% sucrose-containing bottles in their home cages overnight. On the following two days, the mice were stressed through repeated forced swims after receiving either SAFit2 (n=8) or a vehicle (n=7) to the DRN via the cannulas, prior to each swim session. That evening, the mice underwent a sucrose preference test to assess motivation by quantifying sucrose versus water preference using lickometers. On the next day, the mice were tested in a three-chambered social interaction test, where one chamber contained a wired cup enclosing another mouse of the same sex and the other chamber had an empty wired cup. Our results show that the SAFit2 and vehicle mice had the same immobility time during the forced swim stress, signifying that SAFit2 did not interfere with our immediate stressor. The SAFit2 mice demonstrated an increased preference for sucrose after stress compared to the vehicle mice, indicating greater motivation to consume a pleasurable liquid. However, there was no significant difference in the time spent interacting with the same sex during the social interaction test. This suggests that SAFit2 may have blocked stress-induced anhedonia by inhibiting FKBP51 activity in serotonergic neurons, as measured by the sucrose preference test. Further studies of FKBP51 inhibition in the DRN can lead to potential therapeutic treatments of neuropsychiatric disorders.

POSTER SESSION 2

Balcony, Easel 97

1:00 PM to 2:30 PM

Optimized Expansion Microscopy through Thermally Facilitated Digestion

Jonathan Bryce (Jon) Perr, Senior, Biochemistry
Mary Gates Scholar, UW Honors Program
Mentor: Joshua Vaughan, Chemsitry
Mentor: Aaron Halpern, Chemisty

In recent years, researchers have dedicated much effort to overcoming the ˜250 nm spatial resolution limit of light in order to reveal biological details that have been obscured by diffraction. A new form of super-resolution microscopy called expansion microscopy (ExM) relies on physically expanding a fixed specimen in a swellable hydrogel polymer and offers a simple, inexpensive approach to achieving ˜70 nm resolution with conventional confocal microscopy. A critical and understudied step in this process is the homogenization of the embedded sample by proteolytic enzymes, enabling artifact-free expansion. However, in large and complex samples like Drosophila, enzymatic digestion is time-consuming and sensitive to experimental parameters such as fixation, hydrogel composition, and tissue type. To overcome the limitations of enzymatic digestion, I have explored parameter space for rapid peptide cleavage using air-tight stainless-steel vessels to achieve high temperatures and pressures not typically accessible in the lab. Additionally, a small-molecule digestion agent, dimethoxyiodobenzene, was tested in order to provide site-specific peptide cleavage and enhance tissue homogenization. The modified digestion process was first validated using standard immunofluorescent microtubules in cell culture. Next, Drosophila tissue was treated using thermal digestion to confirm the applicability of this technique in robust, difficult-to-expand tissues. This improved ExM protocol holds the potential to increase sample throughput, reduce expansion-related sample distortions, and extend ExM to be applicable to a wide range of previously incompatible tissues types, enabling pathologists to better analyze and assess diseases in human tissues.

POSTER SESSION 2

MGH 241, Easel 138

1:00 PM to 2:30 PM

Phased Array Wireless Power Optimization on a Planar Array of Coupled Resonators
Usman M. (Usman) Khan, Sophomore, Electrical Engineering
Mentor: Joshua Smith, Computer Science & Engineering, Electrical Engineering

Wireless power transfer has many applications, from powering biomedical implants to wireless sensors. For more practical use, however, several challenges must be overcome, such as a lack of efficiency and power leakage to other nearby electronics. These issues become especially difficult to tackle with a moving receiver. To combat these problems, an array of magnetically coupled coils was designed. Previous work has shown the capabilities of this system when one coil of the array is supplied with power. In this work, I explore the possible benefits of having two coils in the array driven with power instead, studying the interaction between the different coils. By adjusting parameters such as the phase relationship between the two transmitters' signals, we aim to optimize power delivery to specific targets and simultaneously minimize leakage to other areas. I tested different configurations of the system in a series of experiments and analyzed measured data to determine which setup is most favorable. Afterwards, I evaluated the efficiency of the configuration compared to the previous single-transmitter case. This provides better insight into how the coils in the array magnetically interact with one another, which will inform future design decisions. It can also eventually lead to better solutions for delivering high power to selected targets within a given space. This can create flexible, efficient, and safe wirelessly charged electronic implants for a variety of biomedical applications, enabling further research in the field and the development of novel solutions.

SESSION 2R

NEW TREATMENTS FOR OLD DISEASES

Session Moderator: Benjamin Freedman, Medicine/Nephrology
JHN 111
3:30 PM to 5:15 PM

* Note: Titles in order of presentation.

Using *C. Elegans* to Study Human Brain Tissue in Alzheimer's Disease
Haoyi Lei, Senior, Neurobiology
UW Honors Program
Mentor: Matt Kaeberlein, Pathology
Mentor: Josh Russell, Pathology
Mentor: Su-In Lee, Computer Science & Engineering

Alzheimer's disease (AD) is the most common cause of dementia, a general term for memory loss and other cognitive abilities. Although this disease has been a major research focus since the 1980s the pathologic mechanisms are still not understood, and therapeutic interventions have been ineffective. The most definitive method for classifying AD is through identifying accumulations of toxic proteins amyloid-beta and tau proteins in post-mortem brain tissue. Dr. Su-in Lee's lab has developed a machine learning method that integrates the pathological tau phenotypes with gene expression levels in the same brain tissue. This analysis highlights the genes with expression level changes that correlate with the pathological protein aggregation phenotypes. For this proposal I will directly test the impact of these candidate genes on cellular pathologies resulting from aggregating human tau protein with a new *C. elegans* AD model in which human tau is expressed in the worm's muscle. This tau expression will likely result in premature paralysis because previous nematode AD models with human amyloid-beta have shown this phenotype. The results of my genetic screening will lead to a better understanding of the human genes that are dysregulated in human AD brains and provide a basis for genetically-dissecting the pathways that influence the mechanisms of tau toxicity.

POSTER SESSION 3

Commons East, Easel 85
2:30 PM to 4:00 PM

Accessible Design on Mobile Apps for Elders
Han (Hannah) Jiang, Junior, Information Technology & Administrative Management, Central Washington University
Mentor: Naomi Petersen, Curriculum, Supervision & Educational Leadership, Central Washington University
Mentor: Josh Welsh, English, Central Washington University
Mentor: Ellen Bjorge

In the era of new technologies, the functions of mobile apps cover all aspects of our lives. Social networking apps expand our social and business groups, as well as increase job and entertainment opportunities dramatically. Other types of apps, such as travel and buying & selling apps, enable people to get both tangible and intangible products without leaving home. The fast development of mobile apps, however, made it difficult for elders over 65 to understand and learn, and the physical condition of elders presents barriers to operating new technologies. Overall, the lack of accessible design on mobile apps has caused elders to not have the equal opportunity to obtain information and enjoy the same conveniences as other age groups; and new technologies have gradually made the older generation feel abandoned. In the past six months, I conducted a competitive analysis of the current situation of using mobile apps by the elderly to gain a broad view on the user experience of mobile apps for elders. I designed and distributed a questionnaire survey among members of the

Yakima Serious Table Tennis Club to understand the barriers they encountered when using various types of mobile apps. I interviewed two retirees from different fields of employment and cultural backgrounds about their views on the usability of different kinds of mobile apps. Ultimately, referring to my collected data and the Web Content Accessibility Guidelines version 2.1, I analyzed possible changes that could be made by some popular apps to improve the accessibility for elders. I created interface templates of an accessible mobile social media for elders using Adobe Experience Design; then I edited it to a final version while doing usability tests on the templates. The conclusions from this research could be used to help design applications that are suitable for more age groups, and to ultimately make society more inclusive by letting elders have equal opportunity to enjoy new technologies.

POSTER SESSION 3

Commons East, Easel 79

2:30 PM to 4:00 PM

Effects of OPN3 on Circadian Rhythms

Shannon Gordon, Senior, Neurobiology
UW Honors Program
Mentor: Russell Van Gelder, Ophthalmology
Mentor: Ethan Buhr, Ophthalmology

Opsins are the light-sensitive proteins in photoreceptors that mediate vision. They are most commonly known to be expressed in rods and cones in the retina of the eye, but some are also expressed in various tissues throughout the body. Because previous research has shown that retinas from OPN3 knockout mice have altered circadian amplitudes, my goal is to further investigate the effects of OPN3 on circadian rhythms of various tissues. In order to determine which tissues actively express OPN3, rtPCR analysis will be done on a variety of Wild-Type (WT) mouse tissues. To determine how circadian amplitude and rhythmicity is affected by OPN3, tissues from both WT and OPN3 knockout mice with the Per2 Luciferase marker are cultured and have their circadian rhythms recorded and analyzed. These cultures are also used to determine the effect of OPN3 on ability to synchronize to light-dark cycles, and to begin investigating the mechanism through which OPN3 works. Preliminary results show that OPN3 knockout mice have significantly decreased amplitudes in tissues actively expressing OPN3, although the lack of OPN3 does not affect rhythmicity or the ability to synchronize to light-dark cycles. So far, I have seen that OPN3 is not acting through a diffusible substance, as other opsins have been shown to do. More investigation should be done in the future to determine the exact mechanism through which OPN3 works, as it will have important consequences for understanding the circadian system.

POSTER SESSION 3

MGH 206, Easel 172

2:30 PM to 4:00 PM

C-di-AMP Regulation and Toxicity in *Listeria monocytogenes*

Kimberly (Kim) Gutierrez, Non-Matriculated, Microbiology, University of Washington
Louis Stokes Alliance for Minority Participation, UW Post-Baccalaureate Research Education Program
Mentor: Joshua Woodward, Microbiology

Secondary nucleotide messengers are used by all domains of life to sense and respond to the changes in their environment. In bacteria these secondary nucleotide messengers play a role in regulating several signaling pathways such as cell wall homeostasis, motility, and the expression of virulence genes. The nucleotide cyclic di- 3, 5' adenosine monophosphate (c-di-AMP) was recently added to the list of secondary nucleotides. C-di-AMP is found in many bacteria such as *S. aureus, S. pneumoniae, B. subtilis, and L. monocytogenes* (Lm). C-di-AMP has been best characterized in Lm, a well-studied intracellular pathogen. Lm has adapted to survive and replicate in the host cell cytosol by evading host cell defenses through use of key virulence factors. In Lm, synthesis of c-di-AMP is catalyzed by the diadenylate cyclase dacA and degradation is coordinated by the phosphodiesterases, pdeA and pgpH. Studies using Lm mutants that lack both pdeA and pgpH contain abnormal c-di-AMP levels that cause growth and virulence defects of about four logs compared to wild type Lm. This highlights the importance of c-di-AMP regulation for bacterial virulence and growth, but we still know very little about c-di-AMP regulation and toxicity. Our goal is to further understand the toxicity of high levels of c-di-AMP during bacterial infection. We aim to create a transposon library in the double phosphodiesterase KO ($\Delta\Delta$ Pde) background to identify suppressor mutations. Previous approaches to analyzing suppressor mutations in the $\Delta\Delta$ Pde strain has not been thorough or cannot be utilized *in vivo*. Therefore, we have created an amenable phosphodiesterase mutant that knocks out the phosphodiesterases in Lm (pdeA and pgpH) to grow *in vivo* successfully to investigate c-di-AMP regulation. Understanding the regulation of c-di-AMP could result in targets for novel treatments against Lm and allow for ways to investigate regulation methods of c-di-AMP in other organisms.

POSTER SESSION 4

MGH 241, Easel 124

4:00 PM to 6:00 PM

The Role of Innexins in Ectodermal Cellular Signaling in *Hydra vulgaris*

Miranda Nicole Howe, Senior, Biochemistry
Mary Gates Scholar
Mentor: Martha Bosma, Biology
Mentor: Joshua Swore

Hydra vulgaris are some of the simplest animals with neurons and have only two thin, near transparent layers of tissue: myo-endodermal and myo-ectodermal layers. Each cell in the animal can be examined simultaneously due to their small size, simple body pattern, and stereotypical (regular and defined) behaviors. This makes *Hydra* great animals for examining simple signal transmission pathways from which the complex pathways in vertebrates derive. Cells in the ectoderm and endoderm use calcium signaling to coordinate contractions and cause the animal to move, but how this mechanism of cell-to-cell calcium signaling functions is not well understood. Invertebrate gap junctions, intercellular proteins that cells use to send signals to adjacent cells, are coded from the innexin gene family. It has been found that the genome of *Hydra magnipapillata* has fourteen predicted innexin genes. Recent data suggests some of these innexins are expressed in the ectoderm, specifically innexins 1,4,5, and 13. I hypothesize these proteins are necessary for the animal to perform coordinated contractions. To determine the role of these proteins, I used shRNA techniques to knockdown innexin expression. After examining wild type *Hydra*, I examined an existing line of transgenic Hydra which express GCaMP in ectodermal cells to identify when cells use calcium to signal other cells. In these animals, signals can be viewed as a wave of fluorescence passing across the ectoderm. I knocked down the genes by electroporating shRNA molecules into adult animals who express GCaMP, and will image these animals' behavior. There should be quantifiable differences in the fluorescent waves, as I postulate that some cells will be excluded from these waves if an innexin is knocked down, and analyzing these differences should clarify the role of innexins in gap junction signaling.

POSTER SESSION 4

Balcony, Easel 114

4:00 PM to 6:00 PM

Do Extracellular Vesicles Transmit Alzheimer's Disease-Induced Stress Signals between Tissues in *Caenorhabditis elegans*?

Katherine Brower, Senior, Japanese, Microbiology
UW Honors Program
Mentor: Matt Kaeberlein, Pathology
Mentor: Josh Russell, Pathology

Previous research has established extracellular vesicle (EV) signaling as a ubiquitous cell-signaling modality used by all cells. In this modality RNA, peptide, and protein signals are packaged together in small vesicles and directed to specific downstream cell targets. In addition to being necessary for healthy physiology, EVs can also contribute to pathological processes such as neurodegeneration in Alzheimer's disease through carrying toxic proteins tau, Aβ and β-synuclein between cell types. Recent research in the Kaeberlein and Mendenhall labs has shown that when human tau is specifically expressed in neurons of *C. elegans*, there is a significant increase in HSP90 chaperone and proteostatic stress reporter expression in the intestine. I hypothesize that the induced human tau neuron-to intestine stress signal is conveyed by the extracellular vesicles. To determine the signal pathway, extracellular vesicle signaling was disrupted specifically in neurons of a transgenic nematode line with neuron-specific human tau and fluorescent intestinal proteostatic stress reporter (*daf-21::GFP*). RAL-1 is a small GTPase that has been shown to be necessary for EV signaling in the *C. elegans* hypodermis and intestine. Therefore, RAL-1 function is disrupted though knocking down neuron-specific expression with either a double-stranded RNA ral-1 construct or a dominant-negative form of RAL-1 The degree of *daf-21p::GFP expression* was compared between the reporter lines and those with disrupted ral-1 function. Many studies utilizing *C. elegans* have shown that neurons send cellular stress signals to other tissues which strongly affect lifespan, metabolism, and proteostatic stress. Therefore, the results from my experiments contribute to determining whether EV-signaling carries neuronal stress-signals induced by human tau and establish a methodology for using *C. elegans* as a model for studying this important signaling pathway.