UNIVERSITY of WASHINGTON

Undergraduate Research Symposium May 19, 2017 Mary Gates Hall

Online Proceedings

Poster Session 1

Balcony, Easel 117

11:00 AM to 1:00 PM

Effects of Varied Fertilization Methods and Mycorrhizae Inoculation on Growth of *Eriophyllum lanatum*

Allison Lee (Allison) Erskine, Senior, Environmental Science & Resource Management, Communication
UW Honors Program
Mentor: Jonathan Bakker, Environmental and Forest Sciences
Mentor: Courtney Bobsin, School of Environmental & Forest Sciences

Mycorrhizal symbiosis is known to be an important component of plant and soil health, and the reintroduction of mycorrhizae into disturbed soils could be an integral piece to improving restoration efforts. The aim of this study was to analyze the effect of mycorrhizal inoculation on *Eriophyllum lanatum* while using current nursery practices, with a goal of creating a replicable protocol to integrate mycorrhizal inoculation into regular restoration activities. *E. lanatum* seeds were sown into pots that were fertilized using one of two common nursery methods (Fertigation and Time-Release) and that were either inoculated or not with mycorrhizae, creating four treatment groups. Germination was tallied, and then plants grew for ten weeks before harvesting. Growth was measured as root and shoot biomasses and as root and shoot lengths. Mycorrhizal colonization success was measured using root stains. Fertilization method had a strong effect on germination; germination rate was higher under Fertigation (47% with No Inoculation, 76% with Inoculation) than Time-Release (24% with No Inoculation, 29% with Inoculation). Growth was statistically greater in the Fertigation than Time-Release method by all measures . No evidence of mycorrhizal colonization was found, but significant differences between the Inoculation and No Inoculation treatment groups using the Fertigation method suggest that the Fertigation method was more sensitive to the effects of mycorrhizae inoculation, even without colonization . Further research should be conducted continuing using Fertigation method, using a different mycorrhizal mix and a larger sample of species.

Session 1H

HIV: Diagnostics, Drug Resistance, and Antibodies

Session Moderator: Dara Lehman, Global Health, Human Biology

MGH 251

12:30 PM to 2:15 PM

* Note: Titles in order of presentation.

Point-of-Care Nucleic Acid Amplification Diagnostic for HIV-1 Using Isotachophoresis

Amanda Moon Levenson, Senior, Chemical Engineering
CoMotion Mary Gates Innovation Scholar, Mary Gates Scholar
Mentor: Jonathan Posner, Mechanical Engineering
Mentor: Andrew Bender, Mechanical Engineering

As of 2015, approximately 36.7 million people worldwide are living with HIV/AIDS, of which almost 15 million receive antiretroviral therapy (ART). These patients require regular HIV-1 viral load (VL) tests to monitor ART effectiveness and compliance. However, the majority of affected people live in low-resource settings, where accurate diagnosis and disease monitoring through lab-based instrumentation systems, such as nucleic acid amplification tests (NAATs), are inaccessible. Thus, there is an increasing need for accurate, affordable HIV-1 VL tests at the point-of-care (POC). We have leveraged an electrokinetic separation and preconcentration technique, isotachophoresis, and an isothermal nucleic acid amplification method to develop a fully integrated POC NAAT for extraction, amplification, and detection of HIV-1 nucleic acids in whole blood. We have demonstrated the ability to extract these nucleic acids from human serum and quantify the nucleic acid amplification with fluorescent detection. The fluorescent read-out is correlated to the initial sample concentration, providing semi-quantitative VL information. Our device operates in a single step with limited equipment in 15 minutes, consequently cutting the time, cost, and complexity of NAATs for infectious disease diagnosis, especially in low-resource settings. Our POC NAAT has the potential to improve patient care, and we are currently investigating applying this technology to diagnose other infectious diseases.

POSTER SESSION 2

MGH 241, Easel 124

1:00 PM to 2:30 PM

Bioprinting Viable Three Dimensional Aligned Tissue Constructs via Simple Biomaterial Post System

Joseph Long, Recent Graduate, Bioengineering, University of Washington

UW Post-Baccalaureate Research Education Program

Mentor: Deok-Ho Kim, Bioengineering

Mentor: Jonathan Tsui, Bioengineering

Heart disease and other cardiac degenerative diseases account for 1 in 4 deaths in the United States. Current *in vitro* tissue models for cardiac disease modeling and potential drug testing lack dimensionality, scale, biomimetic behavior, and longevity. Manipulation of biophysical cues via biomaterial scaffolds in 3D bioprinting methods can alleviate these limitations as have been shown in 2D models. By mechanically inducing alignment in 3D tissue models, cells will respond to extracellular cues and form more organized structures similar to *in vivo*. This project focuses on implementing cardiac muscle cells into a mechanically aligned structure using a decellularized extracellular matrix (dECM) "bioink". A BioBots extrusion based bioprinting system is utilized to manufacture cardiac cells laden in porcine left ventricle cardiac muscle dECM. We hypothesize that a polycaprolactone (PCL) post system design will induce cell alignment in a band-like tissue structure suspended in a Pluronic F-127 polymer bed along the axis of tension during tissue manufacturing. Induced bioink tension will enhance cardiac structure and function compared to current bioprinted models. This bioink composition and biomaterial process will provide cardiac cells with a better niche for development into a mature state that accurately mimics in vivo conditions. Bioprinted tissues will exhibit increased mechanical properties and structural organization with expression of contractile markers via uniaxial cell alignment upon bioink gelation in culture. This process is high throughput and provides a streamlined standard method for drug screening that more accurately tests possible side effects inside native heart tissue.

SESSION 2E

ADVANCED TECHNOLOGIES FOR HEALTHCARE AND OTHER APPLICATIONS

Session Moderator: Daniel Kirschen, Electrical Engineering

MGH 238

3:30 PM to 5:15 PM

* Note: Titles in order of presentation.

UW Medical Center - Motion Control for Fast Neutron Collimator

Joey Thai, Senior, Electrical Engineering

Marissa E (Marissa) Kranz, Senior, Electrical Engineering

Matthew Ross (Matt) Dentinger, Senior, Electrical Engineering

Mentor: Howard Chizeck, Electrical Engineering

Mentor: Robert Emery, Radiation Oncology

Mentor: Jonathan Jacky, Radiation Oncology

Mentor: Payman Arabshahi, Electrical Engineering

The goal of this project is to design a faster and more efficient motion controller for the leaf collimator that is used to shape a neutron beam around a tumor for use in intensity modulated neutron radiation therapy. The system currently in operation was developed in the 80's and is too slow for new treatment techniques we plan to support. We started with familiarizing ourselves with the Galil motion controller and the Experimental Physics and Industrial Control System (EPICS) software to control 40 motors that will adjust the position of the collimator leaves within an accuracy of 2 mm. Because we augmented an existing system, there are some system aspects that could not change and needed to be worked into our design: the 40 motors need to be driven manually with analog feedback and the overall mechanical setup should remain mostly the same. Additionally, we rewired the system to accommodate bipolar power supplies in order to half the number of wires used in the gantry, allowing us to save on space and increase the ease of future system maintenance. This was accomplished by configuring diodes in parallel with relays that allows us to control the direction of the current, which in turn controls the rotation of the motors. Since our system's internal components are heavily exposed to radiation, we implemented the diodes on a printed circuit board to ensure that the system upkeep and component replacement is manageable. Finally, we updated the existing Extensible Display Manager (EDM) user interface so the radiation therapists and technicians can see real-time leaf locations and interact with our motion control system. The final deliverable is a complete installation of our new fully tested system inside the the gantry.

SESSION 2F

POLITICS AND CULTURE

Session Moderator: John Wilkerson, Political Science

MGH 242

3:30 PM to 5:15 PM

* Note: Titles in order of presentation.

Gendered Corruption and Human Rights in Brazil and the US

Leila Waterfall (Leila) Reynolds, Senior, Anthropology, International Studies: Latin America

Mary Gates Scholar

Mentor: Jonathan Warren, Jackson School of International Studies

This project compares the results of recent political shifts n the US and Brazil on human rights in both countries, and examines how gendered perceptions of corruption and media consolidation led to the rise of the political right in both countries. In this research, corruption is examined as a political tool which is particularly 'gendered'; that is, mobilized in order to portray women in power as inherently corrupt. Instead of attempting to ascertain the validity of corruption in either country, I focus on subjective experiences and conceptions of where corruption is situated, disrupting the idea of countries in the Global South as inherently more corrupt than countries in the Global North by examining corruption as a political tool. Thus, this project examines the rhetoric of gender and corruption in the media during political upheaval within the last year in both the Brazil and the US, comparing the conception of "fake news" with #Globogolpista in order to understand the role the media plays in constructing corruption. Discourse analysis is important in order to attempt to understand the possible impact of gendered corruption on politics and human rights in two countries with low levels of female participation in politics. The project concludes that despite different historical and political contexts, both the US and Brazil mobilize corruption as a gendered political tool which centers on women in power.

SESSION 2Q

CENTRAL NERVOUS SYSTEM DISEASE MODELS

Session Moderator: Gwenn Garden, Neurology

JHN 026

3:30 PM to 5:15 PM

* Note: Titles in order of presentation.

Ischemia/Reperfusion-Induced Type 1 Interferon Signaling in Microglia

Chungeun (Chloe) Lee, Senior, Neurobiology

Levinson Emerging Scholar, Mary Gates Scholar, UW Honors Program, Undergraduate Research Conference Travel Awardee

Mentor: Jonathan Weinstein, Neurology

Ischemic preconditioning (IPC) refers to a neuroprotective phenomenon in which a brief ischemic episode confers robust neuroprotection against subsequent prolonged ischemia. Microglia, the resident immune cells in the brain, play a central role in ischemia/reperfusion-induced neuroinflammation and IPC-induced neuroprotection. Previous work in our laboratory has demonstrated that type 1 interferon signaling, specifically in microglia, is critical for IPC-mediated neuroprotection in white matter. We have also demonstrated that both hypoxic/hypoglycemic (ischemia-like) followed by normoxic/normoglycemic (H/H-N/N) conditions in vitro and transient ischemia in vivo leads to robust expression of interferon stimulated genes (ISGs) in microglia that is completely dependent on expression of type 1 interferon receptor (IFNAR1). In vitro, the H/H-N/N-induced ISG expression in microglia is also dependent on Toll-like receptor-4 (TLR4). However, the mechanism(s) of H/H-N/N-induced ISG response is unknown. We hypothesize that TLR activation by damage-associated molecular patterns (DAMPs) induces a signal transduction cascade that leads to phosphorylation of STAT1, which is also dependent on IFNAR1. Phosphorylation of STAT1 activates specific transcription factors that induce transcription of ISGs, which in turn skews the phenotype of microglia toward a neuroprotective state. We sought to test this hypothesis first by culturing primary microglia from wild-type (WT), TLR4-/- and IFNAR1-/- mice, exposing the microglia to type 1 IFNs or TLR4 agonists and quantifying STAT1 phosphorylation using flow cytometry. Next we exposed WT, TLR4-/- or IFNAR1-/- microglia to H/H-N/N and assessed levels of STAT1 phosphorylation at multiple time points. Our preliminary results suggest dynamic and complex temporal changes in the level of STAT1 phosphorylation in microglia with differential effects in the setting of genetic depletion of TLR4 and IFNAR1. These findings will help elucidate the mechanism of the ischemia/reperfusion-induced ISG response in microglia and may identify molecular targets for modulation of the neuroimmune response in stroke.

POSTER SESSION 3

MGH 206, Easel 177

2:30 PM to 4:00 PM

Efficacy of an Atmospheric Pressure Plasma Jet for Spacecraft Sterilization for NASA

Wei Liao, Junior, Psychology, University of Washington

Thinh Pham, Sophomore, Biochemistry, Edmonds Community College

NASA Space Grant Scholar

Cali Drake, Sophomore, Nursing , Edmonds Community College

Mentor: Jonathan Miller, Biology, Edmonds Community College

NASA confronts a forward contamination problem with the launch of spacecraft and probes into extraterrestrial environments with potential for detection of life. Earth-origin microbes risk threatening planetary systems, compromising the

data obtained, and require implementing microbial control for planetary protection from cross contamination. While generally effective, currently approved decontamination methods are costly, involve high heat and chemical treatments, and risk damaging thermally sensitive spacecraft materials and components. Alternative methods, including atmospheric pressure plasma jets (APPJs), show promise as effective technologies for microbial control. Researchers at Edmonds Community College partnered with Eagle Harbor Technologies (EHT) of Seattle, WA to test the capabilities of an APPJ developed by EHT, performing characterization of killing efficacy. Bacillus atrophaeus endospores were spread on tryptic soy agar plates to quantify killing efficacy of over 900 combinations of APPJ parameters including pulse width, frequency, voltage, distance, time, electrode placement, jet configuration, gas composition, and flow rate. Unprecedented independent control of APPJ pulse width, frequency, and voltage allowed researchers to identify combinations of these parameters resulting in greater than 4-log reduction of endospores. A decimal reduction time (D-value) was additionally determined at an average of 160 seconds on aluminum. High humidity and low concentrations of O_2 were identified as conditions that enhanced killing of endospores. Further characterization of higher voltage, frequency, and humidity, as well as variable pulse width and low O_2 should lead to improved APPJ killing efficacy with decreased exposure time and allow for development of an APPJ optimized for microbial reduction for large-area spacecraft.

POSTER SESSION 3

Balcony, Easel 94

2:30 PM to 4:00 PM

Effects of Parasitism and Drought on *Achillea millefolium*

Courtney Matzke, Fifth Year, Biology (Plant)
NASA Space Grant Scholar
Mentor: Jonathan Bakker, Environmental and Forest Sciences
Mentor: Nathan Haan, School of Environmental and Forest Sciences

Hemiparasitic plants have the ability to obtain water, nutrients, and secondary metabolites from nearby host plants, while also retaining the capacity to photosynthesize. Through haustorial connections that form on roots, they can have varying levels of influence on their host plants. Hemiparasites have been recognized as keystone species in some ecosystems, playing essential roles such as suppression of competitively dominant species and alteration of nutrient availability. Thus far, the impact of hemiparasites on grassland communities in the Northwest is largely unknown. In this greenhouse experiment, I am testing the effects of the following treatments: 1) hemiparasite identity (*Castilleja levisecta* versus *C. hispida*), 2) prevention of parasitism, and 3) drought, on the performance of one species of host plant, *Achillea millefolium*. I am measuring whether these treatments alter the size or photosynthetic rate of *A. millefolium*. I expect parasitism to have a substantial effect on the host plant, particularly under drought conditions, with hemiparasite identity being a less significant factor. Anticipated results will show the extent to which *Castilleja* reduces the host plant's biomass and affects its CO2 assimilation rate. It would be interesting to expand this study by duplicating it in the field to gain a more comprehensive understanding of the broader ecological impacts of parasitism. These species-specific findings may also be translated to other plant groups and have significant implications for ecological restoration projects.

POSTER SESSION 3

MGH 206, Easel 178

2:30 PM to 4:00 PM

Proof of Principle of an Atmospheric Pressure Plasma Jet for Spacecraft Sterilization for NASA

Christopher (Chris) Nguyen, Junior, Microbiology, University of Washington
Stephani Bernard, Junior, Nursing, Edmonds Community College
Mentor: Jonathan Miller, Biology, Edmonds Community College

NASA confronts a forward contamination problem with the launch of spacecraft and probes into extraterrestrial environments with potential for detection of life. Microbial control is required in order to avoid cross contamination that would compromise data collected. Currently approved decontamination methods are costly and involve high heat and chemical treatments which risk damaging thermally sensitive spacecraft materials and components. Alternative methods, including atmospheric pressure plasma jets (APPJs), show promise as effective technologies for microbial control. Researchers at Edmonds Community College partnered with Eagle Harbor Technologies (EHT) of Seattle, WA to test the capabilities of an APPJ developed by EHT, performing characterization of killing efficacy and demonstrating proof of principle for large-area spacecraft sterilization. Research demonstrated killing capabilities of APPJ when applied to various conditions including different surface materials, meshes, tapered and elevated holes. The plume of the APPJ traveled through tapered and elevated holes yielding greater than 99% killing of endospores. Application of APPJ as a "brush" demonstrated greater than a 6 log reduction of endospores over 56.75 cm^2/10 minute exposure. Findings suggest a brush composed of multiple jets could be effective for spacecraft sterilization over large surface areas of differing materials with capability to penetrate unusual shapes and surfaces. Anticipated improvements in killing efficacy resulting from better characterization of increased voltage, frequency, humidity,

and the inclusion of low O_2concentrations should lead to the development of an APPJ brush effective at spacecraft sterilization.