Undergraduate Research Symposium May 19, 2017 Mary Gates Hall

Online Proceedings

Poster Session 1

MGH 241, Easel 124

11:00 AM to 1:00 PM

Automated Device for Sensitive Detection of an Influenza Virus Surface Glycoprotein

Alexis Marie Fleming, Junior, Bioengineering
UW Honors Program
Mentor: Joshua Buser, Bioengineering
Mentor: Caitlin Anderson, Bioengineering
Mentor: Paul Yager, Bioengineering

Influenza is a viral respiratory tract infection responsible for 15-60 million infections and more than 200,000 flu related hospitalizations in the United States annually. Diagnostics can help stop outbreaks and treat infections, however the current flu detection methods lack high sensitivity. The Yager Lab at the University of Washington is developing a simple diagnostic test to identify subtypes of the influenza virus. The assay targets the viral surface protein hemagglutinin (HA) and can specifically detect two strains of the influenza virus, the Solomon Islands strain of H1N1 and the Switzerland strain of H3N2. We have developed an automated device for this assay, supplying the reagents sequentially using a pinched valve and water soluble paper. I have tested and modified this device in order to enable hands free operation once the sample (a nasal swab) is inserted in the system. The paper based assay is fast, specific, and easy to use, allowing rapid diagnosis of influenza in any setting.

Poster Session 1

Balcony, Easel 118

11:00 AM to 1:00 PM

Factors Affecting the Geographic Distribution of *Drosera* (Droseraceae) Species in the Cape Floristic Region of South Africa and Implications of Global Climate Change

Alexander Dietrick, Sophomore, Ecology, Evolution, & Conservation Biology, Seattle Central College
Mentor: Joshua Whorley, Science Technology Engineering Math, Seattle Central College

The Cape Floristic Region of South Africa (CFR) is the smallest of the world's six floristic regions, and is known for both its high biodiversity and high number of endemic species, or species that exist nowhere else. Among such species are sundews in the genus *Drosera*, which are small, herbaceous, and carnivorous flowering plants. Of the 34 species of *Drosera* in Africa and Madagascar, 21 of them are endemic to South Africa. *Drosera* in South Africa can be grouped into two categories: generalist species that are widespread in their distribution, and specialist species with highly restricted ranges, often known from only a few sites. The high diversity and variety of life history strategies of *Drosera* in South Africa make the genus an excellent model system for the study of species distribution through the lens of global change. For this project, occurrence data was sourced from citizen science platforms iNaturalist and iSpot, as well as from publicly accessible herbarium and biodiversity databases. Using MaxEnt niche modeling software, occurrence data for *Drosera* in South Africa were used in combination with geographic and climatic data from WorldClim to create a niche occupancy model, which predicted the distribution of these species. This model was used in combination with future climate estimates from WorldClim to predict changes in the distribution of *Drosera* species in South Africa in response to climate change. Results from this study suggest that generalist species are less susceptible to climate change than specialist species with already highly restricted ranges. Understanding how species respond to global climate change is crucial for the success of long-term conservation initiatives.

Poster Session 2

Balcony, Easel 105

1:00 PM to 2:30 PM

Point-of-Care Blood Sample Preparation for Zika Virus Diagnostics

Arielle Howell, Junior, Pre Engineering
Mentor: Paul Yager, Bioengineering
Mentor: Joshua Buser, Bioengineering

Point-of-care diagnostics are needed to improve the detection of pathogens like the Zika virus. The Zika virus can be transmitted by mosquitoes, or by the exchange of blood or other bodily fluids. The implications of the virus in pregnant women and their children are still largely unknown. So monitoring, and if possible, preventing the spread of the disease is critical. Paper-based diagnostic assays enable complex assays in settings without laboratory assets. Today, sample preparation for molecular testing requires training and ex-

pensive machinery. The Yager lab recently created a fully automated multi-material paper-based system that can extract DNA from urine, but had not yet developed an automated system for blood targets. My initial work centered on adapting the paper-based system to enable diluted blood processing. Our updated design successfully flowed ˜1.6 mL diluted blood sample through the paper in ˜20 minutes. By passing large volumes through the system, low-concentration DNA can be extracted from the sample, removing assay inhibitors at the same time. This work continues the study of fundamentals of fluid movement through porous networks in the Yager lab, enabling a foundation for DNA sample preparation necessary for blood diagnostics. These advances will help detect the Zika virus in blood samples outside the laboratory, contributing to the monitoring and prevention of the disease.

SESSION 2M

FUNDAMENTAL IMMUNE MECHANISMS

Session Moderator: Alanna Ruddell, Comparative Medicine

MGH 287

3:30 PM to 5:15 PM

* Note: Titles in order of presentation.

The New Pattern Recognition Receptor RECON Acts as Part of the Intestinal Immune System

Alexie Anne Carletti, Senior, Biology (Molecular, Cellular & Developmental)

Mary Gates Scholar, Innovations in Pain Research Scholar

Mentor: Joshua Woodward, Microbiology

Mentor: Adelle McFarland, Molecular and Cellular Biology/Microbiology

We have recently identified a new cytosolic sensor for bacterial cyclic dinucleotides, the aldo-keto reductase RECON. RECON plays a critical role in surveying the host cytosol for intracellular bacterial pathogens, orchestrating the innate immune response to those pathogens and aiding in bacterial clearance. In the host, RECON is most highly expressed in the small intestinal epithelium, enterocytes and M cells. Its high expression at these important mucosal immune sites raises the question as to whether RECON is part of the intestinal immune system. We have recently made a RECON knockout (KO) mouse and found significant alterations in intestinal inflammation and commensal abundance, particularly an increase in segmented filamentous bacteria (SFB). Using quantitative real-time PCR copy number analyses of SFB 16S gRNA, we detected high SFB burden in the RECON KO mice while SFB was undetectable in wild-type mice. SFB have been shown to impact the development of the immune system, particularly T cell populations, in rodents by colonizing and attaching to the follicle-associated epithelium of the small intestines. We predict that the high abundance of SFB in RECON KO mice may either be the result of immunosuppression due to the presence of too many T regulatory cells or will associate with the increased presence of proinflammatory T helper type 17 cells. Current work is aimed at establishing whether there are changes in these T helper cell types in the intestine, as well as looking at the broader dysbiosis by 16S deep sequencing. This project will establish which immune axes are dysregulated in the absence of RECON and will direct future mechanistic investigations into how loss of RECON enzymatic activity is driving immune dysregulation.

POSTER SESSION 3

Balcony, Easel 90

2:30 PM to 4:00 PM

Using Thermal Infrared Remote Sensing to Identify Effects of Beaver Dams on Stream Temperature

Alishia Elizabeth Orloff, Sophomore, Environmental Science & Resource Management

Mentor: Benjamin Dittbrenner

Mentor: Joshua Lawler, School of Environmental and Forest Sciences

Beavers create complex modifications to the physical and biological components of stream ecosystems through their creation of dams and wetland complexes. Beaver impoundments alter the movement of surface and subsurface waters through riparian systems, which substantially affects biotic and abiotic ecosystem processes that together make up habitats for different species. Although there is general agreement that beaver impoundments modify stream temperature, there has been very little focus on their effect at larger spatial scales. In prior research, traditional temperature assessment methods have failed to capture the full spatial breadth of riverine systems. The use of thermal infrared remote sensing (TIR) is an effective tool for measuring surface stream temperature variability at landscape scales. To better understand the role of beavers in the regulation of stream temperature, we evaluated TIR imagery collected within the Snoqualmie and Stillaguamish River basins in Washington State. Our objective was to identify whether TIR imagery could be used to identify areas where beaver dam complexes have measurable effects in decreasing downstream water temperature due to the upwelling of groundwater. We used an intrinsic potential beaver habitat model to identify areas within the TIR flight paths where beavers were likely present and surveyed these areas to confirm presence of beaver wetland complexes. We compared upstream and downstream surface temperature, thermal complexity, and heterogeneity within these areas using a suite of spatial statistics. Our results have the potential to demonstrate that the use of TIR is a novel approach for monitoring the effects of beaver on riparian systems. Its use provides

for assessments at scales and breadth not previously possible using traditional approaches.

POSTER SESSION 4

Commons East, Easel 69

4:00 PM to 6:00 PM

Super-Resolution Imaging of *Drosophila* Tissues Using Expansion Microscopy

Hyeon Jin Kim, Senior, Biochemistry, Chemistry
Mary Gates Scholar, UW Honors Program, Washington Research Foundation Fellow
Mentor: Joshua Vaughan, Chemsitry

Expansion Microscopy (ExM) is a revolutionary fluorescence microscopy technique that enables super-resolution imaging of fixed biological specimens on ordinary microscopes. By chemically incorporating the specimens into a hydrogel polymer matrix, enzymatically digesting the proteins that hold the structures together, and physically expanding the hydrogel complex, this technique yields expansion of fourfold along each x/y/z axis and a spatial resolution of ˜70nm. The original ExM approach utilized special tri-functional antibodies containing a DNA-dye-linker complex to attach the fluorescent dyes to the expandable polymer. Previously, our group has developed an improved and simplified ExM protocol, which is compatible with conventional antibodies and fluorescent proteins, by using only commonly available reagents, yielding increased fluorophore retention for cultured cells and tissue specimens. In this project, we extend this new approach of ExM to enable ultrahigh resolution imaging of *Drosophila melanogaster* tissues which had previously been incompatible with expansion. To do so, we adapted our existing ExM protocol to *Drosophila* embryos, larval brains, and larval and adult body walls by utilizing an enzyme system that can efficiently digest the tough outer cuticle of the organism. We assessed the uniformity of expansion achieved by our new procedure using correlative pre-expansion and post-expansion imaging and found the distortions to be minimal ($<2\%$). With our new ExM approach, we were able to resolve features of presynaptic active zone structure and study the interactions between the epidermis and dendrites of somatosensory neurons in *Drosophila*. This work should open up this powerful super-resolution microscopy method to a large community of researchers who utilize *Drosophila* as an important model system in biology.

POSTER SESSION 4

Commons East, Easel 68

4:00 PM to 6:00 PM

Design, Synthesis, and Caracterization of Cyanine Fluorophores for Super-Resolution Microscopy

Sarah Marie (Sarah) West, Senior, Chemistry (ACS Certified)
Mary Gates Scholar, UW Honors Program
Mentor: Joshua Vaughan, Chemsitry

Optical microscopy is a cornerstone of biological research. It reveals to scientists phenomena that explain many of life's secrets. Despite its capabilities, traditional optical microscopy techniques are limited to a spatial resolution of ˜250 nm due to the diffraction limit of light. Consequently, features smaller than ˜250 nm cannot be distinguished. However, the development of super-resolution microscopy techniques such as the Stochastic Optical Reconstruction Microscopy (STORM) now enables resolution up to ˜60 nm. An essential criteria of STORM requires that the fluorophores turn on and off (photoswitch) stochastically. Up to date, the fluorophores used in these techniques are commercially available fluorophores with photophysical properties optimized for traditional optical microscopy methods. Since the photoswitching properties of these commercial dyes for use in STORM is not well understood, my project thus involves tuning the electronic properties of the cyanine scaffold by adding various functional groups to the dye in order to improve the photoswitching properties. I am currently working on synthesizing cyanine fluorophores in the red region that have electron-withdrawing groups on the indole molecule and a carboxylate linker attached for bioconjugation. Organic synthetic chemistry techniques will be used in the creation of these dyes. The structure of the dyes will then be characterized by proton NMR and mass spectrometry, while the photophysical properties will be characterized by Ultraviolet-Visual spectroscopy. The dyes will eventually be applied to fixed sample staining and STORM. If successful, these new dyes will improve multi-color STORM and researchers will be able to view cells in greater detail.