Online Proceedings

Session 1E

From Viral Pathogenesis to Genetic Diseases to Building a Better Kidney

Session Moderator: Michael Lagunoff, Microbiology

MGH 231

12:30 PM to 2:15 PM

* Note: Titles in order of presentation.

Using Expansion Microscopy for the Study of Hematopoeisis

Hyeon Jin Kim, Senior, Applied & Computational Mathematical Sciences (Biological & Life Sciences), Biochemistry, Chemistry
Levinson Emerging Scholar, Mary Gates Scholar, UW Honors Program, Washington Research Foundation Fellow
Mentor: Hao Yuan Kueh, Bioengineering
Mentor: Joshua Vaughan, Chemsitry

Epigenetic modifications regulate chromatin structure and function, playing important roles in altering DNA transcription levels and subsequently cell fate decisions. Various next-generation sequencing (NGS) methods have been developed to detect these epigenetic changes in the genome, such as chromatin immunoprecipitation followed by sequencing (ChIP-seq). Even though ChIP-seq is extensively used to analyze DNA and histone modification levels, this method is limited to one histone marker at a time and requires significant amount of input cells, which masks the profiles of cell-to-cell variation and the complex interaction between the epigenome and gene expression. To overcome these limitations in current next-generation sequencing methods, we have been developing a multiplexed assay that could detect multiple epigenetic modifications in single cells. So far, I have developed a NGS data analysis pipeline to identify potential gene candidates that are highly differentially modified by histone markers. In the future, we hope to use these gene candidates as templates to design DNA-fluorescent in situ hybridization (DNA-FISH) probes and perform Expansion Microscopy and DNA-FISH with these probes to link histone modifications to specific gene loci at high resolution. After the assay is fully developed and validated, we plan to utilize the assay to take the epigenetic profiles of hematopoietic stem cells and study cell fate decisions in hematopoiesis.

Poster Session 2

MGH 241, Easel 158

1:00 PM to 2:30 PM

Exploring Test Line Optimization in Diagnostic Devices

Alexis Marie Fleming, Senior, Bioengineering
Mary Gates Scholar
Mentor: Paul Yager, Bioengineering
Mentor: Caitlin Anderson, Bioengineering
Mentor: Joshua Buser, Bioengineering

At the 2017 Undergraduate Research Symposium, I presented a low-cost, automated device for influenza detection that was being developed in the Yager lab. After creating, testing, and optimizing this device, we were left with many questions. While certain components of fluid flow in paper are understood, there is much more to learn. In this device alone, three different types of paper were used to run the two-dimensional assay. Current unanswered questions include the following: how do additives affect protein deposition, rehydration, and capture? How much of a dried protein on paper can be rehydrated by a passing solution, and which paper and solution properties affect this value? How do the viscosity and complexity of our patient samples affect the quality of our results? Our overall goal is to determine how to optimize our test line and generate a better understanding for optimization of future diagnostic devices. To make progress towards this goal, my project centers on the development and characterization of a laboratory technique to quantitatively study the effects of these parameters on protein interactions with membrane surfaces and other proteins bound to those membrane surfaces. Improving our understanding of these interactions in membranes will enable better diagnostic device optimization and enable illness detection with lower amounts of infected sample – allowing for earlier detection and better disease treatment. Through the development of this testing apparatus, I have begun to address these questions.

Poster Session 2

Commons East, Easel 75

1:00 PM to 2:30 PM

The Position of the Uterus, and its Correlation to Ovarian Function

Danisha Christian, Junior, Biology, Seattle Central College
NASA Space Grant Scholar
Chanel Wahidi

Mentor: Joshua Whorley, Science Technology Engineering Math, Seattle Central College

Standard medical practice does not consider a lateral leaning uterus to be medically relevant. However, many indigenous cultures globally have used uterine abdominal massage to correct a "displaced" uterus to enhance fertility. A leaning uterus could theoretically interfere with ovarian function. Additionally, Research indicates that the circulatory functions, the autonomic innervations of the uterus, and pelvic vein incompetence may negatively affect ovarian function, and fertilization. This study examines a population of 30 U.S. fertility patients undergoing ovarian stimulation for an In Vitro Fertilization (IVF) procedure (an assisted reproductive medical technique used to assist with the conception of a child). We will identify differences in the quantity, and size of follicles that are produced by the ovaries of patients with a leaning uterus. At the beginning of a patient's IVF cycle, researchers will palpate the lower abdomen to determine the position of the uterus. After the patient completes their series of gonadotropins, prescribed hormones used to stimulate follicular growth in the ovaries, physicians will record the number, size, and location of each follicle observed. We predict that a laterally leaning uterus reduces follicle number and size. If our results identify a correlation between uterine displacement and follicle development, then additional research should explore potential causes. A positive correlation would also suggest that complementary treatment options for a laterally leaning uterus should be investigated.

POSTER SESSION 3

MGH 241, Easel 162

2:30 PM to 4:00 PM

The Effects of Pond Leveler Devices on Salmon Migration through Restored Riverine Beaver Ponds Complexes

Helena Marie (Lena) Wilson, Senior, Environmental Science & Resource Management (Landscape Ecology & Conservation)
Bridger Machus, Senior, Environmental Science & Resource Management (Landscape Ecology & Conservation)
Mentor: Joshua Lawler, School of Environmental and Forest Sciences
Mentor: Benjamin Dittbrenner

The North American beaver (*Castor canadensis*) is a keystone species and ecosystem engineer, capable of modifying the landscape and creating diverse habitats for other species. Through dam-building, beavers impound streamflow and create ponds and wetland complexes behind dams. The presence of beavers has been shown to increase biodiversity, reduce downstream flooding, and improve water quality. While beavers alter landscapes greatly, often in ways beneficial to native habitats and species, their dam-building can also create conflict with human land-use and infrastructure. One way to reduce human-beaver conflict is to adopt non-lethal approaches such as the use of pond leveler devices. Pond levelers, consisting of a pipe through the beaver dam with a cage around the inlet, control the water level of the pond by establishing a desired level while allowing beavers to persist, thereby reducing flooding. Little observational evidence exists on whether pond leveling devices create fish barriers or otherwise impede fish passage for migrating salmon. The objective of this research was to evaluate whether migrating salmon can pass through or around beaver dams fitted with standard pond leveling devices, under high flow conditions. We tested this by observational analysis collected from five pond levelers on Big Spring Creek, King County, Washington during the 2017 autumn salmon migration. Target migrating species include Chinook (*Oncorhynchus tshawtscha*) and Coho salmon (*Oncorhynchus kisutch*). During prolonged precipitation events it was determined that stream stage overtopped dams, providing unhindered passage in our study areas. Additionally, during the 2017 migration period, overdam stream velocity and through-dam velocity (i.e. within the pipe) were passable by salmonids during 100% of the flows we observed.

POSTER SESSION 3

MGH 241, Easel 152

2:30 PM to 4:00 PM

Improved Nanoscale Imaging Achieved by Index Matching with Expansion Microscopy

Jonathan Bryce (Jon) Perr, Junior, Biochemistry
Mary Gates Scholar, UW Honors Program
Mentor: Joshua Vaughan, Chemsitry

In recent years, researchers have dedicated much effort to overcoming the ˜250nm 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) has enabled ˜65nm image resolution or better by physically expanding fixed specimens in a swellable hydrogel polymer. While ExM allows researchers to achieve high resolution with standard microscopes, the technique requires the use of water-immersion lenses, rather than higher-resolution oil-immersion objective lenses, when imaging more ˜5 μm deep due to spherical aberrations caused by refractive index mismatch with oil lenses and water-based hydrogels (n=1.5 vs n=1.3). Oil-immersion lenses also collect more signal than water-immersion lenses, enabling higher signal to noise with oil-immersion lenses under the same excitation conditions. I have developed an index-matching technique that significantly reduces spherical aberrations when imaging with oil lenses and expanded specimens, facilitating improved resolution (˜1.12x lateral improvement and 1.5x axial improvement) for depths of up to 25 μm. Expanded specimens are index-matched by simply incubating the specimen in a high-index iohexol solution which equilibrates with the specimen in approximately 18 hours. A modest ˜17.5% shrinkage of the hydrogel is produced as a result in the current implementation, which I can in principle compensate for by tuning the hydrogel recipe to achieve a slightly higher expansion factor. I found that the iohexol solution on its own accelerated the rate of fluorophore bleaching and led to some fluorophore quenching. However, the addition of the triplet-state quencher n-propyl-gallate effectively mitigated this chemical bleaching. Ultimately, this iohexol-facilitated index-matching procedure not only combines the utility of ExM and the high collection efficiency of oil immersion objectives but allows researchers to use common chemicals and readily available instruments to obtain images that reveal a previously inaccessible wealth of information.

POSTER SESSION 4

Commons East, Easel 64

4:00 PM to 6:00 PM

Wireless Data Transfer (WDT) for Robotic Fingertips Sensor

Cloe Lee, Senior, Electrical Engineering
Mary Gates Scholar
Mentor: Patrick Lancaster, Computer Science and Engineering
Mentor: Joshua Smith, Computer Science & Engineering, Electrical Engineering

The field of robotics attempts to replicate human intelligence by harnessing vast amounts of information, and will heavily influence next generation technologies. Of course, in order to operate in an intelligent manner, our robots must be equipped with sensors that can provide informative data. By endowing our robots which such sensors, we can enable them to assist humans that are dependent on others for completing every day tasks, such as opening doors, picking up fallen objects, and pulling wheelchairs. Up until recently, many robots required their sensors to be wired to their main computers, potentially impeding their movement and/or limiting the types of sensors that they can employ. Our work, in particular, focuses on pre-touch sensors, which are sensors mounted to the robot's fingers that allow it to sense an object prior to making contact. This project redeveloped the pre-touch sensing system such that data from up to five sensors is wirelessly transferred to the robot's main computer. There are five micro USB ports connecting to the five fingertip sensors, all of which are controlled by the main USB hub. Vocore, a single-board computer, is incorporated, and this Linux based mini-computer is an essential component for sending the sensor data via Wi-Fi to any selected computer. Additionally, the elimination of wires makes it much easier to reconfigure the form factor of the pre-touch sensing system. As a result, these versatile sensors could be applied to any robot in the world.