Undergraduate Research Symposium May 19, 2017 Mary Gates Hall

Online Proceedings

POSTER SESSION 1

MGH 241, Easel 134

11:00 AM to 1:00 PM

Developing Gene Knock-in Technology in Zebrafish

Jessica Erin Gianopulos, Junior, Biology (Molecular, Cellular & Developmental)
Mary Gates Scholar, UW Honors Program
Mentor: Eleanor Chen, Pathology
Mentor: Michael Phelps

Zebrafish are a valuable model organism in scientific research, however there are limited genetic tools available for inserting/integrating engineered DNA into precise locations in the zebrafish genome. This project has developed a new method of precisely integrating engineered genes into specific zebrafish genomic locations. The heat shock-70 like (hsp70l) gene in the zebrafish genome is an ideal location for new gene (transgene) integration because the hsp70l promoter enables temporal regulation of the transgene through a heat shock-inducible mechanism. CRISPR/Cas9 genome editing technology was used to insert genetic markers, called attP sequences, flanking the green fluorescent protein (GFP) gene into the hsp70l gene locus in zebrafish. I built a construct containing attB sequences flanking the red fluorescent protein (RFP) transgene. These attP and attB markers are recognized by viral integrase proteins, bxb1 and fC31, which cut and recombine the attP and attB sequences causing directional recombination replacing GFP with RFP. I performed a proof-of-principle experiment by injecting zebrafish embryos with this new attB-RFP construct and the old attP-GFP construct with both the bxb1 and fC31 integrase enzymes to show functional integration in zebrafish. I optimized injection techniques to maximize the recombination frequency of the attB-RFP integration at the hsp70l gene in the zebrafish genome. This system allows for the rapid insertion of any transgene precisely into the endogenous hsp70l locus. I used this system to create heat-shock inducible Cas9 transgenic zebrafish as a tool for characterizing the function of novel genes essential for promoting or suppressing cancer growth in zebrafish tumor models. Inducing Cas9-mediated gene knockout is allowing us to determine the specific role a gene plays in cancer progression which helps us identify viable targets for the development of new cancer therapies.

POSTER SESSION 1

MGH 241, Easel 135

11:00 AM to 1:00 PM

Characterizing the Role of CD82 in the Pathogenesis of Rhabdomyosarcoma

Phuong Van, Junior, Biology (Molecular, Cellular & Developmental)
Mentor: Eleanor Chen, Pathology
Mentor: Thao Pham, Pathology
Mentor: Terra Vleeshouwer-Neumann, Pathology
Mentor: Michael Phelps

Pediatric rhabdomyosarcoma (RMS) is a rare and aggressive cancer that arises from skeletal muscle precursors in muscle and connective tissues. The molecular mechanisms underlying RMS progression, relapse and metastasis remain poorly characterized. CD82, a novel metastasis suppressor gene, has been shown to decrease tumor progression in a subset of human cancer types when expressed. Recently, two scientific publications investigated the role of CD82 in cellular differentiation and proliferation in muscle precursor cells. Uezumi et. al (2016) claimed that loss of CD82 results in premature differentiation and a depletion of muscle precursor cells. In contrast, Alexander et. Al (2016) discovered opposing results in which loss of CD82 in fetal muscle cells impairs the capacity of myogenic precursor cells to differentiate into mature muscle cells. In RMS, tumor cells keep on proliferating and have lost the capacity to differentiate into mature muscle cells. The role of CD82 in regulating cell proliferation and differentiation in RMS is unknown. In order to investigate the function of CD82 in differentiation of RMS, I used the CRISPR/Cas9 genome engineering system to target the gene in RMS cell lines. To characterize the knockout phenotype, I performed various cell-based assays to characterize the effects of CD82 gene knockout on the cellular phenotypes in tumor cell differentiation, proliferation, and self-renewal. Investigating the role of CD82 in regulating cellular differentiation and proliferation in RMS would provide important insight into the pathogenesis of cancer.

POSTER SESSION 1

MGH 241, Easel 144

11:00 AM to 1:00 PM

The Antiviral Activity of Chimeric APOBEC3 Proteins Against HIV

Elisa Aiko Cano, Senior, Biology (General)
Mentor: Michael Emerman, Microbiology, Fred Hutchinson Cancer Center

The APOBEC3 proteins are a family of antiviral proteins encoded by 7 genes in humans. They act by hypermutating the viral genome due to their cytidine deaminse activity (mutation of cytidines to uracils). However, they are inactivated by the HIV Vif proteins. The APOBEC proteins have been the subject of much research over the years due to their evolutionary arms race with the HIV protein Vif and their restrictive properties the against the Vif-deficient virus. Moreover, some of the APOBEC3 proteins encode two deaminase domains, while others encode only one. It is known that the most restrictive APOBEC3s tend to localize mostly in the cytoplasm and have the propensity to dimerize. It is unknown, however, whether either of these factors cause the proteins to be packaged into the virions more readily, consequently causing them to be more restrictive, or if these factors by themselves are the cause of higher restriction of the virus. In this experiment, I am looking to see if the artificial linking of two weakly antiviral APOBEC3s that encode single deaminase domains and do not naturally link in vivo will increase their restriction factor against HIV. First, the chimera will be made by PCR, then ligated into a mammalian expression vector, pcDNA 3.1, and cloned into bacteria. Next, the plasmid will be prepped and used to do a viral infectivity assay with Vif-deficient HIV by the transfection of HEK293T cells and analyzing the data. Based on the findings in other research, I expect to see an increase in restriction of Vif-deficient HIV, and possibly also Vif-proficient HIV. If this is found to be true, then further research could be done to find the localization of the chimera within the cell. Furthermore, research on the viral packaging of these proteins could reveal more concerning their antiviral activity.

SESSION 1K

MOLECULAR BASIS FOR HUMAN DISEASE

Session Moderator: Caroline Harwood, Microbiology
MGH 271
12:30 PM to 2:15 PM

* Note: Titles in order of presentation.

KSHV Modulates the Expression of Genes Involved in Peroxisome Biogenesis

Yashmira (Mira) Naidoo, Senior, Microbiology
Levinson Emerging Scholar, Mary Gates Scholar, UW Honors Program
Mentor: Michael Lagunoff, Microbiology

Kaposi's sarcoma-associated herpesvirus (KSHV) is the causative agent of Kaposi's Sarcoma (KS), a cancer of endothelial cell origin that is the most common malignancy among AIDS patients worldwide. Previous research in our lab has established that the number of peroxisomes is increased during latent KSHV infection. Peroxisomes are multifunctional cellular organelles involved in a variety of metabolic pathways important to KSHV pathogenesis. My project is to evaluate the cellular mechanism by which KSHV induces peroxisome biogenesis, thereby elucidating one of the key pathways involved in KSHV latency. I hypothesize that KSHV increases the transcription of specific regulatory genes responsible for peroxisome biogenesis. I evaluated gene expression of a known transcription factor, peroxisome proliferator-activated receptor alpha (PPARA), that has been implicated in peroxisome biogenesis during mock and KSHV latent infection of endothelial cells. I used real-time PCR to quantify gene expression of PPARA, in addition to other genes involved in peroxisome formation and function. My data demonstrates that KSHV infection upregulates PPARA and peroxisome-associated genes, suggesting that PPARA may be a key regulator of the expression of peroxisome biogenesis. To further establish the role of PPARA in peroxisome biogenesis, I am currently working on silencing PPARA expression using small interfering RNA (siRNA). I will determine if the knockdown of PPARA prevents KSHV upregulation of peroxisome-associated genes. In the absence of PPARA, I expect that expression of peroxisome-associated genes will be downregulated, suggesting that PPARA regulates them at the transcriptional level. These results will establish a key mechanism in KSHV pathogenesis, and potentially contribute to the development of novel therapeutic avenues for KS treatment.

SESSION 1L

SEX, DRUGS, YOUTH AND LAW: PERSPECTIVES ON REGULATING CONDEMNED BEHAVIOR

Session Moderator: Steve Herbert, Geography
MGH 284
12:30 PM to 2:15 PM

* Note: Titles in order of presentation.

Structural Sexism: Gender Differentiated Restrictions on Drinking within UW Greek Community Honor Codes and Sexual Assault

Cassandra Ann (Cassie) Mc Master, Senior, Political Science
UW Honors Program
Mentor: Michael McCann, Political Science

Previous research on campus sexual assault has found higher

rates of sexual assault committed against members of sororities as opposed to non-affiliated women. Despite this finding, there has been limited research on this topic. This thesis observes the relationship between honor codes that prohibit drinking within the Greek Community on campus and rates of sexual assault. I seek to fill a gap in scholarship by conducting a study of honor codes within the University of Washington Greek Community in order to determine if gender based honor codes increase student vulnerability to sexual assault. I hypothesize that honor codes that restrict drinking are not meeting their intended purpose of preventing students from drinking but rather that they force students to do so outside of their home, which places students in more vulnerable situations. Additionally, I hypothesize that gender based honor codes increase student vulnerability to sexual assault. In order to test these hypotheses, I utilize a combination of qualitative and quantitative data collected from surveys and interviews with students at the University of Washington. I also employ feminist theory and previous research on sexual violence within Greek Communitites. My findings indicate that gender differentiated restrictions on drinking within sorority honor codes reinforce gender structures that have been fonud to perpetuate sexual assault and make sorority women drink in spaces where they may be at a higher risk of sexual assault.

POSTER SESSION 2

MGH 206, Easel 178

1:00 PM to 2:30 PM

Hypoxia Induced Factors in Latent Kaposi's Sarcoma Herpesvirus Infected Endothelial Cells

Jie Yin, Senior, Biochemistry, Microbiology
Mary Gates Scholar, UW Honors Program
Mentor: Michael Lagunoff, Microbiology
Mentor: Daniel Holmes, Microbiology

Kaposi's Sarcoma-Associated Herpesvirus (KSHV) is the etiological agent of Kaposi's Sarcoma (KS), a highly vascularized tumor predominantly made up of cells of endothelial origin. KSHV establishes a predominantly latent infection in endothelial cells in culture and in the KS tumor. KSHV latent infection alters cellular metabolism to improve the survival of the infected cells. These metabolic changes resemble a common alteration in cancer cells, termed the Warburg effect. This refers to an increase in glycolysis in the presence of oxygen and a decrease in oxidative phosphorylation. The mechanism of KSHV induction of the Warburg effect is currently unknown. Hypoxia-induced factors (HIFs) are likely candidates for KSHV induction of the Warburg effect as both HIF1α and 2α are induced by KSHV latent infection. To determine if HIF1α or 2α is required for the survival of KSHV infected endothelial cells, I constructed HIF1α or 2α knockouts using the CRISPR/Cas9 gene editing technique in a lentivirus vector. I expressed the endonuclease Cas9 and guide RNAs that lead Cas9 to cut at the HIF1α or 2α genomic sequences leading to genomic mutations in HIF1α and 2α respectively. To determine if HIF1α or 2α is required for the survival of latently infected endothelial cells, I infected the HIF1α and 2α knockout cells with KSHV and looked for cell death at 48 hours after infection. To evaluate if HIFs are required for KSHV induction of the Warburg effect, I will determine if one or both of the knockout cells produce less lactic acid and increase oxygen consumption at 48 hours post KSHV infection as compared to infection of wild type cells indicating the Warburg effect is not being induced by KSHV in the knockout cells. These results will aid in the future efforts to develop antiviral drugs by inhibiting viral latency.

SESSION 2G

THE DYNAMICS OF CULTURE AND SPACE

Session Moderator: Branden Born, Urban Design and Planning

MGH 248

3:30 PM to 5:15 PM

* Note: Titles in order of presentation.

The Push and Pull of Capitol Hill: An Examination of Gentrification, Acceptance, and Other Social Factors Shape Movement of LGBTQ+ People Out of Seattle's Historic Gayborhood

Adel Clifton, Senior, Sociology
UW Honors Program
Mentor: Sarah Quinn, Sociology
Mentor: Michael Brown, Geography

The city of Seattle has experienced immense urban change. Over the past 15 years, we see companies expanding, neighborhoods evolving, and populations being displaced. Recently, sociologists have discovered that neighborhoods that were traditional oases for queer life and living, including neighborhoods in Seattle, have experienced losses in the queer population. The body of research emerging on this topic largely credits this to a greater public acceptance of LGBTQ+ identities which have reduced barriers that kept queer populations from living in other areas. Though many public sources of information, news sites, blogs, and forums, propose gentrification of these neighborhoods as the force driving queer people from their homes. Between 2000 and 2012 Seattle's traditional gayborhood, Capitol Hill, has seen a significant decrease in same-sex couples, according to the US census. With Amazon and other tech companies expanding into the Capitol Hill neighborhood and subsequent rising rents in that area, it may be the case that queer people can no longer afford to live in the gayborhood has made itself known in Seattle. In this research project I examine the mo-

tives for why queer people leave Capitol Hill through a series of interviews with LGBTQ+ people who are moving out of Capitol Hill. These interviews will provide insight into how gentrification and greater acceptance of LGBTQ+ people and other social factors may play a role in this new form of urban change.

POSTER SESSION 3

MGH 241, Easel 151

2:30 PM to 4:00 PM

Investigating Candidate Variants in *NPR3* and *SRL* in an Extended Family with a History of Joint Hypermobility

Edith P (Edith) Almanza Fuerte, Senior, Biology (Molecular, Cellular & Developmental)

Undergraduate Research Conference Travel Awardee

Mentor: Michael Bamshad, Pediatrics

Mentor: Kati Buckingham, Pediatrics

Investigation of the phenotypic features of a putatively unaffected individual, in a family diagnosed with a multiple congenital contracture disorder called Distal Arthrogryposis Type 2B (DA2B), identified joint hypermobility, a phenotypic trait not commonly associated with DA2B. Review of the family history revealed joint hypermobility in multiple other family members extending back four generations. Analysis of exome data from the family, identified two candidate variants, one in exon 1 of the gene *SRL* and another in exon 8 of *NPR3*, which may explain the joint hypermobility observed in this family. Recently, we used Sanger sequencing to genotype five family members with hypermobility and four unaffected family members for the two candidate variants to see if either variant tracks with the hypermobility phenotype. Briefly, we amplified exons via polymerase chain reaction and verified product sizes using gel electrophoresis. We then sequenced the amplicons using di-deoxy chain termination sequencing and generated electropherograms using an automated DNA sequencer. Using the computer program CodonCode, we aligned and examined the sequences. Analysis of the data is underway. Through pinpointing mutations that cause hypermobility, characterization of Distal Arthrogryposis syndromes will become more accurate which may lead to better patient outcomes for individuals with additional features like severe hypermobility.

POSTER SESSION 3

Commons East, Easel 68

2:30 PM to 4:00 PM

Building a Low Cost Laser Power Meter and Controller for Quantum Information Research

Jared Nakahara, Senior, Electrical Engineering

Mentor: Kai-Mei Fu, Physics/ECE

Mentor: Michael Gould, Physics

Quantum information research often require lasers to deliver energy to devices and to acquire data. The goal of this project is to create an inexpensive and easy-to-build tool to measure and control laser power to support our lab's quantum information research. The tool interfaces with our lab's existing data collection and analysis modules. A standalone module is also present for adoption outside of our lab. Some of the intended applications of this tool are the generation of saturation curves for quantum emitters, and performing photoluminescence excitation spectroscopy on samples, both of which require precise control of laser power. The system uses a National Instruments data acquisition device to record a voltage generated by a laser power sensor. The software module also interfaces with an Arduino microcontroller, which can be used to adjust the laser's power. The software module allows the user to set, monitor in real-time, and record laser power from a graphical user interface. The data taken utilizing the developed power controller will advance the development of quantum computation hardware based on single photons and quantum spins. Quantum computers are theoretically predicted to solve certain classes of problems that are currently unsolvable on today's computers, including the factoring of large numbers which is at the heart of current secure communication protocols.

POSTER SESSION 3

Commons West, Easel 24

2:30 PM to 4:00 PM

Is Forward Osmosis a Viable Method for Desalination of Seawater?

Kateryna (Kate) Gomozova, Sophomore, Civil and Environmental Engineering, Bellevue College

Mentor: Sonya Remington-Doucette, Science Division, Bellevue College

Mentor: Michael Reese, RISE Learning Institute, Bellevue College

In many parts of the world, the lack of fresh water is the single largest factor limiting sustainable development. Water scarcity contributes to poverty and poor public health outcomes, and it can exacerbate ethnic and international conflicts in arid regions. This study aims to determine whether forward osmosis (FO) is a viable method for desalination of seawater. FO is an emerging technology for desalination, in which osmotic pressure is used as a driving force for separation. By using a concentrated solution of high osmotic pressure, called the draw solution, water is induced to flow from saline water

across the membrane, rejecting the salt. To obtain potable water, the diluted draw solution is recovered and then recycled. Two chemicals – ammonium bicarbonate (NH_4HCO_3) and magnesium chloride ($MgCl_2$) – were compared in order to determine which one results in a more effective FO process, in terms of flow and chemical composition of the produced water. The results showed that the FO process is viable in terms of water flow and salt rejection. The effectiveness of the FO process does not depend on the type of draw solution, but instead depends on concentration, volume ratio of feed and draw solutions, and type of mixing. More experiments are required in order to develop the optimal mathematical relationship between the concentration of draw solution, and volume ratio of feed solution to draw solution. Potable water that complies with EPA standards, was obtained only from recovery of $MgCl_2$ diluted draw solution. Methods of NH_4HCO_3 removal described in the FO scientific literature did not result in production of potable water. Further analysis is required to identify possible techniques for NH_4HCO_3 removal from draw solution.

POSTER SESSION 4

Commons West, Easel 30

4:00 PM to 6:00 PM

Influence of Photoresist Deposition on Wafer Features

Max Salire, Senior, Biology (Physiology)
Mentor: Michael Khbeis, Washington Nanofabrication Facility

Photolithography is a process used in nanofabrication to create patterns on different types of substrates. These patterns are used to define structures that are either built up (additive) or etched (subtractive) to form functional layers. These functional layers allow for the creation of different kinds of electronics, such as resistors and semiconductors on an incredibly small scale. The process of photolithography involves the use of light to expose a pattern on a substrate. In order to expose a pattern on a substrate or wafer, the use of photoresist is essential. Photoresist is a viscous solution, which is deposited on wafers. The wafer then goes through a process called spin coating which rapidly spins the wafer to create an even surface. This even surface is crucial in order to properly expose a pattern on the wafer. In order to have an even coating and minimize the discrepancies across a wafer's surface, there are many processes that a wafer must go through in order to ensure the best quality for exposure. This poster discusses techniques including the storage of the wafer, the handling of the wafer and the depositing of photoresist. Analyses of these techniques are discussed as well as critical parameters for the environment in which they are kept.

POSTER SESSION 4

Commons West, Easel 29

4:00 PM to 6:00 PM

Refinement of Dry Etching Parameters to Improve Sidewall Profile of High Aspect Ratio Through-Silicon Vias

Paisley F (Paisley) Zelaya, Senior, Chemical Engineering
Mentor: Michael Khbeis, Washington Nanofabrication Facility

Current research in microelectronic devices made of semiconducting silicon wafers focuses on developing high aspect ratio vertical connections between stacked wafers, known as through-silicon vias (TSV), which result in 3D integrated circuits. These 3D integrated circuits are used to increase density of memory chips, enhance performance, and reduce power requirements, resulting in smaller and more efficient electronic devices. After processing silicon wafers with preliminary photolithography, a dense pattern of high-aspect ratio TSV "holes" is achieved with a deep reactive ion etching (DRIE) tool which utilizes the Bosch process. When a hardware change in the electrostatic chuck of the DRIE tool used for this project resulted in poor etch quality and inconsistent sidewall profile, this experiment attempted to develop a new sequence of steps, or "recipe," for the DRIE tool in order to correct the new issues. Etching parameters were refined in order to achieve the primary goal, to improve sidewall conditions which were not consistently 90 degrees, as well as secondary goals, to obtain the tool's etch rate and selectivity towards photoresist against silicon. Sidewall profile, etch rate, and selectivity were determined by sample analysis via scanning electron microscopy. The conclusion of this experiment was a process recipe which could reliably achieve the desired high aspect ratio vias and continue downstream processing of TSV development.

POSTER SESSION 4

Commons West, Easel 31

4:00 PM to 6:00 PM

Designing a Reproducible Procedure to Develop Through-Silicon Vias on Wafers

Amy Yu Li Chiu, Senior, Materials Science & Engineering
Mentor: Michael Khbeis, Washington Nanofabrication Facility

The advancements of microelectronic structures for high performance electronics are now turning to 3D chip integration technology. The use of vertical connections with high aspect ratios, called Through-Silicon Vias (TSVs), is becoming a popular method for fabricating electronic multi-chip systems and devices. Since these vias do not run along the surface

of the wafer, the high density of the vertical vias allows for more interconnections to be made between chips in a stacked system. The goal of this research was to establish the procedure in which TSVs are produced to maximize the highest quantity of connections (maximum packing of number of number of usable vias per unit area). The experiments that were performed involved the fabrication of TSVs while addressing possible reasons for error in each step. The steps that were improved upon and are discussed include best photoresist spinning techniques, minimizing time between exposure and development, and best development techniques. These improvements offer a higher repeatability of the procedure to result in the same yield and quality of TSVs for future production.

POSTER SESSION 4

Commons West, Easel 34

4:00 PM to 6:00 PM

The Relationship Between Supermassive Black Hole Mergers and their Host Galaxy

Daniel Robert (Daniel) Simons, Senior, Physics: Comprehensive Physics, Astronomy
Daven M (D) Cocroft, Senior, Physics: Comprehensive Physics, Psychology, Astronomy
Mentor: Thomas Quinn, Astronomy
Mentor: Michael Tremmel, Astronomy

Through analyzing the properties of the host galaxies to Supermassive Black Hole (SMBH) mergers, we will be able to determine what phase of galaxy evolution these mergers track. We do this by analyzing ROMULUS25, a large cosmological simulation of the universe, from the Big Bang to present day. The data from ROMULUS25 includes the evolution of thousands of galaxies and is able to resolve the internal structure of galaxies. Most galaxies have SMBHs in their core, and when galaxies merge, it is believed that their SMBHs merge as well. Project LISA, as well as other future projects, will be able to detect gravitational waves coming from these mergers. With simulations like ROMULUS25, we will be able to better predict which galaxies are likely to host these SMBH mergers, which will give context to future gravitational wave studies with respect to galaxy evolution theory.

POSTER SESSION 4

Commons West, Easel 35

4:00 PM to 6:00 PM

Super Massive Black Hole Effects on Galaxy Properties

Zoe Rose (Zoe) Deford, Sophomore, Physics: Comprehensive Physics
Mentor: Thomas Quinn, Astronomy
Mentor: Michael J Tremmel

Little is understood about how supermassive black holes affect their host galaxies in terms of growth and shape. Using a large simulation called Romulus25, we are able to study how galaxy properties correlate with black hole properties throughout time. From this simulation we draw a sample of 40 massive galaxies and analyze their properties to understand how they are affected by the growth of supermassive black holes. We examine galaxies with a variety of star formation histories and investigate how the black hole is involved in determining these histories. We seperate the galaxies into three categories: 1) Galaxies with on going star formation 2) Galaxies that stop forming stars 3.) Galaxies that stop and then restart star formation. We show how the black hole activity changes between categories. These results may lead to solving the mystery: what causes the star formation in the galaxies to quench, (and in some cases) un-quench?