UNIVERSITY of WASHINGTON

Undergraduate Research Symposium May 18, 2012 Mary Gates Hall

Online Proceedings

Poster Session 1

Balcony, Easel 116

12:00 PM to 1:30 PM

Quorum Sensing in *Burkholderia thailandensis*

Thao Truong, Senior, Microbiology, Biochemistry
Mentor: E Peter Greenberg, Microbiology
Mentor: Josephine Chandler, Microbiology

Quorum sensing is cell density-dependent communication that regulates many functions in bacteria. Signal synthases (I) produce acyl-homoserine lactones, which diffuse into the environment and activate signal receptors (R) when they reach a critical concentration. Synthases and receptors often form cognate pairs. The soil bacterium *Burkholderiathailandensis* encodes three I-R pairs. The I-R1 system controls cell-cell aggregation and activates many putative aggregation factors including the bce genes that likely encode an exopolysaccharide. The I-R2 system controls antibiotic production. The antibiotics are members of the bactobolin family and are effective against both Gram-positive and Gram-negative bacteria. Both aggregation and antibiotics are believed to promote competitiveness in the diverse soil communities where *B. thailandensis* is found. We have developed genetic screens to learn more about quorum-controlled antibiotics and aggregation in *B. thailandensis*. The first screen identified bactobolin-resistant isolates of the soil bacterium *Bacillissubtilis*, which is normally sensitive to bactobolin. We submitted these mutants for whole genome sequencing to investigate the mutations that confer resistance, and with our results we hope to gain insight into how bactobolin acts on target cells. The second screen was designed to isolate variants that overproduce aggregation factors. Quorum sensing mutants do not wrinkle but variants arise that produce aggregation factors by other means. We are isolating such variants and identifying the underlying mutations to understand how they compensate for the loss of quorum sensing regulation. This may reveal the elements involved in regulating aggregation. These variants will also be useful to learn about the advantages of aggregation in different contexts. Through our two screens we hope to better understand quorum-controlled aggregation and antibiotic phenotypes. Our findings will be useful in further studies of the importance of each of these in competition.

Session 1I

Innovations in Teaching and Learning

Session Moderator: Todd Herrenkohl, Social Work

Mary Gates Hall 258

1:00 PM to 2:30 PM

* Note: Titles in order of presentation.

Preschool Intervention and the Resilience of Underprivileged Children

Remi Alyssa (Remi) Torres, Senior, Early Childhood & Family Studies
Zesbaugh Scholar
Mentor: Todd Herrenkohl, Social Work
Mentor: Gail Joseph, Education

Research on resilience (ability to overcome obstacles in life) has shown that early childhood socio-emotional competence is a strong predictor of future resilience as an adolescent and adult. Research shows that resilience is not a stable quality of individuals, but rather a changeable, dynamic pattern of functioning that is influenced by protective factors such as positive relationships, strong attachment bonds, and self-regulation skills. Early childhood intervention programs have been found to make lasting effects on the functioning of individuals into adulthood. Children who have attended preschool programs are less likely to be incarcerated, drop out of school, and placed into special education programs. (Barnett, 2002) However, research on preschool intervention has focused mostly on cognitive and adult outcomes, rather than socio-emotional competence in childhood. This study seeks to learn if preschool programs targeting disadvantaged children, is related to outcomes of protective factors and behavioral concerns, as measured the the DECA-C, an assessment tool becoming widely used to study resilient functioning in children ages 2 to 5 years. The design of this study involves two full-day, demographically-similar preschool classrooms. In addition to comparing children's scores on the DECA instrument, teachers were audio-taped and observed for 20 hours to identify the quality of teacher-child relationships, a factor known to be very influential to child self-efficacy. It is hypothesized that children that participate in high-quality preschool intervention programs will show higher DECA scores measured over the course of one

year. This research has implications for teacher-training, curriculum design, and family programs that have a stronger emphasis on socio-emotional development in low-income early childhood classrooms. This research is also specifically interested in how early childhood intervention can promote resilience to future adverse life experiences for underprivileged children.

POSTER SESSION 2

MGH 241, Easel 161

2:00 PM to 3:30 PM

Research of Landslides Triggered by the 2011 Tohuku, Japan Earthquake

Lisa Dunham, Fifth Year, Civil Engineering
Mary Gates Scholar
Mentor: Joseph Wartman, Civil and Env. Engineering

More than 3000 landslides have been identified as occurring as a direct result of the March 11, 2011, Tohuko Earthquake, using Google Earth disaster satellite imagery (1 m resolution). Landslides were categorized into 5 types: disrupted, lateral spread, flow, rock fall, and block slides. These types were analyzed using ArcMap, a type of Geographical Information System (GIS) to map spatial patterns of landslides in relation to surficial geology, peak ground acceleration (PGA), distance to epicenter, and topography. The areal size versus frequency of the Japan landslides was also compared to distributions of landslides inventoried in previous studies. The Japan distribution was found to follow an inverse power law function; this is an extremely useful relationship because it allows us to "fill in" an incomplete inventory, and can have predictive value for landslides in areas that were not covered by the disaster imagery. In knowing how many landslides and where the susceptible areas are likely to occur, potential damage and injury can be avoided. Landslides can be dangerous and the disruption they cause in distribution of supplies especially aid after an event, this research can strengthen the ability for governments to plan for and find ways to diminish problems associated with such blockages. Further work can be done to determine how roadway systems and infrastructure can be safeguarded against failures to ensure life and property damage does not occur.

SESSION 2B

HOST AND PATHOGENS

Session Moderator: Geoffrey Gottlieb, School of Medicine

Mary Gates Hall 231

3:30 PM to 5:00 PM

* Note: Titles in order of presentation.

New Facets of the Type VI Secretion System

Justin De Leon, Senior, Microbiology
Howard Hughes Scholar, Mary Gates Scholar
Mentor: Joseph Mougous, Microbiology
Mentor: Alistair Russell, Basic Sciences, Fred Hutchinson Cancer Research Center
Mentor: Michele LeRoux, MCB/Microbiology

The type VI secretion system (T6SS) is a large protein complex utilized by bacteria to transport proteins into other cells. Initially implicated in virulence, the T6SS also participates in interbacterial interactions. A T6SS found in the opportunistic pathogen *Pseudomonas aeruginosa*, the hemolysin coregulated protein secretion island I T6SS (H1-T6SS), has been found to deliver a set of toxins to other bacteria. This provides P. aeruginosa a fitness advantage over competing bacteria. The H1-T6SS can target neighboring *P. aeruginosa*, which protects itself with cognate immunity proteins. Deleting these immunity proteins leaves *P. aeruginosa* susceptible to self-attack. However, the H1-T6SS as well as other T6SSs can target other bacteria, specifically they only target certain species. One of the goals of this project is determine the nature of such specificity. These findings would implicate new functions for the H1-T6SS. To further this, I am seeking to extend the scope in which the T6SS is viewed, both mechanistically and genetically. In doing so I am searching for new genetic loci that participate in T6SS-dependent interactions. Taken together, this work provides insights into a new aspect of type VI secretion and may change the genetic composition of T6SSs.

POSTER SESSION 3

Commons West, Easel 24

4:00 PM to 5:30 PM

p-type Doping of Zinc Oxide Diluted Magnetic Semiconductor Quantum Dots

Ryan Joel (Ryan) Mc Morris, Junior, Chemical Engineering
NASA Space Grant Scholar
Mentor: Xiaosong Li, Chemistry
Mentor: Joseph May, Department of Chemistry

Diluted magnetic semiconductor (DMS) technology combines the properties of a semiconductor with ferromagnetism. Nanoparticles doped with magnetic elements such as Manganese offer a prime example of this type of material. Our specific task was to analyze the effects of p-type doping with nitrogen in ZnO quantum dots (QD) of 2.4 nm in diameter. p-type doping in this material involves the replacement of an $O^{2}-$ ion with an $N^{2}-$ ion, which has one less electron resulting in a hole due to an empty $N^{2}-$ p-orbital. We hypothesize that when p-type doping is combined with paramagnetic $Mn^{2}+$ doping, the unpaired 3d electrons of two $Mn^{2}+$ ions separated by an $N^{2}-$ ion will adopt a ferromagnetic orientation as opposed to their traditional antiferromagnetic state.

Testing for this experiment was done with the development version of Gaussian. Energy calculations within this program and further data analysis reveal information such as the total energy of each state of the system, molecular orbital data, and energy diagrams concerning the semiconductor properties of these materials. Results show that the lowest energy state occurs when the Mn^2+ ions adopt a ferromagnetic arrangement with the N^2- hole sharing this alignment. The potential for this QD and others with similar properties is extreme as many semiconductor applications could be revolutionized by DMS's. New applications such as solar cells made of DMS's are also under consideration.

POSTER SESSION 3

MGH 241, Easel 174

4:00 PM to 5:30 PM

Investigating the Molecular Mechanisms of Type VI Effector–Immunity Complexes

Taylor Eliza Gardiner, Senior, Microbiology
Mentor: Joseph Mougous, Microbiology
Mentor: Seemay Chou, Microbiology

The secretion of signals or toxins is a vital aspect of bacterial communication with its environment. We recently found that type VI secretion systems (T6SSs) in Gram-negative bacteria mediate interbacterial interactions by translocating protein effectors into neighboring bacterial cells, providing a large fitness advantage. One protein exported by the T6SS is a type VI-exported (Tse) cell wall amidase that degrades peptidoglycan, and secretion of this effector, Tse1, results in target cell lysis. Bacteria can also self-intoxicate by T6S, potentially posing a problem for the survival of a given species. However, bacteria encode cognate immunity (Tsi) proteins that bind and inactivate their Tse partners. As we identify more T6 effectors, it is becoming clear that Tse–Tsi pairs are part of a widespread protein–protein recognition network underlying bacterial diversity and community structure. This study sheds light on how this network influences interbacterial interactions by uncovering the mechanism of Tsi1-dependent inhibition of Tse1 and defining the molecular determinants of this recognition. I have reconstituted the complex in vitro by using recombinant proteins to probe for direct interaction. Then, by mapping conserved residues onto the recently solved structure of Tse1, I have identified and mutationally analyzed candidate surface residues that may be involved in Tsi1 recognition. Further understanding the determinants of this interaction may allow us to predict which bacterial species are vulnerable to Tse1 or provide a template for the design of novel effector-immunity complexes that escape recognition in naturally occurring bacteria as an antibacterial strategy.