Undergraduate Research Symposium May 17, 2013 Mary Gates Hall

Online Proceedings

Session 1L

Quantifying the Effects of Humans on the Environment

Session Moderator: Bonnie Becker, Environmental Science (Tacoma)
271 MGH
1:15 PM to 2:45 PM
* Note: Titles in order of presentation.

Metallothionein as a Bio-Indicator of Metal Toxicity in South Puget Sound
Michelle M. (Michelle) Mc Cartha, Senior, Environmental Science, UW Tacoma
Katie Best, Non-Matriculated,
Mentor: Bonnie Becker
Mentor: Jim Gawel, Environmental Science, University of Washington Tacoma

Metallothionein (MT) is produced by benthic invertebrates in response to metal pollution, and as such provides a valuable tool for monitoring metal contamination impacts in Puget Sound. In this study, we explored the degree of correlation between MT in benthic invertebrates and metal contamination both in the field and in the lab. Seven stations were sampled, including five in Commencement Bay, an industrial harbor, and two control sites near the less impacted Nisqually delta. MT concentrations in collective samples of benthic worms were analyzed and compared with metal concentrations (Cd, Cu, Pb, and Zn) found in sediments to determine the benthic response to metal stress *in situ*. In addition, sediments were collected from all stations and used in a lab validation study exposing clean polychaete worms, *Alitta virens* (formerly *Nereis virens*), to metals in the sediments for 21 days in order to determine how the proteins develop in a controlled environment absent of normal adaptive responses. Both the collective sample of worms and *Alitta virens* were analyzed for MT concentrations using a published spectrophotometric method. Results indicated that average MT concentrations for *in situ* worms and metals concentrations Cu, Pb, and Zn at the Point Defiance station were higher than other stations. This is suggestive of a relationship between metals in the sediment and MT in the worms, although in some cases, the pattern is complicated by the bioavailability of metals as reflected with grain size. Quantifying MT allows for measurement of the bioavailability of metals, which can be difficult to quantify in other ways, such as directly sampling sediments. The use of MT in marine worms as a bioindicator of metal stress may be beneficial in monitoring the health of Puget Sound.

Session 1O

Health in Global Communities

Session Moderator: Stephen Gloyd, Global Health
288 MGH
1:15 PM to 2:45 PM
* Note: Titles in order of presentation.

Farmworker Morbidity and Mortality in Eastern Washington State
Spencer May, Senior, Biochemistry, Biophysics and Molecular Biology, Whitman College
Mentor: Jim Russo, BBMB, Whitman College
Mentor: Jennie McLaurin, Migrant Clinicians Network
Mentor: Adam Hoverman, Director, Clinical Skills I; Director of Global Health and Research, Pacific Northwest University of Health Sciences

Immigrant farmworkers have been an integral part of Eastern Washington communities for decades. Their health and well-being are essential for the health of our communities. But for many farmworkers, health care access is unavailable or limited by a lack of insurance, health providers, discrimination, and social marginalization, making it difficult to assess their health status and burden of disease. A lack of basic information about farmworker health complicates the decision-making of state and local officials, physicians, and other advocates dedicated to improving farmworker health. In partnership with the Migrant Clinicians Network and the Pacific Northwest University of Health Sciences, I used community-based research techniques to design a farmworker public health study which could provide the necessary data to inform policies to improve farmworker health. Our survey research was designed to assess the serious injuries, diseases and causes of death among farmworkers and their families.

Poster Session 2

Balcony, Easel 117
12:45 PM to 2:15 PM

Molecular Simulations of Single-Chain Organic Photovoltaic Polymers in Various Environments

Melissa C. (Melissa) Gile, Senior, Chemical Engineering, Mathematics
Mentor: Jim Pfaendtner, Chemical Engineering

The purpose of this study is to determine fundamental structure-solvent-property relationships in organic photovoltaic polymers (OPV's), with the overarching goal of increasing the efficiency of OPV's. A typical silicon-based photovoltaic plant outputs approximately 88,000 m2 of photovoltaic cells each year- about the size of 16 football fields. On the other hand, an organic photovoltaic printer will produce the same area in up to 10 hours. OPV's are incredibly fast, cheap, and easy to produce relative to their inorganic counterparts, but fall short within the realm of efficiency; the 10% efficiency of OPV's can hardly rival the ˜40% efficiency of inorganic photovoltaic technology. If the efficiency of OPV's can be increased, this will have a drastic impact on the competitive marketability of photovoltaic technology. This project aims at developing computational models to study the role of solvents in the self-assembly of polythiophenes during the printing process. These models are generated in GROMACS, a program that uses classical forces such as Coulombic or Van Der Waals forces, to predict how molecules will behave with time. This is problematic, however, for OPV's, as key interactions occur on the quantum level, and new classical force fields, which are computationally very efficient, need to be altered in order to accurately calculate these interactions. A force field is being developed and refined by comparing our computational results with experimental results from the Pozzo Research Group within the Department of Chemical Engineering. Once these results are reliably consistent with each other, we can begin running simulations and gathering data regarding how OPV's assemble in various environments. In particular, this poster explains a systematic methodology I have developed to use the GROMACS program to perform molecular dynamics (MD) simulations of single chain OPV's in various solvents as well as simulations of bulk OPV's in the melt state.

POSTER SESSION 2

Balcony, Easel 118

12:45 PM to 2:15 PM

Using Molecular Simulation to Improve the Efficiency of Biomass Processing

Zachary Ryan (Zack) Jarin, Senior, Chemical Engr: Nanosci & Molecular Engr
Mentor: Jim Pfaendtner, Chemical Engineering

Currently, the United States faces an impending energy crisis. To ensure energy security, conversion of biomass to small molecules for use in fuels or chemical processes must become more energy efficient. However, a major hurdle to raising productivity is the robust structure of biomass and subsequent resistance to breakdown. In the past ten years, experiments have shown "ionic liquids," a special group of solvents, dissolve biomass. Unfortunately, these experiments are not guided by molecular scale design principles hindering this promising research. This project focuses on providing the fundamental knowledge to guide and explain the phenomenon by using molecular dynamics (MD) to study the interaction of cellulose and other parts of biomass as a function of solvent environment. This new perspective requires simulated MD in combination with an enhanced sampling method. Enhanced sampling, in this case umbrella sampling, involves applying artificial forces on atoms to cause rare events that would not normally occur on the time scale of molecular scale simulations. Examples of rare events that are challenging to directly observe in MD simulation include chemical reactions, protein folding and unfolding and binding and unbinding of polymers. This work focuses on binding and unbinding events of biomass polymers. To cause the binding and unbinding events, umbrella sampling uses a force similar to a spring to hold a variable like dihedral angles and number of hydrogen bonds constant. Umbrella sampling is a versatile technique and is used on a wide variety of variables but this work uses it to vary the position of the dimer with respect to the cellulose surface. By varying position, the interaction energy is calculated. The interaction energy will give a deeper insight into the mechanism of dissolving biomass while providing a profounder understanding of the fairly new materials, ionic liquids.

SESSION 2R

EVOLVING SYSTEMS IN BIOLOGY: FROM MOLECULES TO MARSUPIALS

Session Moderator: Billie J. Swalla, Biology

022 JHN

3:45 PM to 5:15 PM

* Note: Titles in order of presentation.

Genetic Differentiation Among Color Morphs of the Brain Coral *Lobophyllia spp.* from the Indo-Pacific Ocean

Katrina Jane (Katrina) Herlambang, Senior, Aquatic & Fishery Sciences
Mary Gates Scholar
Mentor: Lorenz Hauser, School of Aquatic and Fishery Sciences
Mentor: Shannon O'Brien, Aquatic and Fishery Sciences
Mentor: Isadora Jimenez, Aquatic & Fishery Science

Corals are important marine animals that provide significant habitats for thousands of marine teleost and invertebrate species, natural barriers to protect coastal communities,

and sources of income for people in more than 100 countries around the world. Despite their vital importance, however, little is known about their taxonomy. Currently, they are classified based on their calcium-based skeleton morphology and coloration, which often causes problems because of high phenotypic variability within species. Thus, I used DNA sequencing in my research to identify species of the genus Lobophyllia from the Indo-Pacific Ocean. Specifically, I tested whether color morphs from different areas in Indonesia actually represent different species or mere color variations. For that purpose, I conducted PCR amplification of the mitochondrial DNA cytochrome oxidase gene and two nuclear genes in 42 colonies of 14 color morphs of Lobophyllia sp. The PCR products were sequenced in both directions at the High Throughput Sequencing Center of the University of Washington, and phylogenetic trees including known species were used to determine the species identities. I expected that color morphs would be genetically differentiated and therefore might represent different species. Regardless of the outcome, this project has helped to understand the biodiversity in coral reefs better, and is also useful to identify appropriate units for coral management and conservation.

POSTER SESSION 3

Balcony, Easel 119

2:30 PM to 4:00 PM

The Incidence of Neutropenia in Ceftaroline Users

Neilmegh Lakshman (Neil) Varada, Senior, Biology (Molecular, Cellular & Developmental)
Mentor: Jimmy Chua, Infectious Diseases, KGH
Mentor: Lani Lei, Zain Research LLC

Ceftaroline fosamil, otherwise known by the name ceftaroline (trade name Teflaro) is a cephalosporin antibiotic indicated for the use against MRSA skin and soft tissue infection and bacterial pneumonia. Though approved by the FDA, the drug is thought to be safe and thought to be well tolerated, however, our team has found it to cause neutropenia in patients. Neutropenia is defined as the abnormally low number of neutrophils, which seems to be present in some patients during and after taking ceftaroline. It is our objective in this study to determine the incidence of neutropenia among patients using ceftaroline. The drug has been approved for more than a year but the post marketing experience has been limited. We have seen two cases of agranulocytosis, which has led us to conduct this study. The study will be conducted in the Tri Cities, which is comprised of Kennewick, Pasco, and Richland. The Tri Cities has a diverse population of 193,000 individuals and there are three major medical facilities: the Kadlec Regional Medical Center, Lourdes Medical Center and the Kennewick General Hospital. The study will determine the incidence of neutropenia among patients receiving ceftaroline. We also hope to describe the side effects of the drug, and track patients' health over the course of a 7 month period by reviewing patients' charts and through phone interviews. All patients that are included in the study received ceftaroline from August 2011 to March 2012. The patients' data will be secured from hospital records from the three local hospitals. Our hope is to find a link between usage of ceftaroline and incidence in neutropenia in patients.

POSTER SESSION 3

Balcony, Easel 104

2:30 PM to 4:00 PM

Foliar Uptake of Toxic Metals and Stress Responses of Pine Seedlings from Biosolids-Treated Sites at Pack Forest, WA

Jennifer Lynn (Jen) Vittetoe, Senior, Environmental Science, UW Tacoma
Mentor: Erica Cline, Sciences and Mathematics, Interdisciplinary Arts & Sciences
Mentor: Jim Gawel, Environmental Science, University of Washington Tacoma
Mentor: Gregory Ettl, Forest Resources

Biosolids applications can increase heavy metals in soils, which may impact seedling survival in managed forests. Western white pine (*Pinus monticola*) seedlings, planted in a biosolids-treated site at Pack Forest in the lower foothills of the Washington Cascades, have experienced heavy mortality which has prevented reforestation of the site even after 30 years of replanting. The purpose of this study was to determine whether these seedlings are exhibiting metals stress. Soil and foliar metal content was measured using Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Phytochelatins and glutathione, compounds that are induced by metals stress and serve as bioindicators of metals stress, were measured in freshly emerged needles using high performance liquid chromatography (HPLC). Soil metals, at 16 ppm for cadmium, 293.5 ppm for copper, 585 ppm for zinc, and 509.5 ppm for lead, were substantially elevated at this site compared to comparable untreated sites, and furthermore, these were significantly higher than at other biosolids-treated sites. Foliar cadmium was 2.6 ppm, copper was 10 ppm, zinc was 177 ppm, and lead was undetectable; of these, all but lead was significantly elevated in seedlings growing in the biosolids-treated site compared to control seedlings. While phytochelatins and glutathione measurements are not yet complete, based on preliminary results it appears that seedlings are producing elevated levels of these compounds. The elevated foliar metals, in particular the highly toxic cadmium, suggest that these seedlings are experiencing metals stress. Further analysis of phytochelatins levels in seedlings in this biosolids-treated site may help to explain why these seedlings are experiencing such high mortality rates.

POSTER SESSION 4

Balcony, Easel 96

4:15 PM to 5:45 PM

Wave Energy to Electricity: Maximizing Load Change for Ocean Wave Energy Conversion

Curtis John (Curty) Rusch, Junior, Mechanical Engineering
Mentor: Jim Thomson, CEE/APL

Waves carry a significant amount of energy, but this energy has not been thoroughly explored for human use. There are a myriad of different ways to harness this energy. One very promising method is through the vertical oscillation of a buoy as waves pass beneath it. The Applied Physics Lab (APL) has teamed up with Oscilla Power to test an APL buoy design paired with an Oscilla power generator. This pairing has been tested over a matter of months on Lake Washington, just off of Sand Point. The buoy itself is anchored to the bottom of the lake by three anchors, and a weight consisting of two railroad wheels hangs in the water column beneath the buoy. The Oscilla Power energy-generating device attaches mid-line above the hanging weight. There are a number of data acquisition devices onboard measuring the motion of the buoy via accelerometers, the loading on the tether, and electrical output of the Oscilla Power device. The results of this test show a relation between wave height and power output via tether loading, verifying the buoy design. Optimal power output coincides with optimal wave heights and frequencies, and the results of this test and subsequent data analysis reveal these values. This information is crucial to the design of future moorings for wave energy conversion devices. This work may be scaled up to provide power to open ocean research buoys, extending the battery life of these devices. If these tests are promising, additional uses for this energy on a larger scale could be explored.