Poster Session 2

MGH 241, Easel 156

12:45 PM to 2:15 PM

Allometry of *Cornus sericea*

Gillian Elizabeth Kenagy, Senior, Environmental Studies
Mentor: James Lutz, Forest Resources

All plants contribute to the productivity and biomass of an ecosystem. With generalized formulas we have gained an understanding of these fundamental processes, however, to understand the precise contribution of a particular plant species more accurate and specific equations are required. Through the dissection and fine-scale measurements of individual plants, allometric equations relating detailed plant structure to easily measurable quantities (i.e., stem diameter) can be developed. Because of their relative small stature and relatively small contribution to total ecosystem biomass, little is known about the exact biomass and productivity of shrubs. Yet, diverse angiosperm shrubs in western forests can have a disproportionately large impact on the ecosystem in terms of providing a food source for wildlife and fuel for low-intensity fires. Field measurements and samples were collected from 41 individual plants of *Cornus sericea L. [Cornaceae]* (red osier dogwood) in Yosemite National Park, California, USA. In the lab I processed the field data and calculated a number of allometric equations, including cambial surface area, wood mass, bark mass, and foliage mass in relation to basal diameter and diameter at breast height. This dataset will generate a foundation for future research helping scientists more accurately determine carbon stocks, carbon sequestration rates, fuel loads, and other changing trends. The collection of more comprehensive and scientifically accurate data will also help improve land management policies in an era of projected climate change.

Poster Session 2

Commons East, Easel 50

12:45 PM to 2:15 PM

Sound-Driven Microfluidic Systems in Point-of-Care Diagnostics

Marie Ellen Eberlein, Senior, Bioengineering, Swedish
Mentor: Barry Lutz, Bioengineering

The control of infectious diseases in low-resource settings continues to be impacted by the limited availability of low-cost, easy to use diagnostics. However, even in developing nations, smart phones are common and can be used as "instruments" to control diagnostic devices. My senior capstone project aims to use a smart phone to input a sound wave into a microfluidic card and measure a sound wave coming out of the card to determine whether an analyte—the chemical that indicates whether a person is infected—is present in the sample. This is done by creating a network of fluid channels that can be modeled as an electrical circuit containing the fluidic equivalent of resistors, inductors, and capacitors (RLC circuit). When the sound wave is input to the system, it causes the fluid to oscillate and has a resonant frequency that is dependent on the characteristics of the system (the resistance, inductance, and capacitance). The goal is to cause a change in the fluid resistance, fluid inductance, or fluid capacitance through a chemical reaction (e.g. the creation of a bubble would change the capacitance or a change in viscosity would change the resistance). This change in a characteristic shifts the resonant frequency of the fluid circuit, allowing the presence of the analyte to be recognized. This project seeks to integrate a means of detection (like a microphone) into the diagnostic card to measure the analyte-dependent resonant frequency. This card would then be used as the platform for a measurement of blood clotting. Completion of this project would take the system one step closer to bringing simple and effective diagnostic platforms to developing nations.

Session 2D

Current Topics in Bioengineering

Session Moderator: Elain Fu, Bioengineering

231 MGH

3:45 PM to 5:15 PM

* Note: Titles in order of presentation.

The Smart Shunt: A Smarter Way to Drain Excess "Water in the Brain"

Pranav Venkataraman, Senior, Bioengineering
Howard Hughes Scholar, Mary Gates Scholar
Mentor: Barry Lutz, Bioengineering

Hydrocephalus is a pathology characterized by the accumulation of excess cerebrospinal fluid (CSF) within the brain, which can lead to dangerously high intracranial pressure (ICP) and brain tissue damage. Surgically implanting a cerebral shunt, which keeps ICP under control by mechanically draining the excess CSF, is the most common method of treating hydrocephalus, but these shunts are plagued with problems. Roughly half of all shunts fail within the first two years of implantation, with 98% failing within ten years. Through a collaboration with pediatric neurosurgeon Dr. Sam Browd of Seattle Children's Hospital, Dr. Barry Lutz's laboratory is developing the "smart shunt" – an electromechanical shunt which uses electronic feedback control of ICP and a simpler valve design to regulate CSF drainage. The goal of my research is to design a testing platform for the smart shunt, which will be used to simulate CSF and ICP dynamics caused by the respiratory and cardiac cycles, changes in patient posture, and other physiological phenomena that are typical of the daily lives of patients. Since the smart shunt must function on battery power for several years, it needs to be tested with a physiologically accurate simulation system in order to produce an optimal balance between ICP control and energy efficiency. To maximize simplicity and flexibility, the system will be computer controlled and operated through virtual representations of ICP and brain compliance modeled from patient data. The physical portion of the simulation system consists of regulators which stabilize pressure within fluidic reservoirs representing the brain and abdomen, speakers which produce physiological pressure oscillations within these reservoirs, and a pump which circulates mock CSF through the system. Apart from testing shunt performance, the ultimate objective of the testing system is enabling physicians to optimize the smart shunt to suit the unique brain physiology of each patient.

SESSION 2N

MCNAIR SESSION - IMPROVING LIVES VIA ENGINEERING, NEUROSCIENCE, EVOLUTIONARY BIOLOGY, AND PSYCHOLOGY

Session Moderator: Gene Kim, Education, Office of Minority Affairs & Diversity

287 MGH

3:45 PM to 5:15 PM

* Note: Titles in order of presentation.

Perception and Physiology: A Neurobiological Perspective on Cognition and its Potential Consequences

Tabatha Memmott, Senior, Organismal Biology, Public Health Education, Portland State University
McNair Scholar
Mentor: Barry Oken, Neurology and Behavioral Neuroscience, Oregon Health & Science University

Studying human perception from the perspective of a biologist or physician is a recent innovation, whose aims were previously appropriated by the domain of psychology. Yet in recent years, emphasis on perception has grown in fields like psychosomatic medicine, behavioral neuroscience, stress physiology, and complementary/alternative medicine. This new perspective on perception has prevailed with increased rates of psychosomatic disorders that have physiological and cognitive components (Post Traumatic Stress Disorder (PTSD), depression, etc.), and through recent technological advances made available to researchers (EEG, fMRI, etc.) Most specifically, technological innovations have enabled less invasive and more precise studies of neuroanatomy, which enables us to connect precise physiology with corresponding cognitive change. The manner in which a stimulus is perceived, and the resulting trauma, reward, danger or stress, then cognitively processed can have positive or negative physiological outcomes for individuals. However, researchers are just beginning to understand this mechanism and its implications.My research will study activation differences during visual working memory (VWM) tasks in stressed individuals. The ability to hold and process information in the VWM is related to general alertness, and I anticipate finding that stress will impair functionality of the VWM. This can be ascertained using electrophysiology (event-related potentials). These results would help establish the cycles or mechanisms that characterize these disorders and produce their cognitive-processing malfunctions. I hope to increase awareness of the genuine and detrimental progressions of these disorders, while also identifying treatments that effectively ameliorate both symptoms and identifiable lesions (chemical, physical, or otherwise). Understanding these pathways can assist in the recovery from disorders such as PTSD and depression, or potentially shorten a patient's stay in hospital, where serious infection rates and stress are high, and overall comfort, low.

POSTER SESSION 3

Balcony, Easel 101

2:30 PM to 4:00 PM

Effects of Low-Severity Fire on Structural Attributes and Radial Tree Growth in Abies Concolor-Dominated Forest, Yosemite National Park, CA

Jamie Maran (Jamie) Wilson, Senior, Environmental Studies
Mentor: Kendall Becker, School of Environmental and Forest Sciences
Mentor: James Lutz, Forest Resources

A century of fire suppression has led to higher tree densities, higher basal area, and increased abundance of shade-tolerant Abies concolor and Calocedrus decurrens in the lower montane forests of Yosemite National Park. Although fire was reintroduced to these systems over forty years ago, the effects of fire on forest structure and radial tree growth are still not well understood. This study compares live tree and snag basal area and density, seedling establishment, and radial growth patterns at four 0.1 ha plots in A. concolor-dominated stands of similar climatic water balance. Two sites had burned at different levels of low-severity fire in 2005, and two sites had not burned since the onset of fire suppression. On average, unburned plots had three times the tree density and 2.6 times more trees with DBH between 2.5 cm and 30.0 cm than burned plots. Burned plots had a mean seedling density 3.8 times greater than unburned plots. Low-severity fire also appeared to affect radial growth patterns as both burned plots showed decreased growth relative to the control plots for two years immediately post-fire. However, only burned plot 1, which burned at a higher severity than burned plot 2, showed increased growth relative to control plots 3 to 5 years post-fire. This study has implications pertaining to frequent fire forests of the West.