

*Fostering a Community of Student Scholars in the Arts, Sciences,  
Social Sciences, Technology, and Humanities*

**UNIVERSITY OF WASHINGTON'S**  
**Eighth Annual Undergraduate Research Symposium**  
*A Celebration of Undergraduates in Research*

13 May 2005

**MARY GATES HALL**

12:00 – 5:00 PM

**PROCEEDINGS**

*Sponsors: The UW Office of the President, Office of Research, Office of Undergraduate Education, the Mary Gates Endowment for Students, and the Undergraduate Research Program*

The Eighth Annual Undergraduate Research Symposium is organized by the Undergraduate Research Program (URP), which facilitates research experiences for undergraduates in all academic disciplines. URP staff assist students in planning for an undergraduate research experience, identifying faculty mentors, projects, and departmental resources, defining research goals, presenting and publishing research findings, obtaining academic credit, and seeking funding for their research. Students interested in becoming involved in research may contact the URP office in Mary Gates Hall Room 120 for an appointment or send an email to [urp@u.washington.edu](mailto:urp@u.washington.edu). URP maintains a listing of currently available research projects and other resources for students and faculty at: [www.washington.edu/research/urp](http://www.washington.edu/research/urp).

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*The Undergraduate Research Program is a program of the  
UW's Office of Undergraduate Education.*

## PROCEEDINGS

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**PLEASE NOTE**

Abstracts are listed alphabetically by the presenter's last name,  
unless otherwise noted.

## **ADDITIONAL OPPORTUNITIES FOR UNDERGRADUATE RESEARCHERS!**

### **Travel Awards for Undergraduates to Present Research**

These new awards help make it possible for undergraduates to extend their research experience by contributing to important discussions of current research at professional conferences. Students who have had a paper or poster accepted to a conference may apply for funding for travel expenses and registration fees. Applications are accepted on a continuing basis. For more information visit the Undergraduate Research Program website: [www.washington.edu/research/urp/urta.html](http://www.washington.edu/research/urp/urta.html).

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### **Mary Gates Research Scholarships**

Through participation in research, undergraduate students learn about the essential role of inquiry in a vital society. These competitive research scholarships are available to enhance the educational experiences of students across campus who are engaged in research with faculty. For more information visit the Mary Gates Endowment website: [http://www.washington.edu/oue/mge/becoming\\_research.shtml](http://www.washington.edu/oue/mge/becoming_research.shtml)

### **Library Research Award for Undergraduates**

The University Libraries, in cooperation with the Undergraduate Research Program, is sponsoring the "Library Research Award for Undergraduates" competition, recognizing University of Washington students who produce significant inquiry requiring use of information resources, the library, and its collections. Application deadline: May 16, 2005. For more information visit the Odegaard Undergraduate Library website: <http://www.lib.washington.edu/researchaward/>

*Competition awards are funded through the [Kenneth S. Allen Library Endowment](#).*

## STUDENTS HONOR THEIR MENTORS

*“My mentor, Dr. Bryan Jones, has impacted my educational experience in many ways that go beyond the research project he has spent countless hours helping me with. As a veteran scholar, his guidance has proved invaluable as I struggled with my own project at all stages, from research design to data collection to interpretation. “Struggling,” he would tell me, “is how you know you’re on the right track.” These words of wisdom, as well as many others, have taught me the importance of an open, curious mind not just in academic research but also for life.”*

*- Ashley Watson, Senior, Political Science  
Mentor: Bryan Jones, Political Science*

*“Dr. Horacio de la Iglesia has been a supportive and inspirational mentor since the day I stepped into his lab. He not only teaches me how to conduct the experiments independently, but helps me develop the skills to troubleshoot problems on my own. He is always on hand when I need help and is a tremendous support of my academic and career goals.”*

*- Jennifer Lee, Junior, Neurobiology, International Studies  
Mentor: Horacio de la Iglesia, Biology*

*“It has been an extraordinary learning experience for me to be working in such close contact with an experienced researcher, both practically and personally. The kind of personal attention that I receive as a student researcher is something that is not duplicated in a classroom setting.”*

*- Sophia (Jihae) Kim, Junior, Biology  
Mentor: Wendy Raskind, Medicine, Medical Genetics  
Mentor: Patrick Navas, Medicine, Medical Genetics*

# POSTER SESSIONS

## **PLEASE NOTE**

Abstracts are listed alphabetically by the presenter's last name.

## **Effect of Subarachnoid Hemorrhage on Cerebral Arteriolar Responses to Somatosensory Stimulation and Hypercarbia in the Rat**

*Taylor Abel, Senior, Neurobiology*

*Mary Gates Scholar*

*Mentor: Gavin W. Britz, Neurological Surgery*

*Mentor: Joe Meno, Neurological Surgery*

Cerebral vasospasm and the resultant ischemia remains a significant cause of morbidity and mortality following subarachnoid hemorrhage (SAH). Stroke is the third leading cause of death in the United States and as many as 15% of all strokes occur secondary to aneurismal rupture. Most previous research efforts have focused on vasospasm in larger cerebral arteries following SAH. However, it is the small diameter arterioles that play a critical role in regulating cerebral blood flow. Therefore, understanding the onset of vasospasm following SAH in cerebral arterioles is of critical importance to developing future therapies. The purpose of this study is to directly test the hypothesis that SAH results in time-dependent alterations in functional reactivity of cerebral arterioles in the rat. To accomplish this, we utilized an established model of SAH, the endovascular filament model, and studied functional arteriolar reactivity at varying time points using an *in vivo* method of CBF measurement, the closed cranial window technique. Using the cranial window model to visualize the cerebral circulation, we evaluated pial arteriolar reactivity to somatosensory stimulation (contralateral sciatic nerve stimulation [SNS]) and to CO<sub>2</sub> inhalation at 24, 48, 72, and 96 hours post-SAH. SAH<sup>2</sup> resulted in attenuated vascular reactivity to both SNS and hypercarbia beginning at 24 hours and being most noticeable at 48 hours. We observed a modest trend toward recovery beginning at 72 hours. However, arteriolar reactivity remained below Sham values. These results indicate that alterations in functional arteriolar reactivity do occur in a rodent model of SAH. Furthermore, the time-course of these alterations occurs sooner than is observed in humans.

## **Ionic Wind Lifter**

*Colin Adams, Senior, Aeronautics and Astronautics*

*Mentor: Dana Dabiri, Aeronautics and Astronautics*

The Ionic Wind Lifter project investigates an ionization effect that is capable of accelerating a stream of air through the use of a large voltage potential between two separated electrodes. The implications of being able to accelerate air without moving parts include propulsion for small, unpowered aircraft, enhanced maneuverability for lighter-than-air vehicles, and efficient cooling of electronics. The subject of the Ionic Wind Lifter research are small test bed vehicles consisting of a collector, emitter, and supporting structure, which are capable of accelerating air and generating thrust when high voltage is applied between the collector and the emitter. My research focuses on optimization of the thrust and efficiency of ionic wind lifters with

respect to lifter geometry, component design, and power supply. Recent research has focused on quantifying performance of stacked lifters, multiple layers of collectors and emitters, and different electrical polarities. The most optimized designs constructed so far have been capable of generating thrusts as high as 0.23 Newtons. With clear trends established in most geometric properties of the lifters, current and future research is focused on the electrical paths, power supply design, and investigating methods to increase the amount of ionized molecules generated. Analysis of ionization is mainly based on experimental photographs of the ionization corona. Simulation is also under consideration to improve understanding of the acceleration of the ionized air molecules. The Ionic Wind Lifter Project provides important insight to the future capabilities of ionic flow control and thrust generation.

## **Activity of Cohesin During Cell Division in *Tetrahymena thermophila***

*Amanda Anderson-Green, Senior, Biology, Seattle University*

*Mentor: Michelle Dubois, Biological Sciences, Seattle University*

*Mentor: Marcella Cervantes, Fred Hutchinson Cancer Research Center*

Cohesin is a protein involved in ensuring accurate chromosome replication and distribution in eukaryotes. Its total structure is that of a ring comprised of four subunits, which physically hold sister chromatids together prior to their separation in anaphase. The most highly conserved domains of cohesin lie within the two structural maintenance of chromosomes (SMC) protein subunits, SMC1 and SMC3. It is unknown exactly when cohesin associates with DNA, or during which states of division its subunits are present. Specifically in the model organism *Tetrahymena thermophila*, it is unknown whether cohesin is active in its germline nucleus only or if it is utilized in the somatic nucleus as well. We have constructed a plasmid with an HA-tagged copy of SMC1 with overlapping PCR, and now are in the process of transforming wild type tetrahymena via gold particle bombardment. Both vegetative and conjugating transformants will be studied by observing protein activity *in vivo* with immunofluorescence microscopy. The goal of this study is to localize and characterize the protein, as well as gaining a greater insight into the overall mechanism for sister chromatid cohesion. Also, utilization of germline transformants may aid in observing when the initiation of cohesin synthesis takes place, as the germline nucleus is transcriptionally silent until the latter part of conjugation. Based on previous studies it is expected to see cohesin associated with DNA during metaphase at the centromeres, and possibly along the arms of the chromatids. It is probable that cohesin will be involved whenever reliable copying and dividing of chromatids occurs – pointing to the possibility of observing cohesin in both nuclei of *T. thermophila*.

### **Quality of Life in Seattle: An indicator for a sustainable future**

*Sean Anderson, Junior, Community and Environmental Planning*

*Melanie Lyons, Senior, Community and Environmental Planning*

*Ashley Harris, Junior, Community and Environmental Planning*

*Christina Lock, Junior, Community and Environmental Planning*

*Kirsten Dahl, Junior, Community and Environmental Planning*

*Tingting He, Junior, Community and Environmental Planning*

*Mentor: Chris Campbell, Urban Design and Planning*

For the Quality of Life project, a group of students from the Community, Environment, and Planning (CEP) program collaborated with Sustainable Seattle to create a survey measuring levels of sustainability in four Seattle neighborhoods. The survey focuses on four elements of sustainability: environmental practices, economic behavior, community strength, and neighborhood facilities. This information, combined with physical data and an upcoming indicator report, will give a better idea of what projects should be considered for the further development of these individual neighborhoods. We hope to use this data to focus community and city efforts on the improvement of neighborhoods and also to potentially develop a strategy for increasing sustainable neighborhood development.

### **Using Earthquake Doublets to Investigate Inner Core Rotation**

*Jennifer Bach, Senior, Earth and Space Sciences*

*Mentor: Ken Creager, Earth and Space Sciences*

*Mentor: Sara DeRosier, Earth and Space Sciences*

Rotation of the Earth's inner core was first observed by Song and Richards in 1996 using differences between seismic wave arrival times. The goal of this project is to see this differential inner core rotation through the examination of earthquake doublets, using a dataset different from the most recent studies. An earthquake doublet is a pair of earthquakes that are nearly the same in location but are separated in time by years to tens of years. Because the two earthquakes are in close proximity, both seismograms in the doublet display very similar waveforms, with possible slight variations in amplitude. I will look for doublets among data from the Incorporated Research Institutions for Seismology (IRIS), first by sorting the catalog data by location (both geographic position and depth), and then by examining and cross-correlating the respective seismograms. The cross-correlation algorithm calculates the similarity of two waveforms with respect to time. Pairs with a high cross-correlation coefficient will yield acceptable doublets. The PKIKP waveform phase is of special interest, as

this is the phase that penetrates the inner core. Research shows subtle differences in arrival times of the PKIKP phase between the doublet pair. For phases that do not enter the inner core, such differences are not observed. A change in travel time of only the PKIKP phase over a number of years suggests a change in the inner core. Studies have also shown that this change increases systematically with time, providing evidence for differential inner core rotation. I predict, therefore, that the difference between the arrival times of the PKIKP phase for the doublets I find will increase with the time separation between the pair. These findings may have important implications for other Earth properties, such as the Earth's dynamo and geomagnetic field.

### **Representation and Agenda Setting Continued**

*David Baker, Senior, Political Science, Economics*

*Mentor: Bryan D. Jones, Political Science*

Recent research has pointed to an impressive congruence between the concerns of the public and the government's agenda. Baumgartner and Jones have previously shown that congressional attention to economic issues and the concerns of the public have a very high congruence, higher than any other policy area. This research is an attempt to expand on that previous work by examining additional indicators of government attention and economic change to determine if this congruence is maintained across a wider array of indicators. To determine if this congruence is maintained I will check to see if the trends in these additional indicators correspond across time. The manner in which these indicators correspond or do not will help to develop a better understanding of the relationship between the government's agenda, the concerns of the public and changes in the economy. More specifically, I hope to determine whether or not changes in the economy can have an affect on the congressional agenda, independent of the priorities of the public, and to confirm that the public's priorities correspond to legislative attention. The results of this research may prove important for the further study of traditional representation that requires a correspondence between the priorities of the public and the government in order to occur.

### **High-Energy Electrons in the Magnetosphere**

*Brandon Ballinger, Junior, Computer Science, Physics*

*Mary Gates Scholar*

*Mentor: Robert Holzworth, Earth and Space Sciences*

In 1996, x-ray instruments on a stratospheric balloon found signs of precipitating electrons at energies far higher than expected—1.7 million electron volts. Since previous balloon-borne instruments had only detected lower energies, such high-energy x-rays had never been detected in 40 years of balloon research. What mechanisms could be at work to produce such high-energy precipitating electrons? Electrons come from the solar wind and terrestrial atmosphere, and are accelerated in the earth's magnetic field. Often, they

precipitate into the atmosphere, emitting bremsstrahlung radiation—radiation released upon rapid braking—upon impact in the form of x-rays. The x-rays observed by the 1996 balloon were emitted by these braking electrons, but with energies higher than previously seen. Moreover, precipitation was not uniform in time; electrons tended to precipitate in temporally localized torrents. Several theoretical mechanisms have been proposed for this high-energy, torrential precipitation, but there is presently not enough data to clearly discriminate among them. Our experiment seeks to remedy this lack of good data by launching stratospheric balloons to measure x-rays, electric fields, and magnetic fields in the atmosphere below the electron precipitation events. My part of the project was to help assemble and test the balloon instrumentation, including the circuit boards for processing electric and magnetic fields, as well as a motor for rotating the payload. Four stratospheric balloons were launched from Antarctica in January 2005. They were able to successfully collect x-ray and electromagnetic field data, seeing significant atmospheric activity—one balloon even recorded the largest high-energy solar proton event since 1989. At this time, the newly gathered data is being examined, and we hope that a full analysis will help to decipher the mechanism of high-energy electron precipitation.

#### **Union Democracy Reexamined Project**

*Nowell Bamberger, Senior, Political Science*

*Mentor: Margaret Levi, Political Science*

*Mentor: David Olson, Political Science*

The Union Democracy Reexamined Project is an ongoing study by a working group of the Harry Bridges Center for Labor Studies. Cognizant of previously identified standards of democracy, the project seeks to explore alternative incarnations. Must a democratic organization feature rotating leadership? Are contested elections the only mechanism for understanding rank-and-file participation? How does a movement sustain and develop rank-and-file ownership and participation over time? These are some of the questions being addressed by the group. In previous years members of the group have explored the history of the International Longshore and Warehouse Union (ILWU) as a case study for understanding alternative forms of union democracy. Exploring participation by union members in International conventions and caucuses, the group found a generally high level of member interest in the organizational political culture, despite relatively few changes in leadership. Last year, members of the group took a more focused approach exploring how the union made decisions about specific issues. Last year's analysis has given way to an examination of the experience of union members and their subsequent level of organizational participation during the days of worker screening and blacklisting in the 1950's. Comparative analysis of decision-making in various local union organizations has led to a greater under-

standing of organizational diversity. New statistical analysis of actual member participation has yielded a baseline against which the group can measure variation in participation under different organizational and external political environments. The group has found that, while the ILWU does not present many of the attributes necessary to democracy advocated by earlier studies, other aspects of organizational culture and institutions have contributed to the development of a grassroots-oriented democratic organization. These findings and the accompanying research have been used by the union for member education and development as well as for scholarly purposes.

#### **The UW Image Coder**

*Dane Barney, Senior, Computer Science*

*Mary Gates Scholar*

*Mentor: Richard Ladner, Computer Science and Engineering*

JPEG-2000, the successor to the popular JPEG image format is now emerging as an attractive candidate for the future de facto image compression standard. However, while JPEG-2000 offers superior results over most other modern image coders, it comes with a long list of optional parameters and features, and consequently an overly complex and confusing infrastructure. The purpose of the UW Image Coder (UWIC) Project is to provide an image coder that can compete at the level of performance of JPEG-2000, yet offer a much simpler design and more understandable framework. Our original intention with UWIC was for teaching in an undergraduate data compression course, as a means to introduce students to many of the advanced compression techniques employed by JPEG-2000 and other modern image coders, while avoiding the intricacies of the JPEG-2000 standard itself. Our goal now, however, is to push UWIC to an optimal level of compression performance by fine-tuning each of its settings through a series of experimental studies, without actually adding more features or complications to our initial algorithm. UWIC follows the general three-stage schematic, which has become fairly standardized across all modern image coders. That is, (1) a linear transform, followed by (2) quantization, and finally (3) entropy coding. Yet what makes UWIC unique are the specific methods employed at each stage. It uses a wavelet transform as its linear transform, bit-plane coding as a means of quantization, and arithmetic coding as its entropy coder. With this framework, UWIC achieves lossy compression of grayscale images that can match, and occasionally even outperform, JPEG-2000. Our hope is that through further optimizations, UWIC can reach a level in which it consistently outperforms JPEG-2000 in all situations.

#### **The Effect of Phosphate on Force Generation in Skeletal and Cardiac Muscle: Studying the Molecular Mechanisms of Fatigue**

*Kristina Bezold, Senior, Bioengineering*

Mary Gates Scholar

Mentor: Michael Regnier, Bioengineering

The purpose of this study is to determine how increasing inorganic Phosphate (Pi) levels, experienced with high intensity and chronic exercise, affects mechanical performance of skeletal and cardiac muscle. High cellular levels of Pi are implicated as a possible mechanism of fatigue. With increases in Pi the maximum  $Ca^{2+}$  activated force ( $F_{max}$ ) produced in muscle decreases. Previous studies have focused on a particular muscle fiber type, thus little is known about the Pi sensitivity of  $F_{max}$  across muscle types. To study this, we have measured  $F_{max}$  in demembrated muscle cells exposed to varying [Pi] from 0.5-75mM under maximal  $Ca^{2+}$  activation conditions (pCa 4.0, 15°C). Under physiological conditions, Pi levels normally range from 3-8mM, but can increase dramatically during exercise. Rat fast-type myosin isoform fibers were inhibited, on average, to 0.5  $F_{max}$  ( $K_i$ ) at 23.7mMPi, and inhibition was not saturated at 75 mM Pi.  $K_i$  for rat slow-type myosin isoform fibers was 13.2 mM Pi and saturated above 30mM Pi. This demonstrates that slow-type muscles are affected to a greater extent by the [Pi] than are fast-type muscles. Rat cardiac muscle (Trabeculae) also exhibits loss of force with increasing [Pi]. I am presently examining the Pi dependence of rat heart muscle  $F_{max}$ , and how this varies with temperature ranging from 10°C to 35°C. At 15°C  $K_i$  (54.1mMPi) is greater than for skeletal muscle types, suggesting the heart is less prone to fatigue from increased ATP hydrolysis and product accumulation with increased heart rate. Preliminary data shows that with increasing temperature,  $K_i$  also increases, but plateaus above ~20°C, suggesting that measurements made at 20°C might represent the physiological response at 35°C. This work will identify fundamental differences between cardiac and skeletal muscle chemo-mechanical properties and is being used to develop a comprehensive computational model of striated muscle contraction and fatigue.

### Infants' Threshold for High Frequency in Tone in Noise

Niru Bhandari, Senior, Speech and Hearing Sciences

Mentor: Lynne Werner, Speech and Hearing Sciences

When infants are born, they come prepared to hear the sounds in their environment. However, their hearing abilities are limited compared to what an adult can hear. Hearing in infants doesn't mature completely until school age; however, infants are capable of detecting sounds with higher thresholds than adults. Numerous factors are believed to contribute to the difference in threshold, including inattentiveness, memory, motivation, selective listening, and immaturity of sensory processes. Infants' sensitivity to lower frequency sounds has been studied, but less is known about their sensitivity to higher frequency sounds. It is predicted that the threshold for a high-frequency sound in a noise background will be about 10dB higher in infants. In this

study, infants were tested in a tone-in-noise condition. A 4000Hz tone was presented with a broadband noise in the background. The duration of the tone is 300 ms; the noise is presented continuously. The test method used is the Observer-based method. In this method the observer observes the responses given by the infant through a one-way window in the test booth. The observer initiates a trial, which could at random be a tone or a no-tone trial, when the baby is ready. The infant gives numerous behavioral responses if a tone is heard and it is the observers' job to figure out whether the response was to the tone. A few responses are head turns, eyebrow raising, excited face, and widening eyes. If the observer can figure out when a tone was presented, the infant is rewarded for responding by the activation of a mechanical toy. This approach has been proven to be successful in many studies. Ten adults were tested in this condition and the average threshold measured was 45dB. Results on a few infants indicate that their thresholds are elevated by about the predicted amount.

### Response of Juvenile Rainbow Trout to Pesticides in Surface Waters Within Urban Streams in Western Washington

Sara Bogard, Senior, Biology

Jacqueline S. Bricker, Post-Baccalaureate, Wildlife Science

Erin Lowery, Senior, School of Aquatic and Fishery Sciences

Cara Menard, Junior, School of Aquatic and Fishery Sciences

Christie Shavey, Senior, School of Aquatic and Fishery Sciences

Mentor: Christian Grue, School of Aquatic and Fishery Sciences

Recent efforts to document pesticide concentrations within surface waters have generated a significant amount of information. Unfortunately, these reports uniformly suffer from a lack of adequate biological interpretation. Although levels reported are low (most <1.0 ppb), the presence of these chemicals has generated concerns, particularly their potential effects on salmonids. We exposed juvenile (ca. 10 g) rainbow trout (*Oncorhynchus mykiss*) to a chemical cocktail representative of urban streams in western Washington. Nominal concentrations (ppb active ingredient) of 9 herbicides, 3 insecticides, an insecticide breakdown product, and a fungicide were the maximum reported during peak storm flow events (hereafter 1X). With the exception of the fungicide and the breakdown product, formulated products (single ai) were used and if possible were selected from those available at retail outlets. Two experiments were conducted. In the first, 20 trout were individually exposed to the 1 X cocktail or clean dechlorinated water for 96-h under static conditions at 12 C. In the second, 10 trout were individually exposed to a 1X, 3.3X or 10X cocktail or clean dechlorinated water under the same conditions. Behavior and water quality were assessed at 6, 24, 48, 72 and 96 h. Survivors were euthanized and frozen (-40C) for

subsequent brain acetylcholinesterase assays. All fish survived, except for 1 fish exposed to the 10X cocktail. Fish exposed to the chemical cocktails were more lethargic than controls, particularly those exposed to the 10X cocktail. Brain AChE activity was not inhibited in fish exposed to the 1X cocktail in either experiment, but was in the 3.3X (23%) and 10X (84%) cocktails. Concentrations tested are >2 orders of magnitude greater than mean (geometric) concentrations of the pesticides reported during storm events.

Bogard SM<sup>1</sup>, Bricker JS<sup>1</sup>, Lowery ED<sup>1</sup>, Menard CE<sup>1</sup>, Shavey CA<sup>1</sup>, Curran CA<sup>2</sup>, Grassley JM<sup>2</sup>, Grue CE<sup>2</sup>, <sup>1</sup>University of Washington, FISH 455/ESC457, WTR 2005, School of Aquatic and Fishery Sciences, Seattle, WA, <sup>2</sup>University of Washington, Washington Cooperative Fish and Wildlife Research Unit, School of Aquatic and Fishery Sciences, Seattle, WA

### **Molecular Characterization of Invasive and Non-invasive Nontypeable GBS isolates for Capsule Production**

*Kelley Boyd, Senior, Microbiology  
Mary Gates Scholar*

*Mentor: Craig Rubens, Infectious Disease*

*Streptococcus agalactiae* (or Group B *Streptococcus*, GBS) is a common cause of morbidity and mortality in neonates and is an emerging pathogen in the elderly. Capsular polysaccharide (CPS) is thought to be required for the virulence of GBS and the varieties of CPS distinguish each serotype. In a previous study, 291 GBS isolates from symptomatic and asymptomatic carriers were assayed for GBS serotypes (Borchardt et al. *J. Clin. Microbiol.* **42**:142-150). Of these isolates, 3-5% do not type, by conventional Lancefield serotyping or by molecular genotyping, to the known nine serotypes. From this study, we have received 18 nontypeable isolates; seven of these were from invasive infections. The aim of the study is to examine CPS production for each nontypeable isolate by phenotypic and genotypic analysis. Experiments examining  $\beta$ -hemolysis, CAMP factor production, and GBS group antigen confirmed that all of our isolates are GBS. Buoyant density analysis indicated that 22% (4/18) of the isolates were unencapsulated; two of these strains are invasive. Southern blots of Hpa II digested chromosomal DNA were hybridized to probes from regions of the CPS operon that are conserved between the known serotypes. These data show that there are five groups with similar banding patterns between the eighteen nontypeables (five isolates have unique patterns). Three hybridizing DNA fragments from nontypeable #5 were purified and cloned for DNA sequencing. Preliminary results demonstrated a novel sequence for the sialyltransferase gene, which is required for synthesis of CPS. The results above suggest that the majority of these strains represent novel serotypes. Further characterization of these isolates will facilitate surveillance for emerging serotypes and may provide guidance for the formulation of future vaccines.

### **Teacher Retention and Mobility in Washington State**

*Kristen Brady, Senior, Comparative History of Ideas  
Zesbaugh Scholar*

*Mentor: Marge Plecki, College of Education: Leadership and Policy Studies*

Teacher retention and mobility in Washington's teaching force is examined at district and school levels as a means for exploring issues of equity and student achievement in a sample of 20 districts over a recent five year period. Analyses include an in-depth look at the distribution of classroom teachers, student demographics, measures of student learning, and other school and district characteristics, revealing how the teaching force is distributed across schools serving students within widely varying educational contexts. This study adds to the existing knowledge about factors associated with teacher retention and mobility and provides a baseline of information from which to examine other questions related to the equity of distribution of teacher quality across a variety of schools and districts.

### **Analysis of Phosphorylated Protein Expression in Human Herpes Virus 8 (HHV8)**

*Camille Bretz, Senior, Chemistry, Seattle University  
Mentor: Kristen Skogerbo, Chemistry, Seattle University*

Tyrosine kinase is among a number of genes encoded by herpes viruses that influence cellular kinases. Protein kinases phosphorylate the tyrosine residues of proteins and play a prominent role in growth regulation. Cellular infection with herpes viruses is associated with a ten to twenty fold increase in phosphorylated tyrosine residues. This study looked at all proteins that had been phosphorylated with tyrosine residue in two cells lines utilizing Immunoprecipitation (IP) and electrophoresis methods. The purpose of this study is to find a protein that is responsible for the proliferation of HHV8. Protein expression between infected and uninfected Green monkey kidney (Vero) cells and human fibroblasts (HFs) was evaluated by IP with an antiphosphotyrosine antibody where proteins were further separated using gel electrophoresis, which revealed distinctly different banding-patterns. Infected cells showed protein bands that were not detected in uninfected cells. These bands were then removed and analyzed by mass spectrometry. Several proteins were identified in these bands however; I focused on the proteins from just the HF cells. The proteins recovered from the differing banding patterns included cathepsin D, protein AAH17165 and protein bA255A11.8. Protein AAH17165 is responsible for protein coding, protein bA255A11.8 is unknown and cathepsin D has been implicated in the progression of some cancers. I am currently looking into the role of cathepsin D in the proliferation of HHV8.

### **Open Agent: Designing an RSS News Interface Agent with a focus on User Autonomy**

*Zion Brewer, Senior, Informatics, Political Science*  
*Stephanie Collett, Senior, Informatics*  
*Mary Gates Scholar*  
*Avram Eisner, Senior, Informatics*  
*Mentor: David McDonald, The Information School*

RSS (Real Simple Syndication), a standard for delivering content over the Internet, has been popularized recently by online news and blog publishers as a way to notify readers of new articles on their web site. This new technology enables users to subscribe to several different publishers and monitor all of the news from a central application. While this provides a convenient way for the user to consolidate and organize their news, it can also lead to an overabundance of information. Our research group's goal is to develop an interface agent, a software system with semi-intelligent capabilities, which will assist the user with the management of RSS news content. Over time, by observing and profiling a user's news browsing behavior, the interface agent will display news articles of greater potential interest to the user. The delegation of responsibility to an agent has the potential for compromising a user's control; as such we are designing with a focus on values such as user autonomy. We are employing several user-centered design methodologies to inform our decisions during development. We are currently integrating the agent into RSSowl, an existing open-source RSS client application.

### **The Search for a Universal Effective Medium Theory Based on Integral Geometry**

*Nathaniel Brown, Senior, Physics, Computer Engineering*  
*Mary Gates Scholar*  
*Lucas Wharton, Senior, Physics*  
*Mentor: Gerald Seidler, Physics*

Determining a method for calculating the physical properties of disordered materials has been a long-standing problem in physics. One approach is to use effective medium theory, this presents the problem of determining what the important microscopic characteristics of a material are that strongly affect the macroscopic properties such as conductance or elasticity. The research we have been working is to determine if scalar Minkowski functionals from combinatorial integral geometry are useful for parameterizing macroscopic properties of disordered materials. In particular we have been investigating the relationship between Minkowski functionals and electrical or thermal conductance in 2 dimensions. We began by generating structures of Boolean modeled materials by randomly placing disks or randomly oriented polygons of arbitrary size on a plane. We then calculated the Minkowski functionals for these structures and selected a sample set with varying boundary length and sample genus at a fixed density. The conductance can then be calculated for each structure using finite element software and the correlation to Minkowski functionals shown.

### **RGC Cell Death or Axon Transport Defect in a Mouse Model of Glaucoma**

*Brian Buckingham, Senior, Neurobiology, Psychology*  
*Mary Gates Scholar*  
*Mentor: Philip Horner, Neurological Surgery*

Glaucoma is a group of devastating eye diseases that are characterized by progressive and permanent loss of vision. A prevailing hypothesis is that raised intraocular pressure leads to retinal ganglion cell (RGC) death. One study injected retrograde tracers into the superior colliculus of the DBA/2J mouse, a strain that spontaneously develops glaucomatous symptoms, and showed that labeled RGCs decreased from ~5,000 cells/mm<sup>2</sup> at 3 months of age to ~1,000 cells/mm<sup>2</sup> at 18 months (IOVS 2003; 44:5151-5162). Our study aims to explore the possibility that retrograde labeling may not accurately document the functional state or time of death of the RGC soma. We examined RGC location and number in DBA/2J mouse retina using the neuron-specific DNA binding protein present in mature neurons, NeuN (Neuronal Nuclei). Retinal whole mounts from 8 time points (2 to 18 months) were labeled with anti-NeuN antibody. The ganglion cell layers of these retinas were then analyzed using unbiased stereology. Mean cellular density across all retinas was 4,094 + 347 cells/mm<sup>2</sup>; there was no significant difference in density between young and old DBA/2J. RGC death following glaucomatous symptoms is based primarily on the observation of decreased retrograde transport of tracers injected into RGC projection areas of the brain or the observation of a thinning ganglion cell layer. Our data suggest that RGCs in glaucomatous retina may be dying much later than expected or possibly not at all. The presence of axonal transport deficits might explain discrepancies in RGC numbers obtained via retrograde labeling as opposed to immunohistochemical markers of RGCs. The quantification of NeuN-labeled ganglion cells is now being compared to other RGC markers and a functional assessment of retrograde transport and axonal pathology is ongoing.

### **Risk factor associated with term and preterm LBW in Thai Nguyen, Vietnam.**

*Kelly Bui, Senior, Psychology*  
*Mary Gates Scholar*  
*Lisa Nguyen, Senior, Neurobiology*  
*Mary Gates Scholar*  
*Mentor: Michelle Williams, Epidemiology*  
*Mentor: Tu Phung, Epidemiology*

Objective: Low birth weight (LBW) (<2500 grams) is a significant problem in both developed and developing nations. Using data from a recently completed study, the authors performed the present secondary analysis to identify and compare the risk factors associated with term and preterm LBW. The original LBW case group was stratified into term and preterm deliveries. Methods: The control for this study was term, normal weight births (=2500 gram), derived from the original control group. Logistic regres-

sion was used to estimate odds ratios (OR) and 95% confidence intervals (CI). Results: Risk factors associated with term LBW included: advanced maternal age (OR: 3.2, CI: 1.6, 6.3), unmarried (OR: 5.0, CI: 1.8-13.7), rural residence (OR: 4.1, 95% CI: 2.1, 8.0), farming occupation (OR: 1.8, CI: 1.0, 3.5), shorter stature (OR: 2.7, CI: 1.5, 4.9), have an unemployed partner (OR: 4.4, CI: 1.7, 11.6), lower rate of weight gain (OR: 4.2, 95% CI: 2.3, 7.6), exposure to environmental tobacco smoke (ETS) (OR: 1.9, CI: 1.1, 3.4) and placenta abnormality (OR: 13.9, 95% CI: 3.1, 61.9). Risk factors associated with preterm LBW were: less than 3 antenatal visits (OR: 2.9, 95% CI: 1.6, 5.3), lower (OR: 10.6, CI: 4.9, 23) or higher (OR: 4.5, CI: 2.10) rate of weight gain, an unemployed partner (OR: 2.9, CI: 1.2, 7.0), history of LBW (OR: 2.8, CI: 1.7, 8.7), history of spontaneous abortion or preterm delivery (OR: 2.6, CI: 1.4, 4.7), psychosocial stress (OR: 2.7, CI: 1.5, 4.8), exposure to ETS (OR: 2.2, CI: 1.4, 3.6), vaginal hemorrhage (OR: 7.5, CI: 3.6, 15.7), placental abnormality (OR: 7.7, CI: 1.9, 31.1), gestational hypertension (OR: 2.5, CI: 1.2, 5.2), and anemia (OR: 1.6, CI: 1.0, 2.5). Conclusion: A comparison of the risk factors suggests potential benefits for distinguishing between term and preterm LBW deliveries in some populations.

### **Regulation of the *ydhIJK* operon in *Salmonella enterica* serotype Typhimurium**

*Tara Bumgarner, Senior, Microbiology, Anthropology*  
*Mentor: Ferric Fang, Microbiology*

We discovered a new multi-drug resistance (MDR) pump in *Salmonella enterica* serotype Typhimurium known as YdhIJK. *ydhIJK* is transcribed divergently from a gene encoding a regulatory protein known as SlyA. Transcription of the *ydhIJK* operon is strongly activated in a *slyA* mutant suggesting that SlyA acts as a repressor of this putative drug pump. The transcriptional start site of the *ydhIJK* promoter was mapped using rapid amplification of cDNA ends (5'RACE), revealing two separate promoters for this operon. Analysis of the *ydhIJK* promoter sequence reveals that there are binding sites for SlyA that may interfere with one of the promoters and not the other. We believe that one promoter may be constitutively transcribing low levels of *ydhIJK* transcript. When small ligands (such as salicylate) that may serve as a substrate for the pump are present, SlyA disassociates from the promoter thereby enabling higher levels of transcription to occur. This model is similar to what has been demonstrated for MarR, an MDR regulatory protein that is a close homolog of SlyA.

### **Image Guided Acoustic Hemostasis of Occult Liver Hemorrhage**

*Sean Burgess, Junior, Bioengineering*  
*Mentor: Shahram Vaezy, Bioengineering*

Uncontrolled hemorrhage from grades IV and V hepatic injuries (American Association for the Surgery of Trauma (AAST) Organ Injury Scale (OIS)) are highly lethal. Previous studies have shown that High Intensity Focused Ultrasound (HIFU) can successfully control visible bleeding from solid organ injuries. In this study we investigate the

ability of ultrasound image-guided HIFU to arrest occult hemorrhaging in the posterior liver parenchyma using a pig model. The image-guided HIFU device consisted of an intraoperative ultrasound imaging probe and a spherically-curved HIFU transducer with focal length of 3.5 cm, frequency of 3.23-MHz, and focal acoustic intensity of 2350 W/cm<sup>2</sup>. A total of 19 incisions (14 HIFU-treated and 5 control incisions) were made in 5 pig livers. The incisions, 30 mm long and 7 mm deep, resulted in a mean blood loss rate of 0.336 mL/s and 0.268 mL/s in the treated and control incisions respectively. HIFU was applied within 20 seconds of making an incision. Hemostasis was achieved in all treated incisions after a mean  $\pm$  SD of 65  $\pm$  15 seconds of HIFU application. After 7 minutes the control incisions had a mean blood loss rate of 0.231 mL/s. Histological results showed regions of treated liver in the focal region of HIFU, as evident by coagulative necrosis, surrounded by regions of untreated liver with intact hepatic structure. Thermal induced coagulative necrosis is believed to be the main mechanism of hemostasis. Ultrasound image-guided HIFU offers a promising method of hemostasis in surgical settings in which the hemorrhage site is not accessible.

### **Quantitative Vector Analysis of Cardiomyocyte Topography using Digital Image Processing**

*Carrick Burns, Senior, Bioengineering*  
*Mary Gates Scholar*  
*Mentor: Michael Regnier, Bioengineering*

Cardiomyoplasty (cell transplantation) is an emerging field due to the high incidence of myocardial infarction worldwide. One therapeutic approach is to inject cardiomyocytes into the infarcted region of the myocardium to improve heart function. However, very few investigations have explored how the implanted cardiomyocytes affect cardiac muscle mechanics. Studying ventricular muscle mechanics poses a serious challenge, as most current mechanical evaluations focus on trabecular or papillary tissue because its cellular orientation is linear. However, cardiomyocytes of myocardial tissue (the site of infarction) are circumferentially oriented in the middle of the ventricular wall and vertically oriented along the endocardial and epicardial surfaces. Thus, the dissection of ventricular tissue samples may result in nonlinear and/or offset orientation relative to trabecular tissue. Therefore to determine the mechanical viability of the replacement tissue and compare it with surrounding undamaged muscle tissue we studied the correlation between cardiomyocyte orientation and steady-state force. The correlation determines boundaries for acceptable deviation in orientation, provides a correction factor to normalize force measurements, and provides information about the transverse mechanical coupling of cardiomyocytes. A Matlab program was written to analyze images of histologically stained ventricular tissue preparations. The program uses an intensity gradient filter to highlight cell membranes and calculates the orientation based on a "corrected"

angle analysis. The program analyzed normal myocardium and was compared to manual measurements of the same image. The results indicate the program correctly identifies cardiomyocyte orientation and deviation. Ongoing work includes altering tissue orientation relative to the force-measuring axis and analyzing trabecular tissue controls. The data will strengthen future cardiac mechanics investigations by setting boundaries on optimal preparations and provide a correction factor with which to normalize force measurements. This study is essential for quantitative assessment and comparison of the passive and active mechanical properties of healthy, infarcted, and repaired cardiac muscle tissue.

#### **Exposure of Fishes to Carbaryl Following Applications to Control Burrowing Shrimp in Willapa Bay, Washington: Pacific Herring and Shiner Perch**

*Kristin Bush, Senior, School of Aquatic and Fishery Sciences*

*Christopher Monson, Senior, School of Aquatic and Fishery Sciences*

*Mentor: Christian Grue, School of Aquatic and Fishery Sciences*

Efforts to restrict use of carbaryl to control burrowing shrimp in Willapa Bay, Washington have been driven by concerns over potential effects on non-target species. In 2003, we studied the use of treated areas in the Bay by fishes in an effort to quantify their exposure to carbaryl. Use of the water column above oyster beds by fishes was determined on the first daylight high tide at each of three oyster beds (10-25 ac) preceding two carbaryl spray events (2 and 14 July 2003), and during each of the three subsequent daylight high tides (ca. 6, 30, and 54 h after treatment) using a two-boat trawl net. Exposure was assessed by determining the activity of brain acetylcholinesterase (AChE) expressed as total activity and, if possible, in the soluble fraction. The only salmonid captured before and after treatment were juvenile Chinook (*Oncorhynchus tshawytscha*); additional species of fish included Pacific herring (*Clupea pallasii*) and shiner perch (*Cymatogaster aggregata*). Pacific herring (>10) were collected at one site before and after Spray Event 1 and three sites in Spray Event 2. Perch (>10) were only collected at two sites before and after the first spray event. Because of differences in life history (site fidelity and food habits), we predicted that exposure to carbaryl would be greater in the perch than in herring or juvenile Chinook. Maximum inhibition in Chinook was ~10%, ~15% in herring, and ~28% in perch. AChE inhibition in perch increased with time and was greatest in the membrane-bound fraction, whereas inhibition in the Chinook and herring occurred only during the first tide post spray and differential inhibition was not detected. Results suggest maximum levels of inhibition are less than those associated with overt effects and that the biological significance of forms of the enzyme needs to be determined.

Monson CA, Bush KM, Cabarrus JM, Grue CE, Grassley JM, Curran CA, University of Washington, Washington Cooperative Fish and Wildlife Research Unit, School of Aquatic and Fishery Sciences, Seattle, WA

#### **The Effect of VEGF Delivery on Disease Progression in a Mouse Model of ALS**

*Philamer Calses, Junior, Biology*

*Mentor: Patrick Weydt, Laboratory Medicine*

*Mentor: Albert La Spada, Laboratory Medicine, Center for Neurogenetics and Neurotherapeutics*

Amyotrophic Lateral Sclerosis (ALS) is a progressive adult-onset neurodegenerative disease commonly known as Lou Gehrig's disease. It is characterized by the loss of large motor neurons in the spinal cord, brainstem and cerebral cortex, which leads to muscle atrophy, paralysis and eventually death, typically from respiratory failure. There is currently no cure. Animals transgenic for a mutated version of the human SOD1 gene, which is involved in some ALS cases, are a good *in vivo* model of the disease and are used to test the efficacy of novel therapies. Other researchers and the work of the La Spada group on related motor neuron diseases suggest that vascular endothelial growth factor (VEGF) can promote survival of motor neurons *in vitro* and that loss of VEGF can cause motor neuron degeneration *in vivo*. It is this role in particular that we want to investigate further. Our goal is to test whether VEGF can delay the onset and slow the progression of ALS in the SOD1 model. Growth factors like VEGF can be delivered by gene therapy vectors or by continuous infusion via osmotic mini-pumps. I have therefore compared the effect of these two different VEGF delivery methods on the behavioral deficits of the ALS mouse. Disease onset and progression were monitored with a battery of biological parameters: motor performance, body weight and body temperature. Motor performance was assessed with a clinical score, the PaGE test and the Rotarod task. Body temperature was monitored with subcutaneously implanted transponders. I will report the usefulness of these tests in assessing disease progression and the therapeutic effect of the VEGF delivery methods.

#### **Photo-Generated Singlet Oxygen to Defend Against Biological Agents**

*Charles Chang, Senior, Biochemistry*

*Mentor: Gamal Khalil, Chemistry*

My research project is involved with protective materials that defend against noxious biological agents. The final goal is to manufacture these protective materials onto garments for military personnel. Photodynamic Agents (PDA), which are porphyrins, generate singlet oxygen ( $^1O_2$ ) under the proper light source. Singlet oxygen, as opposed<sup>2</sup> to the triplet ground state, are proven to be highly reactive—reacting with virtually all C=C double bonds. Therefore, they are proficient terminators of biological agents. The

light source that gives the energy to generate  $^1\text{O}$  could come from an Organic Light Emitting Diode (OLED), which has a very low power requirement. We are determining the efficiency of singlet oxygen generation and the competency of the PDA in killing bacteria. To measure the rate of  $^1\text{O}$  generation, we use rubrene as a scavenger for singlet oxygen. Rubrene, a visibly orange compound, is a vigorous reactant with  $^1\text{O}$  and is used effectively as an  $^1\text{O}$  probe. As  $^1\text{O}$  reacts with rubrene, it destroys the conjugated bonds and changes rubrene from orange to colorless. From the optical information, the rate of  $^1\text{O}$  generation and the traveling distance of  $^1\text{O}$  will be determined, as variables such as P and the distance between Pt-porphyrin and Rubrene are changed. As for measuring bactericidal efficiency, we first make a liquid solution of bacteria with Pt-porphyrin. When the light source is given to the Pt-porphyrin and singlet oxygen is produced, bacteria are killed. The experimental controls will have no PDA or no light sources. The data also describes how the deactivation of bacteria is changed due to variables such as light intensity, time of exposure, and [Pt-porphyrin]. A portion of the liquid after the reaction will be grown on bacteria count plates to measure the number of living bacteria, thereby measuring the efficiency of bacteria deactivation.

#### **Environmental Legislation: Policy Learning Study**

*Heather Chase, Senior, Political Science*

*Center for American Politics and Public Policy  
Undergraduate Fellow*

*Mentor: Bryan D. Jones, Political Science*

Environmental legislation has resulted in major regulatory changes to industry over the past fifty years in the United States. Legislation has fallen primarily into two categories: direct regulation (so called command-and-control) and market-based approaches. More recent legislation, however, provides a mix of both direct regulatory standards and market-based flexibility to meeting those standards. While the Environmental Protection Agency (EPA) was organized in 1970 to unify environmental regulation, environmental problems have continued to meet with varying success and failure in relation to their legislatively mandated regulatory scheme. Industrial pollution control provides a relevant model for the effectiveness of current regulatory schemes; legislation has targeted large stationary sources and is only beginning to address mobile and non-point (indirect) sources of air and water pollution. The policy learning study presented will provide information about the regulatory trends in environmental legislation over the past fifty years, focusing in particular on the Clean Air Act and Clean Water Act. Information will include the categorization of amendments and reforms to previous legislation in order to demonstrate the amount of institutional change, or policy learning, over time. Some economic and environmental indicators will be provided to analyze the relative effectiveness of environmental legislation while demonstrating any significant effect on industrial output.

#### **Cache Efficient Simple Dynamic Programming**

*Cary Cherng, Senior, Computer Engineering, Mathematics*

*Mary Gates Scholar*

*Mentor: Richard E. Ladner, Computer Science and Engineering*

Simple dynamic programming finds the sum of all ways the product of a sequence of elements can be completely parenthesized. Matrix Chain Product, Context-free Language Recognition, and Optimal Binary Search Tree are examples of problems for which simple dynamic programming is applicable. The standard algorithm does this is done by solving all contiguous subproblems. For large problem sizes, however, the standard algorithm suffers from many cache misses. New cache-oblivious and cache-aware algorithms based on Leslie Valiant's context-free language recognition algorithm are implemented, analyzed, and empirically evaluated with timing studies and cache simulations. These divide-and-conquer algorithms use matrix multiplication as a fundamental building block. Studies show that for large inputs they perform significantly faster than the standard algorithm even though they use more instructions. Furthermore, the cache simulations clearly show the standard algorithms suffering from many cache misses as the problem size increases.

#### **Fuzzy Logic Identification System Toolkit**

*Sharon Cheung, Junior, Electrical Engineering*

*Arpi Shaverdian, Senior, Computer Science and Engineering*

*Mentor: Howard Chizeck, Electrical Engineering*

The goal of our project is to develop a software toolkit that will extract "if-then" type rules from complex data sets. The toolkit uses an algorithm based upon *fuzzy system* identification, to find the relationships between measured data. Fuzzy logic is a generalization of Boolean logic. Statements in Boolean logic are either true or false while statements in fuzzy logic are represented by degrees of truth. The relationship among the data sets is a set of rules, called the rule base. The rule base is responsible for relating the input model to the output model. Our software will extract the rules that relate different measured quantities to outcomes. This algorithm is developed in Java and will be available in a Matlab toolkit. Matlab was chosen to run this program because of its ease of use. This toolkit will be made accessible to experts in many fields where researchers have a large amount of data and need to find the relationship between the inputs and outputs. Fuzzy logic models of systems are useful when mathematical models do not exist. Commercial applications of fuzzy logic include anti-lock breaking systems in automobiles, controllers for rice cookers, washing machines, moisture-sensing clothes dryers, elevators, and refrigerators. Fuzzy system methods have also recently been applied for genomic sequence recognition.

## **Development of a Corrosion Sensor for Infrastructure Monitoring**

*Alice Chin, Senior, Chemistry*

*Mentor: Gamal Khalil, Chemistry*

Since the Industrial Revolution, method improvement for mixing concrete and the introduction of steel has become the preferred framework of many infrastructures. Infrastructures like bridges and skyscrapers are under constant temperature and weather varying exposure, such that cracks and rust form. The major problems causing structural instability are cracks and corrosion within the framework. Current research by the Gouterman/Khalil Research Group at the University of Washington, in collaboration with the Department of Civil Engineering in New York's Polytechnic University, hopes to provide an innovative and lasting optical corrosion sensor to remotely monitor aging infrastructures. Corrosion in chemistry linguistics is an oxidative reaction of iron and a reductive reaction of water to form rust. The current research employs porphyrin chemistry and evanescent wave spectroscopic theory. The research group has already been successful in finding an oxygen sensor to detect cracks in cement. Now the focus is the design of a corrosion sensor, which is ideally a free base porphyrin dye suspended in a polymer matrix and applied to a fiber optic cable as a layer of paint. A free base porphyrin is an open cavity porphyrin molecule sensitive to zinc. Therefore, when the layer of paint on the infrastructure deforms, a release of zinc ions occurs and zinc incorporates into the cavity of the free base porphyrin. When free base porphyrin integrates zinc ion, a change in light intensity is measured and collected by a detector which signals corrosion will occur in the near future. This project provides a novel and innovative solution for civil engineers to observe corrosion in an infrastructure in situ. Another goal is to create a dual sensor, which measures cracking in cement and corrosion of steel for aging infrastructures made of both concrete and steel.

## **An Embedded Information System for Botanical Gardens**

*Irene Chin, Senior, Electrical Engineering, Informatics*

*Mary Gates Scholar*

*Mentor: David W. McDonald, The Information School*

Like a zoo is a gallery of animals, a botanical garden is a gallery of plants. But unlike a zoo, botanical gardens often are arranged for aesthetics and plants are often unidentifiable to the visitors. A possible solution is to embed Radio Frequency Identification (RFID) tags that respond to a Personal Digital Assistant (PDA) with integrated with an RFID reader to help visitors identify what they are looking at. In context, RFID tags would be placed at an exhibit within the botanical garden. Visitors could use the PDA-RFID reader to learn about the plant species at the garden ex-

hibit. The focus of the project is to enable a typical visitor to gather meaningful information on the plants that exist at an exhibit. This focus helps to narrow the system requirements and aid in the developing the system model, the design of the system, and the creation of a prototype. To assess the needs of the garden visitors, a persona of a typical visitor to a botanical garden was developed. After the process of creating a persona and identifying stakeholders, the information needs of the visitors were discovered and analyzed for feasibility. Based on these information needs a system model for the prototype design was created. An evaluation conducted at the end of the study assesses possible problems or areas for redesign and future work.

## **Monitoring Disease Progression in a Mouse Model of Huntington's Disease**

*Jenny Choi, Sophomore, Pre-major*

*Mentor: Albert La Spada, Laboratory Medicine, Center for Neurogenetics and Neurotherapeutics*

*Mentor: Patrick Weydt, Laboratory Medicine*

Huntington's Disease is a genetic, degenerative brain disorder that slowly robs an individual's ability to walk, think, talk and reason. The disease typically begins around age 40 and is always fatal. Currently, there is no effective treatment or cure. The research I am involved in centers around finding ways to alleviate symptoms of the disease and to ultimately find a cure for Huntington's disease. We use transgenic mice, which express the human mutant huntingtin gene and develop symptoms similar to the human disease to test experimental therapies. For these experiments it is very important to objectively measure onset and progression of the disease. We characterized the HD-171-82Q mouse model by monitoring motor performance, body weight and body temperature over the disease course and in control mice. For the temperature measurements all mice were injected with small temperature-sensitive chips. It was found that, in addition to the well-known motor deficits and the weight-loss, HD mice become hypothermic as the disease progresses. My project was to characterize the onset of the hypothermia in relation to the other deficits. I found, that weight loss is the earliest symptom, then motor deficits become apparent. Hypothermia showed the latest onset. What could be learned from this research project is that temperature is an efficient and objective measure for disease progression in the mouse model of Huntington's disease. This finding is useful for the design of future therapeutic trials using transgenic mice.

## **Thymic Epithelial Gene Expression in Multiple Differentiation Pathways**

*Tina Chu, Senior, Biology, Microbiology*

*Mentor: Andrew G. Farr, Immunology, Biological Structure*

*Mentor: Matt Erickson, Biological Structure*

The expression of tissue-specific antigens in thymic epithelial cells is a unique cell phenomenon. This special property explains central T cell tolerance in the immune system; however, the mechanism through which the phenomenon developed remains unknown. Two possible models serve to explain. One is the “promiscuous gene expression model,” where the genes appear randomly rather than specifically expressed. The other model is the “multiple differentiation pathways model” of epithelial cell development, in which different epithelial cells have alternative differentiation fates during development in the thymus. My independent research focuses on detecting similar tissue-specific antigens in mice skin and trachea based upon the multiple pathways model. Once thymic epithelial progenitor cells begin to differentiate into different organs, tissue-specific antigen expression levels change. By hybridizing with different fluorescent antibodies, which target a few specific proteins, including Rhodopsin, FoxN1, SP-C, and CC-10, murine tissues will be analyzed. Detecting the similar tissue-specific antigens would help determine whether the murine organ cells are derived from the same origin with the same gene expression.

#### **Lack of Association Between DBH -1021C>T and Susceptibility to Parkinson's Disease**

*Lani Chun, Junior, Biology*

*Mentor: Cyrus P. Zabetian, Neurology*

Parkinson's disease (PD) is a degenerative neurological disorder with a prevalence of 1-2% in those above the age of 60 years. It is characterized by four ‘cardinal features’: postural instability, resting tremor, rigidity, and bradykinesia. While the exact cause of PD is unknown, it is believed to result from a complex interaction between genetic and environmental factors, which results in the degeneration of dopaminergic neurons within the substantia nigra. Zabetian and colleagues (2001) identified a genetic marker, DBH -1021C→T, that accounts for nearly 50% of the variation in plasma activity levels of the enzyme, which catalyzes the conversion of dopamine to norepinephrine (dopamine-β-hydroxylase). Individuals of the T/T genotype have very low or undetectable levels of the enzyme. Subsequently, Healy and colleagues (2004) reported that the T/T genotype was associated with decreased susceptibility to PD. Seeking to replicate these findings, we genotyped DBH -1021C→T in a sample of 343 PD cases and 278 age-matched controls. We found no significant association between PD and either allele or genotype frequency, and observed no deviations from Hardy-Weinberg Equilibrium. With the sample size used, we had 73% power to detect a significant effect ( $\alpha=0.05$ ) assuming a genotype relative risk of 2.0 under a multiplicative model. Our preliminary findings cast doubt on the role of the DBH gene as a risk factor in PD, but will require replication in a sample of larger size.

#### **Regulation of Cytokine Gene Expression in Th2 Cells**

*Duangkamol Chungsirawat, Biochemistry*

*Mary Gates Scholar*

*Aniel Solis, Sophomore, Biology*

*Mary Gates Scholar*

*Mentor: Mark Bix, Immunology*

Th1 and Th2 cells play a vital role in the immune system's response to foreign invaders. They each produce cell specific cytokines that help stimulate other components of the immune system to form an attack against the invading pathogen. Th1 cells produce interleukin-2 (IL2) and interferon gamma (IFN-  $\gamma$ ) as well as target intracellular pathogens, while Th2 cells produce interleukin-13 (IL13) and interleukin 4 (IL4) and target extracellular pathogens. Improper regulation of the IL13 and IL4 cytokine genes can lead to autoimmune and allergic disease. It is therefore important to determine what factors could be responsible for the expression states of these genes. Th2 cells can exhibit mitotically heritable monoallelic expression of IL4 suggesting that chromatin structure controls the expression state of IL4. The project will be to target and locate chromatin modifications in the IL4/IL13 locus of Th2 cells, which exhibit monoallelic expression of IL4 and IL13. Real-Time PCR is used to check the expression state of each allele in the Th2 clone; and Chromatin Immunoprecipitation Assay (ChIP Assay) is used to locate histone modifications and map the chromatin landscape of silent and expressed alleles. This will allow for better understanding of the mechanism by which the IL4/IL13 locus is transcriptionally regulated.

#### **Materials Characterization of Electro Optic Polymers**

*Deniz Civay, Senior, Materials Science and Engineering*

*Mentor: Alex K-Y Jen, Materials Science and Engineering*

Materials characterization of electro-optic polymers (EO polymers) is used to determine the electrical and optical properties that make these polymers unique. EO polymers are primarily used to produce electro-optic modulators, which are used in high-speed broadband communication. In an EO modulator, light is rapidly switched on and off, encoding digital or analog signals. The modulated light is then sent through fiber-optic cables, allowing information to be transmitted at high speeds. Sending light through fiber-optic cables is more efficient than sending electricity through wires. Current EO modulators use lithium niobate crystals, but EO polymers would make the EO modulator easier to integrate, cheaper, and faster. In my research, I performed materials characterization tests on EO polymers before and after they underwent a high temperature stamping process to determine if the effective modulation output was affected. The stamping process caused the effective modulation output to be reduced to zero in most cases. Another experiment I am working on involves determin-

ing if the absorption peak of an EO polymer has an effect on the experimental modulation output. The absorption peaks were tested and found to have an irregular effect on the modulation output. More experiments need to be performed in the future to determine the effect of the absorbance peak on the experimental modulation output.

### **The Fluency Project**

*Brooke Clark, Senior, Sociology, History, American Ethnic Studies*

*Zesbaugh Scholar*

*Mentor: Sheila Valencia, Curriculum and Instruction*

I have been working with Dr. Sheila Valencia and a number of graduate students on a research project entitled, "The Rush for Oral Reading Fluency: Issues of Assessment and Implications for Instruction." In practical terms, oral reading fluency means students must be able to accurately and quickly decode the words in a text, and they must read with phrasing and expression, which indicates they understand. The aim of the project is to disentangle the factors that influence students' reading fluency such as decoding, rate, and expression, and to evaluate how well students are able to decode and understand the material they are reading. They tested second, fourth and sixth grade students in seven schools having each one read at least six passages, both narrative and informational, at different levels of difficulty. They are currently scoring these oral readings to identify rate, accuracy, expression, and comprehension. Eventually, statistical analyses will be run to determine how all these factors interact to produce good reading and how well these correlate with standardized test scores. My personal role in working with this project has included converting raw scores into standard scores, listening to students reading the word lists and scoring errors, and coding qualitative, categorical information into quantitative measures to ultimately be able to run statistical analyses on the information they collected. In this project, I am learning valuable skills putting my book knowledge of research methods and statistics into practice.

### **The Distant Gardener: What Conversations in the Telegarden Reveal about the User Experience of Telepresence**

*Stephanie Collett, Senior, Informatics*

*Mary Gates Scholar*

*Mentor: Batya Friedman, The Information School*

Telepresence – a unique form of human-computer interaction – presents the user with sense-data that corresponds to a remote physical reality, and allows the user to perform a remote physical action. In this study, we sought to understand the human experience of a specific instantiation of telepresence. We analyzed 3 months of online chat (347 participants, 22,952 postings) in the Telegarden: a com-

munity garden that allows users to plant and tend seeds in a remote garden by controlling a robotic arm through a web-based interface. Results showed that (1) conversations focused less on nature (13%) and technology (22%) and more on human relationships (69%); (2) as individual participation increased, conversation about nature and about technology shifted from inside to outside the Telegarden; and (3) patterns of conversation appeared to follow patterns of physical activity in the Telegarden. Discussion focuses on the depth and quality of participants' telepresence experience.

Kahn, P. H. Jr., Friedman, B., Alexander, I. S., Freier, N. G., and L. Collett, S. L. The distant gardener: What conversations in a Telegarden reveal about the user experience of telepresence. Short paper to be presented at CHI 2005 (alt.chi session). April 2 - 7, 2005, Portland, OR.

### **Landscape Evolution of the Dry Valleys, Antarctica**

*Jonathan Connolly, Senior, Earth and Space Science*

*Mentor: Jaakko Putkonen, Earth and Space Science*

Erosion and down wasting of the Earth's surface is generally assumed to be ubiquitous, yet surprising findings from Antarctic Dry Valleys suggest nearly total preservation of ancient landscapes (~10 Myrs old). This notion challenges our fundamental understanding of the rates and corresponding geological processes active on the Earth's surface. Our recent field observations on the active degradation of glacial moraines contradict the suggested stability of the Dry Valleys' landscape. In the field we focused on glacial moraines that start with a sharp crested profile, which over time become smeared and rounded by erosion. To quantify our field observations, we used differential GPS to create high-resolution topographic profiles of previously dated moraines. To calculate rates and magnitudes of surface erosion and the magnitude of topographic diffusivity, we will set up a computer model that is guided by the measured moraine profiles. Erosion of sediments, such as glacial till, can often be modeled as repetitive transport of small soil parcels preferentially down slope. This conceptual model is captured by the following generally accepted mathematical formulation of hill slope degradation, where  $z$  is the height,  $t$  is time,  $q$  is the soil flux and  $x$  is the horizontal distance normal to the moraine axis. The soil flux is described as  $q = k \frac{\partial z}{\partial x}$  where  $k$  is topographic diffusivity. Using the field data to constrain the parameters, this model will track the soil transport over the moraine surface and the relaxation of the moraine slopes over time. The expected results are twofold: 1) prove that landscapes in the Dry Valleys, Antarctica degrade significantly faster than currently believed, and 2) quantify the soil erosion rate.

### **Mechanisms of shear activation in the von Willebrand Factor A1 domain**

*Tim Connolly, Senior, Bioengineering*

*Mentor: Wendy Thomas, Bioengineering*

Molecular dynamics simulations were executed to study the mechanism for shear activation of von Willebrand Factor, a platelet-binding blood protein. The systems studied are based on crystallized structures of the A1 domain. The first structure is the A1 wild type; the second is the A1 I546V mutant; and the last is the A1—GPIIb/alpha complex. The NAMD software package was used to provide a constant force pull on the molecule, simulating the pulling that is caused by high shear stress. Studies are still in progress. Simulations comparing different wild type crystal structures may show some differences in the size of a hydrogen binding site near residue 546. This site is known to be crucial to shear activation as the I546V mutation is the basis of von Willebrand disease, a disorder that results in having a version of von Willebrand Factor that binds to GPIIb/alpha in the absence of high shear conditions.

### ***Tigriopus californicus* in marine closed ecological systems: Does phytoplankton species affect copepod populations?**

*Stephanie Conrad, Senior, Oceanography*

*Mentor: Frieda B. Taub, Aquatic and Fisheries Science*

Closed ecological systems are microcosms with no exchange of resources with the outside world. Only light and heat are allowed to enter or leave the system. *Tigriopus californicus* are small marine zooplankton that live in tidal pools ranging from Baja to British Columbia. In this experiment *T. californicus* were enclosed with different species of algae to determine which algal species positively affected the copepod populations. Three experimental groups and a control were investigated: the addition of both algal species *Nannochloropsis* and *Tetraselmis*, only *Nannochloropsis*, only *Teaselmsis*, and the control with no algae added. The results showed no statistical difference in the different algal treatments with exception of the control, which showed a steady decrease in *T. californicus* populations. The conclusion of this study was *Nannochloropsis* and *Tetraselmis* do not produce statistically different populations of *T. californicus*.

### **Greco-Roman Sources in George Caleb Bingham**

*Erin Corrales-Diaz, Senior, Art History*

*Mentor: Susan P. Casteras, Art History*

There has been a longstanding tradition of using ancient art as inspiration for modern works, due partly to traditional art education methods and curricula, which emphasized the importance of art students in the U.S. and abroad studying and drawing from plaster casts. Late 18<sup>th</sup>- and 19<sup>th</sup>-century excavations at Pompeii and elsewhere also fueled artists' interests in "quoting" classical statuary in their own paintings. George Caleb Bingham did precisely this, perhaps reflecting his brief study in 1837 at the renowned Pennsylvania Academy of the Fine Arts, which had a huge cast collection. Little has been noted by scholars about the

impact of classical art in his oeuvre, but this subject intrigued me. First, a careful overview of Bingham's art needed to be done in order to determine which works revealed an identifiable Greco-Roman influence. Then, closer study of the relevant ancient art was necessary to understand their original significance or meaning. Finally, the ancient sources had to be related to Bingham's time and to contemporary American history. Ultimately, he appears to have carefully selected key works of Greco-Roman art such as, the *Doryphorous* and the *Dancing Satyr*, to incorporate into his own works both to promote American nationalism, and, in other cases, to question American legal or political situations. In his earlier works, the linkage of classical statuary to paintings such as *Daniel Boone Coming through Cumberland Gap* and the *Verdict of the People* seemingly focused more on American courage, pride, and freedom, concepts often attributed to American nationalism. By contrast, some later works, notably *Martial Law*, utilized Greco-Roman sources to question American morals and ethics. The result is an examination of how a 19<sup>th</sup>-century artist commented on American culture, life, and politics by utilizing ancient art which he knew mostly secondhand from casts and prints.

### **Monitoring Invasive Species Using a GIS Approach: Scotch-Broom (*Cytisus scoparius*) on the Mima Mounds**

*Catherine Crook, Senior, Environmental Science, Geographic Information Systems*

*Ursula Kehaulani, Senior, Urban Studies, Environmental Studies, Geographic Information Systems*

*Mentor: Tom Carlson, Geography, Geographic Information Systems*

*Mentor: John Banks, Environmental Science*

This study examines the development of a spatial and temporal database to monitor scotch broom expansion into the Mima Mound Natural Area Preserve, WA. Geographic information system (GIS) analysis was used to monitor the invasive distribution of *Cytisus scoparius* into this sensitive area. Time series aerial photographs were scanned and geo-registered to develop a model to quantify the expansion of *Cytisus scoparius* across the study site from 1965-2003. Thus far, our observations indicate that the expanding *Cytisus scoparius* is competing with the natural vegetation. This study demonstrates that the distribution and abundance of an invasive species on protected land can be accurately described and interpreted over diverse spatial and temporal scales using a GIS model. This study contributes to the preservation of natural features and has further implications for ecological restoration efforts in this area.

### **Genetic Polymorphism of Floral MADS Box Genes in Natural Populations of a Dioecious Angiosperm**

*Andrea Crosson, Senior, Biology*

*Mentor: Verónica Di Stilio, Biology*

A key focus in the study of molecular evolution of flower development is the ABC model, consisting of homeotic genes involved in the determination of floral organ identity and patterning. The B-class genes within this model belong to the plant MADS box family of transcription factors, and they are involved in petal and stamen development. The genus *Thalictrum*, in the Buttercup family, has varied types of floral development, including hermaphroditic and dioecious. In an effort to understand genetic structure and variability of these transcription factors in dioecious *T. dioicum*, homologs of the *Arabidopsis* B class gene *APETALA3* were isolated. Gene duplications were identified and the paralogous loci were isolated and amplified from natural populations and controlled crosses. In addition to genetic polymorphisms, the possibility of sex linkage amongst these paralogs was examined. This project is framed within broader research studying the genetic basis of flower diversity in angiosperms.

### **Internal Solitary Wave Dissipation in Port Susan, Puget Sound**

*Lauren Curry, Senior, Oceanography*  
*Mentor: Seelye Martin, Oceanography*

Every tidal cycle, a packet of waves with amplitudes greater than 10 meters travel through Port Susan, Puget Sound, almost unnoticed. These waves travel just a few meters under the surface of the water and, except for a series of surface slicks, are invisible to the casual observer. During the ebb flood, the input of more fresh water off the Stillaguamish delta displaces salty marine waters in Port Susan. This initiates an internal solitary wave (ISW) that propagates to the mouth of the basin. The water column in Port Susan is extremely stratified; that is, buoyant fresh waters float on the salty marine waters. This creates an interface for the ISW to propagate along within the water column. The interface of the wave itself eventually becomes unstable and “breaks,” mixing the water. This breaking is important for the ocean’s structure, biological processes, and even acoustic properties. It is also believed to dissipate a large portion of tidal energy. The strong stratification in Port Susan could be weakened by the mixing event with effects on nutrient and oxygen availability for phytoplankton; understanding this process will lead to a better understanding of the health of Port Susan. These major biological changes have consequences higher up through the food chain and are important to water quality. My investigation focuses on the cause of the ISW dissipation. There was a preliminary cruise in March to define the stratification within Port Susan and there will be final cruise in April to follow the ISW as it breaks. There I will record measurements of the salinity and temperature to determine the structure of the ISW as it decays to help define the mechanism that causes this wave to break.

### **Werner Syndrome Protein Expression and the**

### **Genesis of Meningiomas**

*Zainab Dagher-Alnoor, Senior, Biochemistry, Chemistry*  
*Mentor: John Silber, Neurological Surgery*

Meningiomas are benign tumors that can progress into a higher-grade tumor accompanied with chromosomal rearrangement and translocation. Werner syndrome (WS) is an autosomal recessive genetic disorder that causes premature aging and the risk of developing cancer and cardiovascular diseases due to genomic instability. This syndrome is characterized by the absence or the mutation of the Werner protein (WRN). WRN protein is a member of the RecQ family of DNA helicases that plays a role in DNA transcription, replication, recombination and repair. It acts partly to suppress the recombination between homologous DNA sequences; it also interacts with other proteins to repair damaged DNA. It had been observed that higher grade tumors have low amounts of WRN protein; therefore, the purpose of this study is to quantify this protein in meningiomas of different malignancy (grades). Due to Werner protein’s role in DNA repair, its absence or mutation in higher grade tumors means that the progress of the tumor may be partly due to the inactivation of this protein. As a result, WRN protein will be extracted from human meningioma tissue and will be quantified using Western blot analysis. Preliminary results show a correlation between the absence of the Werner protein and the grade of the tumor. The higher the grade, the lower the amount of protein present. This concludes that the absence of the Werner protein does not only lead to the formation and the progression of meningioma tumors, but it also shows that individuals with Werner syndrome are more likely to develop such tumors.

### **Gender Differences in Infant Imitation**

*Derek Dauphin, Senior, Psychology*  
*Mary Gates Scholar*  
*Mentor: Betty Repacholi, Psychology*

When infants witness someone manipulating an object, they have an almost uncontrollable urge to imitate. To date, gender differences in children’s imitative capacity have not been reported. However, a recent study by Betty Repacholi suggests that gender differences can be observed under some circumstances. In this study, an experimenter performed an action on an object and another adult responded to this with an angry or a neutral emotional expression. Infants were then given an opportunity to play with the object. Infants were more likely to imitate the action in the neutral condition. Interestingly, across all conditions, boys were more likely to imitate than girls. The goal of the project was to undertake a detailed investigation of infants’ behavior in order to explain this gender difference. There was no gender difference in infants’ emotional response, latency to touch the object, or duration of play. Thus, girls were no more intimidated by the procedure than were the boys. On the other hand, girls spent more time than boys looking at

the experimenter and their parent during the play period. In addition, when infants did imitate, girls were less likely than boys to repeat the action. Taken together, these findings suggest that imitation serves a different function for girls than boys. Girls may imitate not simply because they are interested in the action, but also because imitation provides a means of establishing or maintaining an interaction with another person. Unlike the standard imitation paradigm, the experimenter in this study ignored the infant during the play period, thereby removing what may be the primary drive for imitation in girls. Consequently, girls were less motivated to imitate. These findings are consistent with a small but growing body of evidence that, from an early age, girls are more interested in social stimuli than are boys.

### **Real-Time PCR Detection of Adeno-Associated Viruses in Human Clinical Samples**

*Becky Dierks, Junior, Biology*

*Mentor: Meei-Li Huang, Laboratory Medicine*

The helper-dependent parvovirus, adeno-associated virus (AAV), has created great excitement among the gene therapy world. AAV has recently been discovered, as a more useful gene vector than the previously used retroviruses due to its ability to infect non-dividing cells as well as the fact that it seems nonpathogenic. However, AAV is known to establish latent infections due to one of its viral proteins, Rep, as it integrates into active genes of cellular chromosomal DNA. Helper viruses, such as herpes viruses or adenoviruses, can reactivate these latent infections. Because AAV is severely prevalent in humans and gaining attention as potential gene therapy vectors, it is important that this virus is truly understood. More research is needed to ascertain the safety of AAV vectors in gene therapy and assure that AAV vectors are completely nonpathogenic. The goal of this project is to develop a real-time PCR assay using Pan1/Pan3 primers to detect adeno-associated virus in human clinical samples. This assay will be able to detect all human isolates of AAV including AAV1, AAV2, AAV3, AAV5, and AAV6 serotypes. The results will provide information to understand natural history and disease association of AAV infection and reactivation.

### **Snow Leopard Population Survey in Areas of Sichuan Province China**

*Chris Domschke, Senior, Wildlife Science*

*Mary Gates Scholar*

*Katharine Liang, Junior, Bioengineering*

*Mary Gates Scholar*

*Mentor: Randall Kyes, Psychology*

The snow leopard (*Uncia uncia*) is one of the world's most endangered cats, and the top predator in its environment. Little is known about this animal, and even less is known of the status of the snow leopard in China, with next to

nothing being known of their status in Sichuan Province. In China there are many threats to the survival of the cat, including deforestation, increasing population and trade in traditional medicine. These three major threats have led to a decline in the population of the snow leopard. To better protect the animal, more needs to be known about its distribution and population. Using the methods outlined in the *Snow Leopard Survey and Conservation Handbook* we have completed a population study for *Uncia uncia* in the Litang area of Sichuan Province, China. We found pugmarks of snow leopard in the Geye mountain area near Litang and surveyed locals on their opinions of the cats. The data collected will be able to help the Chinese and the international community to protect the snow leopard. In addition to the fieldwork completed, we will give presentations to children in America about the studies and time spent in China, helping them to learn more about conservation and the problems facing the both countries. A written thesis is also forthcoming. We would like to acknowledge the International Snow Leopard Trust and Professor Zeng of Sichuan University for invaluable insight.

### **Optimized Growth of Single-Walled Carbon Nanotubes on Substrates**

*Robert Dormaier, Junior, Physics*

*Mary Gates Scholar*

*Mentor: David Cobden, Physics*

Carbon nanotubes are long tubular carbon molecules that act as one-dimensional electrical wires. As such, nanotubes present fascinating possibilities for studying physics in one dimension, specifically the physics of electron transport through the nanotubes when metal leads connect them. Such research is important because although carbon nanotubes are widely acknowledged to have many possible uses in emerging electronic device technologies, as well as in advanced structural materials, current knowledge of many of their properties is lacking. I have developed a novel procedure for efficiently synthesizing long and aligned carbon nanotubes. My method of nanotube synthesis yields an optimized arrangement of the nanotubes such that they may be directly used to create nanotube transistors. The transistors are then used in the UW physics department to study the physics of one-dimensional electrons at liquid helium temperatures. I will present the procedures I use to create and characterize the nanotube growths.

### **Cardiomyocyte Apoptosis in the Development of Cardiac Fibrosis**

*Teja Dyamenahalli, Junior, Biology*

*Mentor: April Stempien-Otero, Cardiology*

Cardiomyocyte (CM) apoptosis has been shown to be elevated in cases of end stage heart failure. Cardiac fibrosis is a common phenotype of heart failure. In previous stud-

ies we have shown that in SR-uPA transgenic (TG) mice there is an increase in plasmin-dependent cardiac fibrosis (CF). We hypothesize that in these mice, plasmin causes the pericellular proteolysis of laminin, an extracellular adhesive glycoprotein that acts as a bridge between proteins attached to the cell membrane and the basal lamina. Consequently, due to the loss of cell-matrix contact, apoptosis is induced. Apoptosis of CM then leads to replacement fibrosis. To test this hypothesis, we will be measuring CM apoptosis in the hearts of SR-uPA transgenic and non-transgenic (NTG) mice using TUNEL staining of apoptotic nuclei, and gel electrophoresis to detect DNA laddering. In addition, since caspases are known mediators in the apoptotic pathway, we will measure caspase-3 activity in heart lysates obtained prior to the onset of CF. To determine whether uPA and plasmin play a causal role in CM apoptosis we will perform *in vitro* assays on cultured CM treated with uPA and plasminogen, and quantify the number of apoptotic cells and caspase-3 activity. To test the hypothesis that cleavage of a specific matrix component is associated with apoptosis, we will perform immunoblotting to measure total laminin and degradation products in heart lysates from SR-uPA TG and NTG mice. Elucidating the mechanisms that lead to CF has major implications for the treatment of the disease in humans.

### **Research and Development of a High Performance Electric Vehicle**

*Ronald Easley, Senior, Mechanical Engineering*  
*Mentor: Ashley F. Emery, Mechanical Engineering*

Electric vehicles have always had the stereotype of being unattractive, slow, and limited in range and thus impractical. It is the aim of a team of undergraduate engineering students at the University of Washington to dispel these myths and to design an all electric car that accelerates on par with exotic sports cars, looks attractive, and gives a driving range between charges long enough for multiple round trip commutes to work. Through research this team has discovered the high performance potential of electric vehicles and an ever increasing driving range from precision engineering for aerodynamics and weight reduction as well as advanced battery technology providing very high energy density storage. The research and design is subdivided into multiple projects including: exterior design, interior design, driver interface, structural modification, electrical storage systems, motor coupling, drive train, and safety systems. The final product will compete in the Michelin Challenge Bibendum, which is a yearly competition testing vehicles in a variety of challenges sponsored by Michelin for the display of sustainable energy automotive design. The design approaches of the multiple facets of the project will be discussed.

### **Demonstration of Molecular Chaperone Activity in SPARC**

*Ryan Emerson, Senior, Biochemistry, History*  
*Mary Gates Scholar*  
*Mentor: John I. Clark, Biological Structure*

The protein SPARC (Secreted Protein, Acidic and Rich in Cysteine) is a matricellular modulator of cell interactions with the Extracellular Matrix (ECM). SPARC is important in cell adhesion and proliferation, and is expressed primarily in remodeling tissue such as gut mucosa, bone, healing wounds and tumors. The regulatory activity of SPARC was shown to involve binding with structural matrix proteins including integrins, laminins and collagens. The purpose of this project is to determine SPARC activity as a molecular chaperone, preventing or slowing the aggregation of proteins. Experiments to date have used spectrophotometry to measure the thermal aggregation of proteins in solution. Alcohol Dehydrogenase, a protein whose aggregation properties are well known from previous studies, was used in the experiments to demonstrate the ability of SPARC to inhibit thermal aggregation. In the test system SPARC prevented protein aggregation, an observation that has implications for the function of SPARC *in vivo*. Further experiments will be conducted using physiologically relevant proteins including integrin, laminin and collagen, matrix proteins suspected to interact with SPARC *in vivo*.

### **A Design Expertise Continuum**

*Athena Epilepsia, Sophomore, Pre-Arts and Sciences*  
*Diana Baral, Sophomore, Pre-Engineering*  
*Rebecca Kim, Sophomore, Biochemistry*  
*Michael Music, Sophomore, Pre-Engineering*  
*Tarrah Wells, Junior, Pre-Engineering*  
*Shannon Westphal, Sophomore, Computer Science, Statistics*  
*Mentor: Susan Mosborg, Center for Engineering Learning and Teaching*

What should universities be teaching students to prepare them for the real world? Insights can be gained by studying how experts in fields such as medicine, history, or engineering solve problems. What is learned from those studies can then be used to help guide teaching. As part of the Design Expertise Continuum project at the Center for Engineering Learning and Teaching, we are studying experts in engineering design. Our research team asked 19 professional engineers to solve a “real-world” engineering problem—designing a playground—in a three-hour laboratory session. The participants were audiotaped as they worked on the problem while thinking aloud. We will be carrying out two specific analyses: first, examining how long the participants spent on each step of the engineering design process (problem definition, gathering information, generating ideas, modeling, feasibility analysis, evaluation, decision, and communication) and, secondly, identifying themes in how experts solved the problem they were presented. After segmenting the transcripts into units (short lines) and time-stamping each segment, we are coding each

segment, naming which design step the participant is in at that point. This allows us to calculate the amount of time the experts spent on each step of the design process and to trace their movements back and forth among the steps as they solved the problem. We are also identifying themes in their methods of design by reading the transcripts closely. Finally, we will make comparisons to similar data gathered from undergraduate engineering students in earlier studies. We hope to draw some preliminary conclusions about what pre-engineers should be focusing on in school to best prepare for their future careers.

### **Quantifying the Contact Angle Hysteresis of Water Droplets on Textured Surfaces**

*Aziel Epilepsia, Senior, Electrical Engineering  
Mary Gates Scholar*

*Mentor: Ashutosh Shastry, Electrical Engineering  
Mentor: Karl Böhringer, Electrical Engineering*

By strategically texturing a chemically hydrophobic surface, it can be made to exhibit superhydrophobic properties. This technique could prove useful for the optimization of electrowetting lab-on-a-chip systems. Through experiment, we have quantified a water droplet's contact angle hysteresis for hydrophobic textured surfaces. Silicon etching, followed by a hydrophobic thin-film coating, created textured micro-pillar surfaces of varying roughness. By depositing a water droplet to the surface and tilting it, we measured the droplet's advancing and receding contact angles at the instant gravitational force caused it to release from the surface. Contact angle hysteresis was quantified as the difference between the advancing and receding contact angles versus the roughness of the surface it sat upon.

### **The Eocene-Oligocene Boundary Reflected on the Olympic Peninsula**

*Emerald Erickson, Senior, Earth and Space Sciences  
Mentor: Michael Brown, Chairman, Earth and Space Sciences*

*Mentor: Elizabeth A. Nesbitt, Curator, Burke Museum  
Invertebrate Paleontology Division*

The Eocene-Oligocene boundary was host to the onset of extreme changes in climate, biology and geology including a switch to an "icehouse" climate as well as mass extinctions, all of which are reflected in the rock record. The Hoko Formation on the Olympic Peninsula was deposited at the Eocene-Oligocene boundary. What I intend to do is identify calcareous planktonic foraminifera from the Hoko Formation, assemble the foraminifera into their respective planktonic zones, and map these zones on a map of the Olympic Peninsula. The high-resolution foraminifera will enable me to locate where the Eocene-Oligocene boundary is in the Hoko Formation. The foraminifera collected will be analyzed isotopically to obtain information about the

condition of the ocean at the Eocene–Oligocene boundary. Locating the Eocene-Oligocene boundary in the Hoko Formation by means of high-resolution foraminifera and examination of information yielded by an isotopic analysis will contribute to our understanding of the nature of the climate, biology, and geology at the Eocene-Oligocene boundary on the Olympic Peninsula and Pacific Northwest margin.

### **Creation of Human Thymidine Kinase Mutants for Safe Gene Therapy**

*Nolan Ericson, Senior, Biology  
Mary Gates Scholar*

*Mentor: Jason Bielias, Pathology*

*Mentor: Lawrence Loeb, Pathology*

Gene therapy has vast potential for treating genetic disease, but has faced significant setbacks in its development. In human trials, several patients have experienced full correction of genetic deficiencies. Three years after these initial successes, however, multiple treated individuals developed leukemia. Random retroviral insertion of a corrective gene near an oncogene leads to its activation, and thus, malignancy. This risk of cancer has brought human trials to a standstill worldwide, signifying the need for a safer form of gene therapy. A potential solution to this problem is temporal suicide gene therapy. This would involve coupling a corrective gene with a suicide gene that would lead to cell death when exposed to a prodrug. Should the treated cells become malignant, the drug can be administered and kill the transgenic cells. The goal of our project is to create and select a mutant of human thymidine kinase to serve as this suicide gene. Thymidine kinase is an enzyme that phosphorylates thymidine, prior to its integration into nascent DNA during synthesis. Some species have a thymidine kinase that can phosphorylate the prodrug ganciclovir, which, when phosphorylated, can be integrated into DNA. This integration blocks further DNA synthesis, effectively killing the cell. Wild-type human thymidine kinase, however, does not phosphorylate ganciclovir. By employing random mutagenesis and screening for thymidine kinase function, we have obtained a library of functional thymidine kinase mutants. We have screened this library for ganciclovir sensitivity, and we have identified proteins for safe gene therapy.

### **Increased Plasma TGF- $\beta$ 1 Does Not Accelerate Atherosclerosis in Mice**

*Parak Eshetu, Senior, Biology*

*Mentor: Andrew Frutkin, Cardiology*

*Mentor: David Dichek, Cardiology*

Atherosclerosis is characterized by the accumulation of lipids, cells, and extracellular matrix in the artery wall. The molecular mediators of atherosclerosis remain poorly un-

derstood. Transforming growth factor beta-1 (TGF- $\beta$ 1) is expressed in atherosclerotic arteries and affects cell proliferation, cell migration, matrix synthesis, and lipid deposition, processes that contribute to the development of atherosclerosis. Some studies associate plasma TGF- $\beta$ 1 levels in humans with the development of atherosclerosis. Most of these data are correlational, however, and therefore cannot reveal causality. To prospectively test the hypothesis that elevated levels of plasma TGF- $\beta$ 1 will accelerate atherosclerosis, we generated transgenic apolipoprotein E-deficient mice with regulated expression of TGF- $\beta$ 1. Feeding these atherosclerosis-prone mice doxycycline prevents expression of TGF- $\beta$ 1. Removal of dietary doxycycline activates expression of the TGF- $\beta$ 1 transgene and should increase plasma TGF- $\beta$ 1 levels. We compared atherosclerosis development in fat-fed transgenic mice off doxycycline (TG-OFF) to fat-fed transgenic mice on doxycycline (TG-ON) and fat-fed non-transgenic mice off doxycycline (NTG-OFF). TGF- $\beta$ 1 expression was measured by ELISA of plasma, and atherosclerosis was measured by planimetry of pinned, Sudan IV-stained aortas. Results: The TG-OFF mice had a 10-fold increase in plasma TGF- $\beta$ 1 compared to the controls: (TG-OFF:  $26 \pm 4.5$  ng/ml versus  $2.5 \pm 2.1$  for TG-ON and  $2.9 \pm 0.67$  for STG;  $P < 0.001$ ). Plasma cholesterol and triglycerides did not differ between the groups. The percentage of aortic surface area covered by atherosclerotic lesions was similar in each group: TG-OFF:  $7.7 \pm 2.9\%$ ; TG-ON:  $6.4 \pm 1.7\%$ ; NTG-OFF:  $7.1 \pm 3.1\%$  ( $P = 0.42$  by ANOVA). Plasma TGF- $\beta$ 1 levels can be varied over a wide range in atherosclerosis-prone mice. However, we found no evidence that plasma TGF- $\beta$ 1 levels affect the rate of development of aortic atherosclerosis. Studies currently under way are examining whether atherosclerotic plaque composition is altered in mice with elevated plasma TGF- $\beta$ 1.

### **Role of Multiple Contexts in TEP students' development of teaching identity, interest and commitment to learning to teach.**

*Katherine Estacio, Junior, Interdisciplinary Visual Arts  
Zesbaugh Scholar*

*Mentor: Susan Bobbitt Nolen, Educational Psychology*

*Mentor: Reed R. Stevens, Educational Psychology*

*Mentor: Ilana Seidel Horn, Curriculum & Instruction*

*Mentor: Christopher J. Ward, Educational Psychology*

Researchers have recently examined the role of multiple contexts in pre-service students' developing interest and motivation to learn, showing that student teachers often experience conflicting messages about teaching in the different contexts of their teacher training programs. As an effort to further this understanding in the field of education and to make the University of Washington's Teacher Education Program (TEP) more coherent, this study seeks to investigate the role of three social contexts in the development of student teachers' interests in learning and their

emerging identities as teachers in and beyond the Teacher Education Program. In consideration that secondary TEP students come with varying interest in their subject field and in learning about teaching, they also have wide-ranging connections and histories in relationship both to teaching and their subject matter. In the TEP, learning occurs in at least three social contexts: methods classes, foundations classes, and the school-based field placements. Interest, and disinterest, in learning from the program and teaching and subject identities are channeled in different ways in these contexts by interactions with individuals, participation in social groups with different values and by experiences in the social context of the classroom itself. As a result of these various experiences, TEP students are left having to resolve conflicting ideas about what is important to learn in becoming a teacher, as well as who they personally might be as a teacher. Lastly, their emotions as they deal with these conflicts and changes may also serve to channel their interests in learning and shape their identities as teachers.

### **Functional Comparison of Recombinant and Naturally Occurring Human Paraoxonase (PON1) Activities**

*Lesley Everett, Junior, Biochemistry*

*Mary Gates Scholar*

*Mentor: Clement Furlong, Medicine and Genome Sciences*

The genetic basis for individual differences in response to toxicants has widespread implications in medicine, environmental health, and biodefense. By characterizing environmental response genes such as paraoxonase (PON), we can better understand their functions and develop therapeutics for individuals with elevated susceptibility to toxicants. Human paraoxonase 1 (PON1) is an enzyme that detoxifies organophosphorus compounds and functions as an antioxidant associated with coronary artery disease. PON1 was originally studied for its ability to metabolize the organophosphorus compounds typical of certain insecticides, drugs, and chemical nerve agents. The paraoxonase 1 gene is highly polymorphic; our goal is to characterize PON polymorphisms and to ultimately engineer a more active human paraoxonase enzyme for therapeutic use. A polymorphism at codon 192 [Gln (Q)/Arg (R)] confers variable rates of organophosphate hydrolysis upon individuals. Homozygous R/R individuals demonstrate low organophosphate detoxification rates whereas homozygous Q/Q individuals demonstrate superior PON1 activity. Heterozygous individuals, Q/R, exhibit medium PON1 organophosphate hydrolysis rates. Utilizing recombinant human PON1 expression constructs, I will explore the paraoxonase activity of four PON1 isoforms. In addition to the naturally occurring human<sup>192</sup>PON1 arginine (R) and glutamine (Q) isoforms, PON1<sup>192</sup> lysine (K) and asparagine (N) mutants will be analyzed. <sup>192</sup>PON1<sup>192</sup> lysine occurs

naturally in rabbits (rabbit paraoxonase activity is superior to that of humans) and because of structural similarities, we hypothesize that PON1<sup>92</sup> asparagine mutants will have similar or improved activity<sup>92</sup> to that of PON1<sup>92</sup> glutamine. Hydrolysis rates of four organophosphorus<sup>92</sup> compounds (paraoxon, chlorpyrifos-oxon, diazoxon, and arylesterase) will be measured. GFP (green fluorescent protein)-PON1 fusion proteins will also be used for PON1 purification and visualization.

### **The 1950 Treganza Excavation: Archaeological Ethics and Museum Collections**

*Tyler Faith, Senior, Anthropology*  
*Mentor: Julie K. Stein, Anthropology*

Lynott and Wylie (1995), in a discussion of archaeological ethics, maintain that because excavation destroys part of the archaeological record, "It is especially difficult to justify opening new sites when enormous stores of archaeological material from sites that have already been excavated or collected lie unexamined in warehouses and museums" (Lynott and Wylie 1995:30). In 1950, Dr. Adan E. Treganza of San Francisco State University led a University of Washington field school in the excavation of English Camp (45SJ24) on San Juan Island. Since then, the recovered artifacts have been stored in the Burke Museum of Natural History and Culture. This study contributes to the ethical responsibility of archaeologists by presenting a summary of the Treganza excavation, his findings and insights into what we can learn from this past archaeological investigation of Northwest Coast Prehistory through an analysis of the recovered projectile points and the faunal assemblage. A comparison of this information with the data generated from Dr. Julie K. Stein's more recent excavations yields a more complete picture of the prehistory of English Camp while illuminating the impacts of widespread changes in archaeological field methods over the past fifty years. This analysis provides archaeologists with a clearer picture of the archaeological material found at English Camp. It is also apparent that a great deal of information was lost in the 1950 excavation that, by modern standards, involved very primitive field methods. By extension, the field methods we use today will be considered primitive in the future. Thus, archaeologists should be more conservative and make efforts to preserve the archaeological record for future research. Museum collections provide archaeologists with the means to elucidate valuable knowledge while preserving the archaeological record.

### **Sexual Reproduction in Mushrooms: the Mating System of *Tubaria furfuracea***

*Lili Fang, Junior, Biology*  
*Mentor: Joseph F. Ammirati, Biology*

Sexual reproduction in mushrooms is normally an out-crossing system (heterothallic), controlled by either one or two

mating loci, each with one or more alleles. Rarely is it a selfing system (homothallic). The mushroom *Tubaria furfuracea* has been regarded as a complex of two or more species based on time of reproduction, morphology of mushroom fruit body and ecology. Individuals of this species complex have been grouped on the basis of observed similarities and distinguished from one another on discontinuities in these characters. Intermediates between these species commonly occur, making it difficult to separate them from one another. In this study sexual mating compatibility will be used to evaluate similarities and differences within this species complex. Mating studies are being done with sexual spores from single mushrooms to first determine the type of sexual compatibility found in this species, since this is unclear in the literature. Relationships among different individuals and populations of the *Tubaria furfuracea* complex in the Seattle area will be determined using mating studies. Compatible individuals or populations will be scored for seasonal, morphological and ecological characteristics to determine what patterns they might show within the compatibility groups. Samples will be collected from six different sites at different times of the year. A single basidiome from each collection will be used to obtain single spore isolates. To date two have been sampled. Single-spore isolates were obtained from spore deposits on an agar medium using standard dilution-plating technique. For each collection, nine single spore isolates, recognized by the absence of clamp connections, will be paired in all possible combinations on 2% malt extract agar. The formation of clamp connections will be used to recognize a successful (compatible) mating.

### **Hydrogel Phantoms for High-Intensity Focused Ultrasound Research**

*Carie Frantz, Senior, Biology*  
*Mary Gates Scholar*  
*Mentor: Shahram Vaezy, Bioengineering*

Hydrogel phantoms used in ultrasound research are solid gelatinous substances that mimic the response of tissue to ultrasound by simulating the acoustic properties of the tissue. Phantoms are a central part of High-Intensity Focused Ultrasound (HIFU) research and are used extensively in all HIFU laboratories; they allow investigation of the effects of ultrasound on various tissues without using actual human or animal tissues. Currently, the HIFU laboratory at the University of Washington's Center for Industrial and Medical Ultrasound (CIMU) uses phantoms made of bovine serum albumin (BSA) embedded in polyacrylamide hydrogel. The BSA in the phantoms is used as a protein thermal indicator that clearly shows when and where the applied HIFU is having its effect. When HIFU is applied in the BSA gels, lesion formation can be observed as an opaque region in the otherwise transparent gel. There are two major problems with BSA-Polyacrylamide gels: (1) BSA gels are expensive to produce: a typical 200-mL BSA phantom used for HIFU experimentation costs approxi-

mately \$20, with over 90% of this cost due to the expense of BSA and acrylamide. (2) Acrylamide is a carcinogen and a neurotoxin. In the preparation and use of polyacrylamide gels researchers are repeatedly exposed to this potentially dangerous substance. Therefore, everyone working at CIMU is eager to find a suitable replacement for BSA-Polyacrylamide gels. Work done by a group of German scientists showed egg whites to be an effective replacement for BSA in protein thermal indicator phantoms. I was able to duplicate these results and fresh egg whites are now used instead of BSA in our lab, representing a 50% cost savings in the production of tissue-mimicking phantoms. I am now focusing on replacing the polyacrylamide with a non-toxic and, ideally, less-expensive substance.

#### **How is my bladder?: Type IV collagen synthesis by human urothelial cells and their adhesive interactions in the urothelial basement membrane**

*Yasuko Fujiike, Sophomore, Biochemistry*  
*Mentor: James A. Bassuk, Urology*

Bladder disease is a widespread problem, especially among women who endure “quiet-suffering. The transitional epithelial lining of the lower urinary tract, comprised of urothelial cells, is responsible for preventing the penetration of urine into the bladder wall. The adhesion of urothelial cells to its underlying basement membrane is key to ensuring that the epithelium remains functionally intact. Type IV collagen is the major constituent of the urothelial basement membrane and selective defects in this collagen have been linked to invasive transitional cell carcinoma and interstitial cystitis. The goal of this project is to determine to what extent type IV collagen is synthesized by normal urothelial cells in vitro and to define its mode of secretion and adhesive properties. Primary cultures of human urothelial cells were propagated from surgical explants provided by the urology service, with informed consent, at Children’s Hospital. Anti- type IV collagen monoclonal antibodies were used to immunostain fixed preparations of urothelial cells grown on glass in serum-free medium. Widefield fluorescence microscopy, Z-plane stack acquisition, deconvolution, and 3-dimensional rendering were used to analyze the immunostaining pattern.

All cells were observed to be immunoreactive. 3-dimensional datasets were collected at a Z resolution of 0.2 micrometers. Thirty iterations of blinded deconvolution removed out-of-focus light and restored these datasets to an unblurred state. The pattern of immunoreactive signals was consistent with type IV collagen being transported from ribosomes into the endoplasmic reticulum, Golgi apparatus, and secretory granules. Ongoing experiments will determine if urothelial cells will spread on glass slides coated with type IV collagen and to what extent this spreading can be blocked. An understanding of how type IV collagen plays a role in urothelial cell attachment and spreading will help us to better define how derangement of these processes can lead to diseases of the bladder and lower urinary tract.

#### **Microprinting on-chip culture: An investigation of concanavalin A adhesion for yeast.**

*Tracy Fung, Junior, Electrical Engineering*  
*Undergraduate Research Travel Award*  
*Mentor: Sarah McQuaide, Electrical Engineering*  
*Mentor: Joseph Chao, Electrical Engineering*  
*Mentor: Deirdre Meldrum, Electrical Engineering*

In contrast to conventional cellular research performed with bulk cell populations, the Microscale Life Sciences Center (MLSC) at UW seeks to study cells at the single cell level. This approach enables detecting variations among cells that may be lost from taking averages of heterogeneous populations. An effective single cell level technique is microprinting, which is the process of using a stamp with patterns at the micron scale to stamp an adhesive. Although cells can be trapped by mechanical, electrical and magnetic means, microprinting provides a simple, cost effective solution. Our microprinting process involves the use of soft lithography to stamp the protein called concanavalin A (con-A), a naturally occurring glycol protein that adheres strongly to glucose. The membranes of yeast are covered in glucose and when in contact with con-A they will bind to it. The stamp is microfabricated with silicon polymer polydimethylsiloxane (PDMS). Con-A is dried onto the surface of the stamp then gently stamped onto a glass substrate and the pattern formed is transferred to a glass substrate. Yeast cells in media are then flowed adhering to the con-A. Afterwards only the yeast in contact with the con-A stick to the glass and the excess yeast can be removed. So far we have been able to stamp in sizes as small as 40µm. Yeast cell sizes range from 5-10 µm and the goal of stamping a single cell per spot in an array is clearly possible. Future studies will investigate how to stamp with increasing accuracy and resolution, improve techniques for adhering yeast in single cell arrays, and branch out into other types of cells. We acknowledge the Molecular Sciences Institute for providing the information on con-A, and the support of the NIH National Human Genome Research Institute Centers of Excellence in Genomic Sciences program, grant 1 P50 HG002360.

#### **Women, Population Planning and Family Planning: The Contributions of International Development Organizations in Guatemala**

*Samantha Funk, Senior, Women Studies*  
*Mentor: Priti Ramamurthy, Women Studies*

This project explores the relationships between international population policy and reproductive health services or family planning programs through an examination of international development organizations in Guatemala. The research will also address the connection between the cultural, historical and social factors within the Guatemalan context and the reproductive health policies and practices that emanate from the region. In order to inform these in-

quiries, five non-governmental organizations, working in urban and rural areas in Guatemala, were selected to respond to a survey about local perceptions of reproductive choice, the types of family planning services they provide (or do not provide), and the predominant demographics of the individuals who utilize their services. The responses that the organizations supply will be analyzed to address the following questions: to what extent does the organization in Guatemala compensate for lack of state resources, how are women situated within the organization's strategy, is the family planning policy rooted in an understanding of reproductive rights, is the organization beholden to international donors, and what challenges specific to its region of operation does the organization face? The answers to these questions will not only contribute to a discussion on the status of family planning programs in Guatemala but will also provide insight into larger debates concerning representations of Third World women and population growth in international policy.

### **Neurons in the Eye Movement-Related Part of the Cerebellar Cortex Project Bilaterally to the Cerebellar Nuclei**

*Evan Galloway, Senior, Neurobiology*

*Mentor: F. Ric Robinson, Biological Structure*

Saccades (voluntary rapid eye movements) are an excellent model of cerebellar motor control. They are highly stereotyped, unlike complex arm or leg movements, and we can measure them very accurately. Additionally, part of the cerebellar cortex strongly influences saccade production. This work characterizes where the axons of neurons in this saccade-related part of the cerebellar cortex terminate, indicating which parts of the brain receive signals from this area. We injected a neuronal tracer into a region on the left side of the cerebellar cortex that produced a leftward saccade when electrically stimulated. This injection into the left side of the cerebellar cortex labeled axon terminals in both the left and right cerebellar nuclei. Previous work indicates that this region of the cerebellar cortex projects only to nuclei on the same side of the cerebellum. To confirm the existence of bilateral connections from the cerebellar cortex to the nuclei, we are performing similar injections in rats. If our initial result is confirmed, it would require reconsideration of the current model of cerebellar control of saccades. Refinement of the saccade model would also serve to clarify the mechanism of cerebellar motor control in general.

### **Advanced Oxidation Treatment of Bisphenol A and Diethylstilbestrol in Water**

*Lili Gan, Junior, Environmental Engineering*

*Mentor: Gregory Korshin, Civil and Environmental Engineering*

Bisphenol A (BPA) is a commonly used intermediate in the

production of polycarbonate and epoxy resins. Diethylstilbestrol (DES) is an artificial estrogen for birth control. BPA and DES have similar structures and have been shown to exhibit carcinogenic and endocrine-disrupting activity. BPA and DES tend to persist in the environment and trace levels of these compounds have been found even in seemingly pristine drinking water sources. An effective way to remove BPA and DES is to oxidize them into small-size harmless molecules. This research focuses on the use of three oxidation methods, including electrochemical treatment, ozonation and chlorination to break down these compounds in water. Another goal is to determine the mechanisms of the processes that cause them to break down. Currently, a micro cell electrolysis reactor is used to carry out the electrochemical treatment at different current densities. The examination of the ultraviolet absorption spectra, total organic carbon and most likely products of BPA and DES breakdown, it was found that BPA and DES are destroyed at current densities above a certain threshold, but the speciation of the treatment by-products is not well understood. The goal of the next phase of work is to perform a more accurate analysis of the degradation products, and to determine the possible processes in which these two chemicals are oxidized. Following that, ozone and chlorine will be used to react with the target compounds. The products of chlorination will be examined especially carefully because chlorination by-products are complex and some of them can be highly toxic. This research will help determine the fate of endocrine disruptors such as BPA and DES in the drinking water systems.

### **Genetic Phase Variation Related to Serum Resistance in *Haemophilus influenzae***

*Jennifer Geelhood, Junior, Microbiology*

*Mary Gates Scholar*

*Mentor: Arnold Smith, Pathobiology*

*Mentor: Alice Erwin, Seattle Biomedical Research Institute*

The small, Gram negative bacterium *Haemophilus influenzae* commonly colonizes the human nasopharynx. Unencapsulated, or non-typeable *H. influenzae* (NTHi) do not typically cause life-threatening disease, but can cause less serious infections, such as otitis media or bronchitis. Understanding why one NTHi strain can cause such dangerous invasive disease while another nearly identical strain can live harmlessly in a person's throat is critical to develop vaccines and treatments for *H. influenzae* infections. Certain NTHi genes involved in lipopolysaccharide (LPS) biosynthesis have been shown to undergo phase variation through the addition or deletion of one unit in a series of tandem tetranucleotide repeats. While evaluating the heterogeneity of the locus between the genes *infA* and *ksgA*, one LPS biosynthesis gene, *losA*, often inserted at this site was found to have a novel region of tandem octanucleotide repeats with 2-10 repeat units in each individual strain. The

number of repeats in the *losA* reading frame of each strain was compared to the strains resistance to the bactericidal activity of normal human serum: the most serum-sensitive strains had a *losA* truncated by the repeat region making the open reading frame "OFF." Hypothesizing that phase variation leading to a switch from "OFF" to "ON" would increase serum resistance, a serum-sensitive strain was passed in serum to select for resistance-increasing mutations. Individual colonies were assayed for serum resistance and sequenced to determine changes in repeat number. Colonies that switched from "OFF" to "ON" were more serum resistant, indicating that the phase-variable change in number of repeats that places the *losA* gene in frame increases the resistance of the bacterium to normal human serum. Thus a novel phase-variable locus with a heretofore unseen octanucleotide repeat pattern has been discovered. Its ability to alter serum resistance *in vitro* may have implications for the survival of infecting bacteria *in vivo*.

### **Understanding Sleep Quality in Older Adults**

*Teresa Gegax, Junior, Nursing*

*Mentor: Carol Landis, Biobehavioral Nursing and Health Systems*

Sleep disturbance is a common problem among the older population, as many as 40% of the elderly report difficulty sleeping. My research focuses on evaluating the degree of sleep disturbance experienced by a group of potential subjects upon screening for a clinical sleep study, *Valerian for Sleep Disturbance in Older Adults*. This study is a double-blind randomized cross-over trial that is designed to evaluate the sleep enhancing effects of valerian in a sample of 20 older adults that report disturbed sleep. The screening process starts with a telephone interview, followed by a collection of sleep history and related data. If still eligible, a clinical interview is conducted to determine the subject's mental status and health, and to gather sleep & stress information. During this process each potential subject completes a variety of tools used to evaluate sleep including a Pittsburg Sleep Quality Index, an Insomnia Severity Index, a sleep diary and a sleep history form. This data will be used to quantify the degree of sleep disturbance experienced by the potential subject. This will be completed for subjects that successfully move through the selection process and into the study, and for those eliminated from the study. For those that are eliminated, I will determine what factors prevented them from participating. Previous studies have found that when subjects are eliminated at the telephone screen stage the cause is generally related to major screening criteria (age, medical illness, etc.). Exclusion from study entry made in later screening stages is often due to previously unrevealed medical issues. I hypothesize that among this group of potential subjects cause for elimination will be congruent with these previously discovered patterns.

### **Masking Biomaterial Surfaces with Tissue Engineering Techniques**

*Stephen Gingrich, Senior, Bioengineering,*

*Mary Gates Scholar*

*Mentor: Heather Canavan, Bioengineering*

*Mentor: David Castner, Chemical Engineering*

*Mentor: Stephanie Bryant, Bioengineering*

*Mentor: Buddy Ratner, Bioengineering*

The foreign body response (FBR) is a formidable immune reaction that occurs at the surface of all *in vivo* biomaterial implants, regularly leading to device malfunction. Current methods of minimizing the FBR towards a biomaterial implant have dealt with attaching molecules or thin polymeric films onto implant surfaces. These methods have unfortunately shown weak improvements *in vivo*. Our goal is to sidestep these limitations by using autologous, native tissue as a surface coating. We thus propose a novel method that combines conventional tissue engineering and biomaterials. Titanium (Ti) and polyethylene (PE) biomaterials were used as model substrates. RF-plasma polymerization of L-lactide created a thin poly-L-lactic acid (PLLA) adhesive film onto Ti and PE surfaces. High resolution X-Ray Photoelectron Spectroscopy (XPS) analysis of these surfaces displayed bonding schemes similar to reference PLLA films. XPS survey scans show a 3:1 and a 3:5 C:O ratio for PE and Ti surfaces, which are equivalent to elemental ratios in PLLA films. The PLLA films are then adhered to a porous PLLA cell scaffold, prepared with a salt-leaching technique. SEM (Scanning Electron Microscopy) illustrated interconnected pores on the scaffold surface with pore diameters ranging from 38-75  $\mu\text{m}$ . In PBS at 37 °C, scaffolds on biomaterials with plasma-deposited PLLA surfaces took twice as long to delaminate than those placed on untreated biomaterial surfaces. PLLA scaffolds are currently being seeded with 3T3 fibroblasts for murine *in vivo* implantation. We predict that initiating tissue growth on a biomaterial's surface will minimize the FBR and furthermore improve biomaterial interaction through engineered and host tissue integration.

### **Timescales of seawater-oceanic crust interaction from uranium-series disequilibria**

*Jennifer Glass, Junior, Earth and Space Sciences, Oceanography*

*Mary Gates Scholar*

*Mentor: Kari Cooper, Earth and Space Sciences*

The presence of vigorous hydrothermal systems resulting in alteration of fresh mid-ocean ridge basalt has been well-documented along the crests of mid-ocean ridges. There is also evidence that hydrothermal circulation and alteration can persist for tens of millions of years as the oceanic crust moves away from the spreading center axis. To assess the distribution and timing of off-axis alteration, we are using uranium-series disequilibria measured in cores recovered from 500 m of drilling into basaltic basement at Ocean Drilling Program Site 1256 in the Guatemala Basin. The cored basalts were erupted ~15 million years ago (Ma) at

the East Pacific Rise during a period of superfast (>200 mm/yr) spreading and have since been macroscopically altered to saponite, pyrite, iron-oxyhydroxides and carbonate; the overall extent of alteration is slight to moderate. We have measured  $^{234}\text{U}/^{238}\text{U}$  disequilibria in whole-rock and vein samples from this core, which is evidence for recent (<1.25 Ma) rock-water interaction. Reasons for the observed  $^{234}\text{U}$  excesses and depletions at different depths in the core are being investigated. Measurements of  $^{230}\text{Th}/^{234}\text{U}$  disequilibria in the same samples are in progress. U-Th disequilibria are sensitive to timescales of tens to hundreds (~350) kyr; therefore, these analyses will better delimit the timing of alteration and the geochemical fluxes between the ocean and seafloor.

### **Synthesis, Surface Modification, and Characterization of Gadolinium Oxide Nanoparticles for use as MRI Contrast Agents**

*Neil Golke, Senior, Materials Science and Engineering, Mechanical Engineering*

*Mary Gates Scholar*

*Mentor: Miqin Zhang, Materials Science and Engineering*

Gadolinium oxide (Gd O ) nanoparticles were synthesized via a two-step chemical<sup>2</sup> synthesis and were then surface modified with poly (ethylene glycol) (PEG) to develop a novel magnetic resonance imaging (MRI) contrast agent. Surfaces coated with PEG are known to resist protein adsorption and help nanoparticles avoid recognition by mononuclear phagocyte system (MPS). PEG coated nanoparticles were characterized by transmission electron microscopy (TEM) and dynamic light scattering (DLS) to determine particle size and polydispersity after surface modification. X-Ray diffraction (XRD) was used to confirm the crystal structure and composition of the particles while Fourier transform infrared (FTIR) spectroscopy was used to verify successful surface modification with PEG. Intracellular uptake of the nanoparticles was then evaluated *in vitro* using human breast cancer (BT20) cells. Finally, magnetic resonance imaging (MRI) was used to measure relaxation time and observe cellular uptake. Results from this study suggest that Gd O nanoparticles coated with PEG are sufficiently internalized<sup>3</sup> by cancer cells and thus have potential for use as a novel MRI contrast agent.

### **Spectral Methods in Data Mining: Collaborative Filtering**

*Michelle Goodstein, Senior, Computer Science, Mathematics*

*Mary Gates Scholar*

*Mentor: Anna Karlin, Computer Science & Engineering*

The growing popularity of the Internet has created large repositories of data, with potential data mining applications in the fields of collaborative filtering and web search. Data mining is the process of analyzing these sets of data to ob-

tain useful information. However, retrieving meaningful results from such a vast set of data can be difficult. Collaborative filtering is the process of combining sparse amounts of data from many users to make recommendations. We are investigating the use of spectral techniques as a means of making better recommendations to users. Our research currently focuses on generalizing and simplifying previously published algorithms, proving new theorems regarding performance guarantees, testing how the addition of normalization techniques affects the accuracy of our algorithms, and empirically evaluating how the various algorithms work in practice. Joint work with Anna Karlin, Frank McSherry, Matthew Milcic, Peter Turschmid and Danny Wei.

### **“Feminine” Speech in Japanese Animation**

*Kristi Elaine Govella, Senior, Political Science, Japanese Mary Gates Scholar*

*Mentor: Amy Ohta, Asian Languages & Literature*

Gendered language exists in all areas of linguistics and in every language. In the Japanese language particularly, speech has traditionally been characterized by very distinct male and female registers, with women generally speaking in a relatively more “polite” manner and using more formal types of grammatical structures. In recent years however, preliminary research suggests that many young Japanese women may be using less feminine, or more masculine, speech patterns (Okamoto & Sato, 1992; Matsumoto, 1996). This observation prompts a number of questions. Does it imply that young girls are intentionally using masculine speech to sound “cool”? Is it a phase that will end once they enter the working world and are called upon to obey societal gender norms? Or is the new data an implication that speech forms previously available only to men are now being opened up to women and that definitions of “male” and “female” speech are simply changing with time? An important step in answering these questions is examining language use in order to discover if and when these masculine speech patterns are actually used by young Japanese women. In my research, I use discourse analysis to examine samples from several types of Japanese animation, particularly focusing on the sentence-final forms used by female characters. Unlike cartoons in the West, anime in Japan is a truly mainstream pop cultural phenomenon, simply accepted by virtually all the younger generation as a cultural staple. As a result of its popularity and scope, it provides a field for the playing out of traditional cultural visions of men’s and women’s natures, and the language appropriate to these natures. Anime scripts potentially reflect a number of stereotypes regarding how men and women should and/or do speak, and I hope to identify some of these trends through my research.

### **Effects of Apoptosis on a Mycobacterial Infection;**

### **Role of 19kDa Lipoprotein Antigen**

*Katherine Graef, Senior, Microbiology*

*Mary Gates Scholar*

*Mentor: Lalita Ramakrishnan, Microbiology*

*Mentor: Christine Cosma, Microbiology*

With one-third of the world's population currently infected, *Mycobacterium tuberculosis* (MTB) remains an important pathogen; yet little is known about its pathogenesis. Research has shown that host macrophage apoptosis is induced in response to a mycobacterial infection, but it is unclear if this apoptosis benefits the host or bacterium. One key microbial antigen that induces apoptosis is the *lpqH* 19kDa lipoprotein that is expressed on MTB's cell wall. This lipoprotein, which signals via TLR2, has been shown to induce apoptosis in macrophages as well as prevent antigen presentation. Using the model organism *Mycobacterium marinum* (MM), we tested the effects of an *lpqH* knockout on the host-pathogen interactions. Our early data shows increased bacterial growth in vitro macrophage cultures, suggesting apoptosis is key to bacterial clearing and host survival. However, growth of WT and the *lpqH* knockout were identical in the frog model of infection in vivo. To further our study of *lpqH* and apoptosis, we are currently investigating the effects of the *lpqH* knockout on apoptosis in zebrafish embryos and murine macrophages using TUNEL staining. Through this, we hope to understand *lpqH*'s function and the role of apoptosis in a mycobacterial infection.

### **The Role of the Mismatch Repair Proteins In B Cell Class Switch Recombination**

*Jesse Green, Senior, Biology*

*Mary Gates Scholar*

*Mentor: Nancy Maizels, Immunology, Biochemistry*

Adaptive immunity to disease requires that B cells produce and secrete millions of different antibodies that each recognizes a different antigen. When a mature B cell encounters an antigen that can bind its surface receptors, its immunoglobulin genes are stimulated to carry out two key genetic processes: somatic hypermutation and class switch recombination. Class switch recombination is a regulated and irreversible process of DNA deletion that allows production of a different antibody isotype. It involves transcription of and recombination between two switch regions. Switch regions are guanine-rich repetitive sequences, 2-10 kilobases in length, located upstream of the constant genes in the immunoglobulin heavy chain locus. Several endogenous cellular proteins are necessary for class switching, including the mismatch repair complex, which normally binds to mismatches in the DNA strand and initiates their repair. I am interested in the role of the mismatch repair factor MutS $\alpha$  in class switching and genomic stability. I have shown that MutS $\alpha$  associates with secondary DNA structures (G4 DNA) that form in guanine-rich transcribed switch regions. I am asking how MutS $\alpha$  affects plasmid

maintenance, and in particular, the stability of transcribed switch regions. I have developed an assay to test the effects of MutS $\alpha$  on the stability of model substrates in *E. coli*. In this assay, cultured cells are induced to transcribe model switch regions, which are then captured through non-denaturing lysis of the cells, isolated, and analyzed by gel electrophoresis. I have generated a panel of mutant strains, which lack the *E. coli* homolog MutS in combination with other mutations. These strains allow me to test the effect of MutS on the stability of transcribed switch regions in experiments currently underway. The results of my experiments will further understanding of the process of class switch recombination as well as the factors that affect genomic stability

### **Study Extracellular Matrix Using Ultra High Vacuum Surface Science**

*Max Greenfeld, Senior, Chemical Engineering*

*Mentor: David G. Castner Chemical Engineering, Bioengineering*

Surfaces coated with plasma polymerized *N*-isopropyl acrylamide (ppNIPAM) have a temperature sensitive property that is currently being exploited in a variety of tissue engineering applications. A ppNIPAM surface transforms from hydrophobic to hydrophilic as the temperature drops below  $\sim 32$  °C, the lower critical solution temperature (LCST). Many cells that readily adhere and proliferate on the hydrophobic surface will spontaneously release below the LCST with apparent preservation of the extracellular matrix (ECM) proteins. Cell-cell junctions are maintained during release of cells allowing the harvest of confluent cell monolayers. Cell integrity and orientation are maintained by temporarily laminating the apical cell surface with a support membrane at the time of cell release. This advanced tissue engineering technique gives unprecedented access to an intact ECM interlayer. Ultra-high vacuum (UHV) surface analysis is for the first time being applied to the ECM surface. Light microscopy and scanning electron microscopy has been used to verify cell morphology is maintained in the UHV environment. Electron spectroscopy for chemical analysis (ESCA) has revealed the presence of amino acids on the basal cell surface. Complementary to ESCA, time-of-flight secondary ion mass spectrometry (ToF-SIMS) has uniquely identified arginine and tryptophan amino acids as part of the ECM. Preliminary results have indicated the apical and basal surfaces can be distinguished with ToF-SIMS.

### **The Redesign and Characterization of a Depth Sensor Amplifier for a Robotic Fish**

*Laura Grupp, Junior, Electrical Engineering*

*Dana Wen, Sophomore, Computer Science and Engineering*

*Mentor: Krisi Morgansen, Aeronautics and Astronautics*

The robotic fish is a tool designed to independently collect

oceanographic data such as salinity and temperature. Cluttered environments in the ocean can make data collection difficult. Eventually, scientists may use the robot to more effectively complete this task in order to, for example, create oceanographic maps of salinity, temperature and other information. The robotic fish introduces flapping pectoral fins rather than a spinning propeller to more easily maneuver at low speeds in these surroundings. Designed to function as an autonomous device, the fish will eventually be capable of completing tasks independent of continual human interaction. Our contribution to the project started at the beginning of Summer 2004. We focused on the depth sensor - a navigational instrument in the fish. Most of our work centered on characterizing the depth sensor amplifier in order to find optimal settings on two variable resistors. Work following this summer focused on repairing several components of the fish's hardware - the compass and the main computer inside of the fish. A goal for work in the future is to transfer the tail fin's control over maneuverability to the pectoral fins.

#### **Mathematical Model Selection in Muscle Contraction**

*Divakar Gupta, Senior, Bioengineering, Statistics*

*Mary Gates Scholar*

*Mentor: Paolo Vicini, Bioengineering*

*Mentor: Michael Regnier, Bioengineering*

The mechanics and kinetics of contraction in skeletal, cardiac and smooth muscle account for limb movement, blood circulation and nutrient or waste transport, respectively. At the macroscopic level these processes are understood reasonably well, however, a complete model of muscle contraction must rely on an accurate description of the time-dependent state of contractile proteins and their respective substrates. These proteins include myosin (molecular motor and ATPase), actin (the protein which myosin acts on), and regulatory proteins (which facilitate actin and myosin binding). A model that explains the interactions of these molecular contractile elements could be applied in the diagnosis and design of therapeutics of muscular diseases such as congestive heart failure, the leading cause of death in the United States. This research aims to determine the rates of transition of muscle proteins between different actomyosin (crossbridge) states during the contractile process. Currently, fiber force tracings are analyzed with exponential models whose parameters are estimated from nonlinear regression. These parameters, however, are summary statistics and are ambiguous in determining specific muscle protein state transitions. This research has used force tracings from rabbit psoas muscle fibers to develop a five-state model informed by the data. This model was generated in the compartmental modeling program Simulation, Analysis and Modeling II (SAAM II). The model accounts for calcium activation of regulatory proteins and crossbridge formation in weak, strong and force generating states. Also, the temporal and steady-state distribution of crossbridges in the different binding states as well as the component of

force provided by strongly bound crossbridges are predicted by this model. The performance of the model on three muscle fibers over a range of calcium levels has been superior to that of the widely used exponential models. These preliminary results provide a more complete and mechanistically based description of muscle protein-protein interactions.

#### **Flagellar Assembly in *Salmonella typhimurium*: Regulation of Flagellar Rod Length in Super-Rod Mutants and Wildtype**

*Grace Gyurkey, Senior, Biology*

*Mentor: Kelly Hughes, Microbiology*

The flagellum of bacteria, and more specifically *Salmonella typhimurium*, is a complex nanomotor that is required for motility, chemotaxis and virulence factors. The purpose of my research is to identify what genes regulate rod length in flagella and identify a potential molecular ruler. My project is focused on the assembly of the hook-basal body (HBB) structure, the four rod genes and two regulatory proteins which regulate the completion of the flagellum. To identify the genes involved, I used a strain of *Salmonella typhimurium* that is missing two stabilizing proteins that allow for the filament of the flagellum to be built. Without these proteins the HBB cannot be completed and thus cannot grow a filament. In the same strain we placed a reporter in a class 3 gene to show if the class 3 genes are on or off. We then screened for mutants that were expressing class 3 genes without a functional HBB. We found four classes of mutants, three of which were predicted and one new class called the "super-rods". The super-rods had class 3 gene expression as well as much longer rods. Using PCR and sequencing, we confirmed that two mutants had mutations in the rod genes leading us to believe that the rod genes play a role in rod length regulation. Using genetic recombination techniques, I am currently putting the identified mutations back into wildtype cells that have the full complement of genes needed to build the flagellum. We are trying to determine if the super-rod mutants are motile and if they continue to have long rods as well as a functional HBB and filament. Results will allow us to focus our efforts on identifying a potential molecular ruler.

#### **Creating Meaning Across Curriculum**

*Brandi Hair, Senior, Comparative History of Ideas*

*Zesbaugh Scholar*

*Mentor: Reed Stevens, College of Education, Cognitive Studies in Education*

Promoting Argumentation Through the Teaching of History and Science [PATHS] is a three-year project funded by the National Science Foundation. Its goal is to facilitate and study cross subject connections that students are capable of making in two subjects, history and science. These two subjects have generally been viewed in intellectual history and in classroom practice as being very different ways

of making and using knowledge. This research project explores the question of whether students reproduce these differences when students are given relatively genuine versions of historical and scientific problems to solve in their classrooms. In these classrooms, students experienced collaborative environments in which student led discussion in small groups forms the curriculum, students were assigned questions but are also given the space to pursue emergent questions, and the role of the teacher became that of a facilitator. Recorded discourse data was collected in the classrooms, with the students talking history and science. This analysis explores the ways in which students' approaches to answering inquiry-based questions in history and science were similar and different through a comparative analysis of segments of the discourse data. Our goal is to understand "what counts" to students as good evidence and good argumentation in each subject. We also discuss the implications of this study in terms of what it tells us about human cognition and about teaching and learning in classrooms.

### **Physiological protein interactions in skeletal muscle**

*Megan Ham, Junior, Bioengineering*

*Mentor: Michael Regnier, Bioengineering*

Our lab studies molecular mechanisms of cardiac and skeletal muscle force generation and regulation by calcium. Understanding the molecular mechanisms of muscle regulation is important because it provides information about potential therapeutic targets to treat cardiovascular and skeletal muscle disease. For example, site directed mutants of regulated contractile proteins might enhance performance of muscle with pathological contractile dysfunction. Following this line of thinking we engineered mutations into recombinant regulatory proteins and tested their effect on the calcium dependence of contraction in cellular muscle preparations. Several mutants resulted in more force generated at a given calcium level, making them potential candidates for gene therapy approaches to improving muscle function that occurs with musculoskeletal disease.

### **Localizing Gamma Ray Sources Using Wavelet Analysis**

*Scott Hanes, Sophomore, Physics*

*Mentor: Toby Burnett, Elementary Particle Physics*

The process of locating gamma ray sources depends on collecting many individual gamma rays originating from the source, tracing them back to their respective directions, and employing statistical methods to determine the most probable location of the source. This process is complicated by a uniform background of gamma ray radiation. We cannot effectively use the Gaussian distribution to the data acquired from the gamma rays because it does not filter out the uniform background, making the localization process less precise. To address this complication, our goal

is to simulate and implement an application of wavelet analysis for the data, which employs a function similar to the Gaussian curve but becomes negative at all values beyond a certain distance from the center. We can use this function as the basis of an estimator that makes use of the background radiation along with the additional gamma rays originating at and near the source, allowing us to determine the most probable location of the source to precisions close to that achieved using the Gaussian distribution. A successful application of this method would increase the precision to which we can localize known gamma ray sources, and can be utilized by the forthcoming GLAST gamma ray observatory to further improve its resolution.

### **Direct Methanol Oxidation Pathways**

*Danielle Hansgen, Senior, Chemical Engineering*

*Mary Gates Scholar*

*Mentor: Eric M. Stuve, Chemical Engineering*

*Mentor: Liney Árnadóttir, Chemical Engineering*

Direct methanol fuel cells have many advantages due to the characteristics of the fuel. Although methanol is easier to handle than hydrogen, direct methanol fuel cells suffer from low power densities due to slow reaction rates at the anode. As methanol is oxidized to  $\text{CO}_2$ , many intermediates are formed, including CO. At low temperatures carbon monoxide has been shown to have a poisoning effect, binding to the platinum catalyst sites, rendering them inactive. The effects of this poisoning are reduced efficiency and reaction rates. Under certain conditions, it has been shown that a parallel oxidation pathway, which does not form CO, may exist. An understanding of the reaction mechanism would allow for a DMFC design to accommodate these conditions. Ultimately, we seek to find the state under which CO is not produced. After oxidizing methanol with a platinum catalyst, we are able to test the extent of CO accumulation on the platinum catalyst through cyclic voltammetry. Combined cyclic voltammetry and potential step measurements provide two independent measurements of total reaction charge and CO stripping charge. From this, we can determine the selectivity for the parallel oxidation pathway.

### **The Regional Albedo of Arctic Sea Ice in the Coastal Zone and Its Response to Varying Surface Conditions**

*Jeremy Harbeck, Senior, Atmospheric Sciences*

*Mentor: Thomas C. Grenfell, Atmospheric Sciences*

Recently throughout the Arctic Basin significant changes have been observed in the extent and thickness of both single and multi-year sea ice. Sea ice plays a major part in the global climate system as an atmospheric energy sink, but holds an even more important position, whereby mass fluctuations are used to gauge the changing climate. Understanding these fluctuations is essential for improving current climatological and general circulation models. Regional albedo (reflectance), along with its spatial and tem-

poral evolution, is a key ingredient towards model construction. This is particularly true during the summer melt season, when the development of melt ponds and areas of open water decrease albedo significantly. Due to particularly strong seasonal variations, this effect remains most prominent in the coastal regions, where ice typically melts away in the summer, making them critical regions for understanding the consequences of climate warming. To study this area, data were collected during the winter and through the melt seasons over a three-year period (2000-2002) at Barrow, AK. Observations taken included digital photomosaics from aircraft across the coastal zone (in bands 5-10 km in length), and surface-based albedo measurements representative of prevalent surface types – bare and snow-covered sea ice, fresh water lake ice, and tundra. Presently, my goal is to use image analysis to determine the relative areas covered by each surface type throughout the year, combine these with measured albedos and subsequently calculate the critical regional albedo values. A surface type of primary concern is melt-pond covered ice. The evolution of the area covered by melt ponds and its resulting effect on regional melting can vary rapidly and remains not yet well understood. I will then present quantitative results describing this behavior, along with the role of other surfaces as they respond to a progressing melt season environment, will be presented.

### **Language Attitudes and Phonological Variation in Sichuan Mandarin**

*Alissa Harrison, Senior, Linguistics, Computer Science  
Mary Gates Scholar, Space Grant Scholar  
Mentor: Yu Liming, Sichuan University, Chinese Language*

China's language policies in the last fifty years have focused on promoting a standard common language across the entire country, namely Mandarin. Prevailing attitudes among government officials and textbooks have led to the received wisdom that Beijing Mandarin is the only acceptable standard. However, the majority of Mandarin speakers have deviations from this so-called standard. For instance, the retroflex initials /ts-, ts.h-, s-/ of Beijing Mandarin are often merged with the alveolar initials /ts-, tsh-, s-/ in southern varieties of Mandarin. Furthermore, there is evidence that suggests the growing economic status of southern cities like Shanghai, Hong Kong, and Taiwan is positively correlated with prestige in southern varieties of Mandarin across mainland China (Li 2004). On the other hand, a recent study of Shanghai Mandarin found younger and higher educated speakers tend to distinguish retroflex and alveolar sibilant initials in accordance with the Beijing Mandarin standard (Starr 2004). In light of these conflicting findings, I propose to investigate how language attitudes and sociological demographics affect phonological variation of retroflex initials in Sichuan Mandarin. The phonological variables that will be surveyed include the retroflex sibilants /ts-, ts.h-, s-/ and alveolar sibilants /ts-,

tsh-, s-/. The author will conduct face-to-face interviews among Sichuan University students to elicit speech data in multiple styles and a matched-guise test to survey their language attitudes. Multivariate statistical analysis will be conducted to examine the sociolinguistic variation of the retroflex initials, the variety of Mandarin held in higher prestige, and correlation of language attitudes to phonological variation.

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### **Optical Palpebral Fissure Measuring Device for Diagnosis of Fetal Alcohol Syndrome**

*Ryan Hartmaier, Senior, Bioengineering  
Mentor: Kirk Beach, Bioengineering  
Mentor: Tom Lewis, Bioengineering  
Mentor: Frederick Reitz, Bioengineering*

Identifying facial features, including the palpebral fissure length, has been shown to be effective at diagnosing Fetal Alcohol Syndrome (FAS). Since it is undesirable to measure these distances directly, a non-contact method must be used. However, current non-contact palpebral fissure measuring methods have a fundamental flaw by making gross assumptions about eye shape. Here I report a fast, easy, and accurate non-contact method to measure palpebral fissure lengths. An array of polycarbonate sections were used to split a short burst of collimated light from a single 785 nm laser diode into 14 parallel sheets of light. This array was mounted under a digital camera and calibrated at various distances. Although the sheets of light are parallel, they appear to move closer together in the camera's field of view as objects move further away from the camera. This fact was used to obtain a depth measurement from the 2-D digital camera image. Image processing algorithms have been created to generate this measurement with minimal user interaction. Initial prototypes have produced accuracy to within 2 mm. The prototype in production is expected to produce accuracies <1 mm. This system could be used to generate a more extensive library of palpebral fissure lengths so that diagnosis of FAS in patients of all ethnic groups can be performed accurately. Considerations were made during the designing of the device for possible future large scale production.

### **Position-Detector Photodiode Sensitivity**

*Suzanne Hayward, Junior, Physics, Astronomy  
Mary Gates Scholar  
Mentor: Jens Gundlach, Physics*

Photodiodes are electronic devices that can be used to mea-

sure position of a light source by where the light falls on the diode. My objective was to determine the sensitivity and stability of readings for different types of position-detectors. In order to conduct the tests, I designed and constructed an apparatus for holding the photodiodes and light source. Once my testing system was built, I calibrated the system to determine the linear range of positions the photodiode could measure. After the range had been found, I began long-duration testing of the photodiodes over several weeks to measure the fluctuation of readings and the stability of the system. Following analysis of these long-duration readings, I will be able to determine the relative characteristics of the different types of position-detectors. Such knowledge can then be used to select the appropriate photodiode for small distance measurements on applications relating to components of the Laser Interferometer Space Antennae (LISA) project.

### **Modeling Cortical Mechanics and the Establishment/Maintenance of PAR Polarity in the *C. elegans* Embryo**

*Eliana Hechter, Junior, Mathematics, Computer Science  
Mary Gates Scholar, Goldwater Scholar, NASA  
Space Grant Scholar*

*Mentor: Garrett Odell, Biology*

*Mentor: Edwin Munro, Biology*

During polarization of the one-cell *C. elegans* embryo, an asymmetrical actomyosin-based contraction drives cortical flows away from a localized sperm cue. These flows redistribute PAR proteins, which interact with one another and also modulate cortical contractility and flows, leading to the formation and maintenance of cortical PAR domains. Many of the key players and their interactions have been identified, but the complexity and distributed nature of these interactions makes verbal analyses of the polarization mechanism impossible. Here we present a computational model that integrates local biochemistry/mechanochemistry, transport processes and Newtonian mechanics to predict spatiotemporal patterns of cortical deformation/flow and protein movements from known interactions among PAR proteins and components of the actomyosin cytoskeleton. We show that local actomyosin dynamics and cortical furrowing observed during polarization in living embryos emerge as a robust consequence of conserved interactions within a cross-linked actomyosin meshwork. Different quantitative tunings of model parameters that govern actin, myosin and cross-linker levels, assembly/disassembly kinetics or activities reproduce the full range of contractility phenotypes associated with genetic and pharmacological disruption of polarization, including those caused by PAR mutants. We verify experimentally the predicted cortical response to some parameter tunings. Finally, we explore factors that could jointly determine the normal cortical response to a transient sperm cue, namely a self-limiting asymmetrical contraction that forms a stable anterior cap. These include: 1) the local contractility state and

its modulation by members of the PAR network; 2) interactions within the PAR network; 3) contractile “hoop stresses” that could impede or stall anterior flows; and 4) structural elements within or closely associated with the actomyosin meshwork that passively resist cortical compression or “crowding”. These results set the stage for (and will guide) further experimental analyses of the polarization mechanism.

### **Studies of *aghino*, a gene required for male fertility in *Drosophila melanogaster***

*Mary Alice Hiatt, Senior, Biology*

*Mentor: Barbara Wakimoto, Biology*

In the biological process of fertilization, egg-sperm interaction is crucial to development, as no embryo will form without this interaction. A class of male sterile mutations have been identified in the fruit fly *Drosophila melanogaster* that provide useful tools for identifying genes essential for normal fertilization. I am studying a mutation in a gene called *aghino* (*agho*), which causes sperm to arrest development shortly after entering into the egg. This mutation is particularly interesting because ongoing studies in our laboratory have suggested a role for *agho* in targeting or stabilizing a key protein in developing spermatids. I am using several strategies to determine which of 11 candidate genes is *agho*. One strategy is DNA sequencing, which will identify any differences in DNA between the mutant fly and a wild-type fly. A second approach is to refine the search for the gene by constructing new chromosomal deletions and testing those deficiencies by complementation. Finally, to confirm the identity of the gene, I will isolate DNA fragments containing the candidate genes, and test for rescue of male sterility of the *agho* mutant. These studies will allow me to identify the *aghino* gene and discover the nature of its protein product. This knowledge will allow me to test current models of the molecular means by which *agho* affects sperm development and function.

### **Clustering a Set of Proteins**

*David Hiller, Senior, Mathematics, Statistics*

*Mentor: Marina Meila, Statistics*

Clustering a set of data can be useful in a variety of applications, including sorting results from internet search engines, image segmentation, or applications in the life sciences. Clustering a data set means partitioning the data into clusters such that the elements in each cluster are similar to each other, but the elements in different clusters are different from each other. In this project, a dynamic programming algorithm for clustering was developed and tested. Dynamic programming uses a technique known as spectral clustering, which clusters a set of similarity data by finding the eigenvectors of a matrix derived from the data. Dynamic programming detects which eigenvectors indicate the true clustering of the data, and then clusters

them in order to determine how the original data are clustered. The advantage of dynamic programming is that it can be run fairly quickly and still achieve an optimal result. The algorithm was tested on a data set consisting of 4352 protein sequences. For comparison, the protein sequences were also clustered using a standard algorithm called K-means. The clusters of proteins which were discovered by the algorithms were compared to the known biological classifications of the proteins. While dynamic programming showed promising results, more work is needed in order to more accurately predict the clusters.

### **Nature and Needs of Young Children with Down Syndrome**

*Jocelyn Hilo, Senior, International Studies, Comparative Religion*

*Zesbaugh Scholar*

*Mentor: Susan Sandall, Area of Special Education*

Down Syndrome is a genetic condition caused by extra genetic material (genes) from the 21<sup>st</sup> chromosome. The extra genes cause certain characteristics that we know as Down syndrome. Among these characteristics is developmental delay. Young children with Down syndrome are frequently enrolled in inclusive education programs. Personnel who work in these programs include licensed teachers and therapists, but may also include various aides, assistants and volunteers. Sometimes these aides have limited knowledge of the nature and needs of children with Down syndrome. The purpose of this project was to understand the current knowledge of aides in an early childhood program and to use this baseline information to develop a resource notebook to increase their knowledge. I developed the survey to determine the baseline knowledge of the aides. The notebook consisted of basic information about the disability as well as simple strategies that these aides can use in the early childhood classroom. Following the development and dissemination of the resource notebook. I will return to the participants in the baseline survey and ask them to retake the survey. I will also ask them to evaluate the format and acceptability of the resource notebook. If the results are positive, additional resource notebooks will be created for other developmental disabilities.

### **Bootstrapping Imitation via Vision Based Shared Attention**

*Matt Hoffman, Senior, Computer Science, Mathematics*  
*Mary Gates Scholar*

*Mentor: Raj Rao, Computer Science*

Shared attention refers to the simultaneous perceptual focus of two or more agents on a single object in their shared environment. Endowing robots with the capacity for shared attention can lead to systems capable of complex, natural forms of learning, specifically learning by imitation. This

presentation will discuss various methods of building shared attention on a robotic platform, focusing on the use of vision and interaction to bootstrap the process. The methods used are based on Meltzoff and Moore's AIM model for imitation in infants and are implemented through the use of Bayesian methods. These Bayesian algorithms, used for their robustness to noise and tractability under large data sets, implement the core of a shared attention framework that follows the gaze and attentional locus of an instructor and learns task-specific saliency models from a cluttered scene. The results demonstrate the value of our system for promoting interaction between humans and robots.

### **Natural predation as a means for invasive species control: Can *Cancer productus* aid in controlling populations of the invasive bivalve *Nuttallia obscurata*?**

*Zackary Holt, Senior, Environmental Science, UW Tacoma*

*Mentor: David Secord, Program on the Environment*

*Mentor: James Gawel, Interdisciplinary Arts and Sciences, UW Tacoma*

*Mentor: Lia Wetzstein, Interdisciplinary Arts and Sciences, UW Tacoma*

*Mentor: John Banks, Interdisciplinary Arts and Sciences, UW Tacoma*

The presence of invasive species can alter marine ecosystems due to a lack of competition or predatory population control from native organisms. In some instances this alteration has resulted in displacement or large scale restructuring of species composition within invaded ecosystems. Control or regulation by native predators has been suggested to aid in control of invasions from non-indigenous species. This study explores some aspects of control mechanisms between the invasive bivalve *Nuttallia obscurata* and a potential native predator, the red rock crab *Cancer productus*. The objectives of this experiment were to determine whether crabs prefer *N. obscurata* over two local bivalve species *Venerupis philippinarium* (an established non-indigenous aquaculture species) and *Protothaca staminea* (a native clam) based upon physiological attributes and habitat use of prey species. Prey species were presented to *C. productus* specimens in three laboratory sea tables with continuously flowing seawater. Two of the sea tables simulated intertidal habitat and consisted of shallow sediment (4cm) and deep sediment (14cm). A control tank with no sediment was also used. Results indicated a preference for *N. obscurata* in the zero sediment (control) tank, *V. philippinarium* in the deep sediment tank, and *P. staminea* in the shallow sediment tank, indicating a possible preference of prey species which settle near the sediment surface. This could be suggestive that natural control of *N. obscurata* by *C. productus* may not occur.

### **Control of Protein Synthesis During Embryonic Stem Cell Differentiation**

*Brittany Hopkins, Sophomore, Biology*  
*Mentor: Charles E. Murry, Pathology*  
*Mentor: Prabha Sampath, Pathology*

Repair or regeneration of a damaged heart after a heart attack (myocardial infarction) is the ultimate goal of Dr. Murry's Lab. Current treatments focus on increasing blood supply to the damaged area of the heart. While beneficial, many patients still progress to heart failure after an infarct. Stem cells offer the opportunity to rebuild the heart from its component parts. The signals that regulate differentiation of embryonic stem cells to cardiomyocytes (heart muscle cells), however, are poorly understood. We hypothesize that many genes involved in stem cell differentiation are regulated at the level of protein translation. We intend to identify these genes by comparing the polysome profiles and the translation state array analysis of undifferentiated cells with that of the differentiated embryonic stem cells. Elucidation of the molecular mechanism involved in the differentiation of embryonic stem cells to cardiomyocytes can be applied clinically in cell-based therapy for the treatment of heart attacks.

#### **Accumulation of Organic-Rich Sediments in an Avulsive River System: Examples from the Cumberland Marshes, Saskatchewan, Canada**

*Erin Howell, Senior, Environmental Science*  
*Mentor: Siân Davies-Vollum, Environmental Science*

Avulsion is the process by which flow is diverted out of an established river channel into a new course on the adjacent floodplain. The literature on ancient fluvial systems has indicated that there is a link between avulsion processes and the deposition and accumulation of organic-rich sediments. However, it is unclear where organic deposits form in an avulsive river system and whether the location of formation influences their purity. The Cumberland Marshes of the Saskatchewan River in Canada are part of a well-studied avulsive river system. The last major avulsion took place around the 1870s when the Old Channel of the Saskatchewan River diverted northward and formed a network of anastomosed channels. Currently, the floodplain consists of numerous active and abandoned channels, the 1870s avulsion belt, and a diverse arrangement of wetland settings. Organic material is accumulating in both low-lying flood plain environments and shallow (less than 1m depth) lake environments. Cores were taken from transects across floodplains inside, at the edge, and outside of the avulsion belt to determine trends in organic deposits and their purity. In general cores contained clay, peat and organic-rich mud. Laboratory analysis of total organic carbon content (TOC) by combustion for three floodplain transects yielded values ranging from 15% up to 86%. Average TOC values generally increased with increasing distance from the channel, which can be explained by trends

in grain size and the tendency for fine sediments to be organic-rich. Maximum TOC levels recorded for individual transects also increased with distance from the avulsion belt. Results indicate that avulsion processes, overbank flow, and associated sediment inputs act as controls on organic deposition. Further analysis of additional transects in addition to more detailed field work is required but initial results indicate that while location does play a role in purity, organic deposits accumulate on floodplains within and just outside the avulsion belt.

#### **Developing a New Shear Stress Sensor**

*Anh Ho, Junior, Bioengineering*  
*Mentor: Wendy Thomas, Bioengineering*

The bacterial adhesive protein FimH is force activated. FimH binds to monomannose receptor strongly within a characteristic force range and weakly below or above this range. This binding property of FimH can be used for technological application such as shear stress sensor. In a moving fluidic system the drag forces exert on a particle depend on the particle size and the shear stress caused by the fluid. Thus, by attaching FimH to microspheres of various sizes and coating the surface with monomannose, the shear stress of the surface can be determined based on which size of microspheres stick to the wall. My project focuses on building a sensor that can detect wall shear stress with high accuracy using FimH and microspheres. Such sensor can be used to measure wall shear stress in systems with irregular geometries and non-Newtonian fluid where computational methods of finding wall shear stress become difficult and existing techniques of measuring wall shear stress often fail.

#### **Competition between Macrophyte and Algae in Fresh Water Laboratory Microcosms Supporting *Daphnia magna* Populations**

*Vanessa Hoy, Senior, Physiology*  
*Kana Imakura, Senior, Biology*  
*Mentor: Frieda Taub, Aquatic and Fishery Sciences*

The most readily available Closed Ecological Systems (CES) today can be ordered online and shipped to your doorstep for your viewing pleasure within days. However, aesthetic value aside, CES provide a valuable means of studying biological interactions. In a CES, physical processes such as diffusion can be minimized and variables easily manipulated, making investigation much simpler than in situ studies involving large lakes and oceans. Expanding on the general autotroph-grazer model, we wanted to look at how algae and a macrophyte - *Ceratophyllum demersum*, would compete in the presence of a grazer - *Daphnia magna*. Given the similar needs of algae and macrophytes, we predicted that the algae would be out competed because *C. demersum* can extract nutrients (N, P) more efficiently. This was examined by means of 3 types of microcosms; algae

and *Daphnia* in the presence of no plant, live plant, and artificial plant. All three groups were observed under closed and open conditions (six replicates each). Results showed a similar trend of peaking populations after 14 days followed by a slow decline. Small sized *Daphnia* tended to dominate the population as time elapsed. In general, open systems sustained higher peak populations indicating that atmospheric exchange is vitally important in determining competition results. An interesting point was that closed microcosms with live plants yielded higher *Daphnia* populations than other closed systems. We suspect this was a result of excess nutrients in the system due to the decomposition of *C. demersum*, as plants looked sickly in closed systems. It can be concluded that the shape of the plant itself may be involved in either suppression of algal growth or direct inhibition of *Daphnia* feeding.

### **Rapid Evolution of the Chloroplast-Encoded *cfxQ* Gene**

*Amanda Hoyt, Senior, Biochemistry*  
*Kun-Lin Lee, Junior, Biochemistry*  
*Mentor: Rose Ann Cattolico, Biology*

CO<sub>2</sub> entrance in the Calvin Cycle of many autotrophic organisms is driven by the enzyme *Rubulose 1,5-Bisphosphate Carboxylase/Oxygenase (RuBisCO)*. The product of the gene *cfxQ* plays an integral role in modifying cellular CO<sub>2</sub> processing, and is thought to act as a transcriptional regulator of *RuBisCO* gene expression or as a molecular chaperone for the *RuBisCO* enzyme. Analysis of the chloroplast-encoded *cfxQ* in the golden-brown alga *Heterosigma akashiwo* shows that this gene is rapidly evolving. Though *cfxQ* is present in almost 2,500 copies per cell, the presence of single nucleotide polymorphisms (SNPs) has been documented to occur when fourteen geographically distinct algal populations are compared. These nucleotide changes are observed to cause alterations in the resulting *cfxQ* protein, which may be synonymous (amino acids in the protein remain the same) or non-synonymous (amino acids in the protein are changed). Molecular modeling shows that changes in amino acid composition can alter *cfxQ*'s structure, and thus function. The goal of this study is to complete examination of SNPs among selected *Heterosigma* strains and to probe the functionality of the *cfxQ* protein product. PCR, cloning and sequencing will be used to complete the SNPs study. Overexpression of *cfxQ* genes will be used to produce protein product from select *Heterosigma* strains, which can then be utilized to compare and analyze gene function.

### **Cymric, a Novel SHARK Tyrosine Kinase Implicated in Ascidian Development and Evolution**

*Jennifer Hsu, Senior, Biology*  
*Mary Gates Scholar*  
*Mentor: Billie J. Swalla, Biology*

SHARK (Src-homology ankyrin-repeat containing tyrosine kinase) non-receptor tyrosine kinases are a unique family of genes that contain five ankyrin repeats located between two SH2 domains on the 5' end. Previously, there have been two genes isolated from this family – *Drosophila* SHARK and hydra HTK16. A new gene of the SHARK-family tyrosine kinase, *Cymric*, was identified through subtractive hybridization between two sister species of ascidians with contrasting larval morphology. Ascidians are a good developmental model system because their larvae display simple yet defining characteristics of all chordates, including a notochord, dorsal hollow nerve tube and tail muscle cells. Two species of ascidians used in our studies are *Molgula oculata*, which has a tailed larva, and *Molgula occulta*, which exhibits a tailless larva. *In situ* hybridization of both species' gonads revealed that *Cymric* is expressed only in the oocytes of tailed, but not tailless, species. Protein localization shows *Cymric* localized in the myoplasm, a cytoskeletal domain necessary for later ascidian tail muscle development. Southern blots show that *Cymric* may not be present in the tailless, *M. occulta*, genome. We propose that *Cymric* plays a significant role in axis determination, gastrulation, and tail muscle formation of ascidians. We hope to understand more about the development of the chordate body plan by studying *Cymric* activation during embryogenesis.

### **Using Computational Methods to Analyze Possible Bacteria-to-Plant Transfers**

*Diane Hu, Junior, Computer Science*  
*Mary Gates Scholar*  
*Mentor: Martin Tompa, Computer Science and Engineering*

The bacterium *Agrobacterium tumefaciens* is known to have the remarkable ability of being able to excise its own DNA and transfer it into plant cells. The transferred DNA then integrates itself into its host genome and directs the expression of various disease related genes. The specific problem we are interested in analyzing is whether or not these "bacteria-to-plant" DNA transfers may have appeared in the evolutionary history of various plant species. Though it is common for prokaryotes to depend on horizontal gene transfer to facilitate recombination, evidence of gene transfers from prokaryotes to eukaryotes, and even eukaryotes to eukaryotes have sparked much debate and speculation. This study is a part of a much larger effort in trying to understand gene exchange between eukaryotes, and whether or not to actually consider interspecies gene transfer as an important evolutionary process in eukaryotes. We approach this problem by finding long DNA sequences (100 to 200 bases long), or "fingerprints" of bacterial plasmid DNA within the sequenced genomes of various plants. The Blast program is used to compare various bacterium genomes (with capabilities similar to that of *Agrobacterium tumefaciens*) against sequenced plant genomes (obtained from the NCBI database) commonly affected by the spe-

cific pathogen. By doing so, records of past pathogenic activity may be discovered.

### **UBuildIt/Indicator Browser**

*Casey Huggins, Senior, Computer Science and Engineering*

*Mary Gates Scholar*

*Mentor: Alan Borning, Computer Science and Engineering*

UrbanSim is an integrated simulation system that models the development of urban areas over periods of 20 or more years. Its purpose is to help inform public decision-making on decisions involving major transportation system changes, land use decisions, and their environmental impacts. Using the UrbanSim simulator, large volumes of data are processed in a variety of statistical models. Changes in population, land use, employment, transportation and more are all calculated and stored in an output database. The interpretation of this data is largely accomplished by means of indicators. As defined in modeling literature, an indicator is a variable that conveys information on the condition and/or trend of an attribute (or attributes) of the system being considered. The challenge, then, is to create a system in which interested persons can conveniently view different indicator results using a web-based interface. The Indicator Browser will accomplish this. There are several interesting technical questions to be addressed in the implementation of this software, including how to manage complex indicator computation; ways design an intuitive UI for large numbers of indicators, and how to manage communication between system components.

### **Fringing Field Sensor Array Interface**

*Marc Eric Hungerford, Senior, Electrical Engineering*

*Mentor: Alexander Mamishev, Electrical Engineering*

Fringing electric field (FEF) sensor arrays are being developed by many research groups. Their potential lies in noninvasive three-dimensional imaging of internal structures for use in tomography, material sciences, and other fields. Small-scale FEF sensor arrays are already benefiting research and manufacturing fields including medical, material study, and even quality control for automated food production lines. Unfortunately, FEF sensors have electrical characteristics that are hard to measure without specialized equipment. Thus, research in this field is limited by practicalities such as the cost and size of equipment necessary to acquire measurements from the individual sensors. It is significantly more impractical to use this equipment for arrays of sensors—as is required for imaging. Therefore a small, modular, and cost-effective multiple-sensor interface is being developed. A single device will cost an estimated \$200—a fraction of the price of the equipment already in use—and will interface eight sensor cells to a

standard computer or embedded system. In addition, it will be modularly expandable to handle virtually an unlimited number of sensors grouped into an array. The miniaturization and modularization of the interface equipment into a single cost effective device will enable the expansion of research and interest in fringing field dielectric sensing to a wider audience, including more research laboratories, students, and anyone else interested in this field.

### **Site Analysis and Remediation Prospects for Lead Contamination in Former WWI and WWII Army Firing Ranges: A Study of the Miller Hill Ranges of Fort Lewis, Washington**

*Justin Hurt, Senior, Environmental Science*

*Mentor: James Gavel, Environmental Science*

As the concepts and techniques of warfare change, so do the tools and facilities that are used to train to fight those conflicts. In the United States, the use of rangelands for firing lines and gunnery sites has placed an unusually high burden on the soil with regards to heavy metals contamination. The ballistic projectiles used in conducting modern firing practice have changed in composition significantly from their WWI and WWII predecessors, which were comprised almost exclusively of lead composites. This has left a high amount of lead contamination in the soils of ranges used in the first half of the 20<sup>th</sup> Century, and now that ranges are being consolidated on installations in an effort to lessen the impact of military maneuvers on the environment, what is to be done with the former firing ranges and what are the potential impacts on future development of such lands? Very little research has been done to address this issue on a service-wide scale at the more than 200 military installations still in use in the United States today. This study investigates the site history, extent of lead contamination and prospects for site remediation utilizing both historical data and systematic sampling and chemical analysis in order to determine what methods are feasible and environmentally sound in returning a series of former WWI and WWII small arms firing ranges to potential residential, commercial, or recreational use, and how this can be applied on a larger scale to address similar issues at other Army installations.

### **The Evolution of the Judicial Process: United States Supreme Court Agenda Setting in the Wake of a Changing Public Sentiment**

*Michelle Huynh, Senior, Political Science, Marketing*

*Kyle Sommer, Senior, Political Science, Spanish*

*Mentor: Bryan Jones, Political Science*

The United States Supreme Court as an institution is a body that follows only one rule: the rule of law. Yet, it is possible that certain outside factors play a significant role in their decision-making process. Our research project introduces two potential factors: public attention and opinion. Using datasets from the Policy Agendas Project (all of

which are coded according to 19 major topic codes and 224 subtopics) we measured public attention by what stories are featured in the New York Times and public opinion by the Most Important Problem identifier featured in the Gallup Poll. We also created a new dataset, using the Policy Agendas Project coding scheme, to measure Supreme Court agenda setting. This allows for consistent analysis across datasets. The dataset includes all cases acknowledged by the Supreme Court (1954-1997 terms) and found in the United States Reporter. Using these measures we set out to find whether or not public sentiment (measured by public opinion and attention) influences the Supreme Court's agenda.

### **Isolation and Analysis of Chloroplast DNA in Plants**

*Richard Huynh, Junior, Biology*

*Mentor: Delene Oldenburg, Biology*

*Mentor: Arenold Bendich, Biology*

Plants are commonly assumed to maintain a constant level of DNA in mature, photosynthetically active chloroplasts. However, when isolating chloroplasts from tissue in plants like *Arabidopsis* and maize, plants lose chloroplast DNA with development. We want to determine whether changes and degradation of chloroplast DNA in mature leaves is common to all plants or only specific types. For example, will there be a loss of DNA in herbaceous species (pea and carrot) and also in woody plants (oak and maple)? Another comparison is between deciduous plants (azalea and maple) that lose their leaves every year and evergreen plants (rhododendron and pine) that retain their leaves for several years. To achieve this goal we are surveying chloroplast DNA in different stages of plant leaf tissue through the isolation of chloroplasts from young and old plant tissues. Once the chloroplasts are isolated, the DNA content will be identified by staining the chloroplasts with the DNA-specific dye, DAPI, and examination through fluorescence microscopy. With DAPI-DNA staining, data will be gathered through visual examination (qualitative analysis) for the presence of chloroplast DNA. The other method of determining chloroplast DNA is by taking pictures of chloroplasts using a digital camera connected to a fluorescence microscope. The intensity of the fluorescence of chloroplast DNA will be measured using a computer to average the pixels from the digital images of chloroplasts (quantitative analysis). This research will attempt to establish the characteristic loss of chloroplast DNA in various types of flora as they mature, which has now been determined to occur in pea, carrot, and cucumber plants. If we can establish the universal loss of chloroplast DNA, then we can try to find out the mechanism through which plants continue to live without chloroplast DNA.

### **Pacific Northwest English Vowel Study**

*Jennifer Ingle, Senior, Linguistics*

*Mentor: Richard Wright, Linguistics*

*Mentor: Alicia Beckford Wassink, Linguistics*

According to current literature a large region encompassing nearly the entire west half of the U.S. belongs to one dialect region referred to as Western, which furthermore, according to Labov et al., "... has developed a characteristic but not unique phonology." [[http://www.ling.upenn.edu/phono\\_atlas/NationalMap/NationalMap.html](http://www.ling.upenn.edu/phono_atlas/NationalMap/NationalMap.html)] This paper will describe the vowel space of a set of Pacific Northwest American English speakers native to the Ballard neighborhood of Seattle, Wash. based on the acoustical analysis of high-quality Marantz CDR 300 recordings. Characteristics, such as low back merger and [u] fronting will be compared to findings by other studies. It is hoped that these recordings will contribute to a growing number of corpora of North American English dialects. All participants were born in Seattle and began their residence in Ballard between ages 0-8. They were recorded in two styles of speech: individually reading repetitions of a word list containing one token each of 10 vowels within carrier phrases, and in casual conversation for 40 minutes with a partner matched in age, gender, and social mobility. The goal was to create a compatible data set for comparison with current acoustic studies. F1 and F2 and vowel duration from LPC spectral analysis will be presented.

### **An Age Dependent Sensitivity to Kisspeptin in Male Mice**

*Sonya Jakawich, Junior, Biology*

*Mary Gates Scholar*

*Mentor: Robert Steiner, Physiology, Biophysics*

The brain triggers the release of gonadotropin-releasing hormone (GnRH) and luteinizing hormone (LH) to initiate the onset of puberty; however, the neural mechanisms governing this process remain poorly understood. Recently, the neuropeptide kisspeptin and its receptor (GPR54) have been implicated as key regulators of pubertal activation. Humans and animals with a mutation in GPR54 fail to undergo normal pubertal maturation, indicating that the kisspeptin/GPR54 pathway is essential for normal pubertal development. However, the role of the kisspeptin/GPR54 path in regulating puberty has not been fully elucidated. Recent observations in mice have shown that central infusions (ICV) of kisspeptin stimulate GnRH and LH secretion and that GnRH neurons express GPR54. Moreover, GnRH neurons, (studied *in vitro* preparations), from prepubertal animals are less sensitive electrophysiologically to kisspeptin than GnRH neurons from adult animals. We hypothesize that an up-regulation in the expression of GPR54 in GnRH neurons at puberty is responsible for the increase in electrophysiological responsiveness of GnRH neurons to kisspeptin across pubertal development. To search for *in vivo* evidence of an age-dependent change in sensitivity to kisspeptin, we challenged prepubertal and adult male mice with kisspeptin (ICV) and measured their LH response. We found that adult animals responded to kisspeptin in doses ranging from 10 fmol to 0.1 nmol, whereas prepubertal mice responded only to the highest

dose (0.1 nmol). These observations indicate that prepubertal mice are less sensitive than adults to kisspeptin, suggesting that alterations in the responsiveness to kisspeptin may be an important mechanism for timing the onset of puberty

### **Characterization of Internal Waves in the Aegean Sea**

*Ilan Jen-La Plante, Freshman, Biochemistry*

*Mentor: Kathryn Kelly, Oceanography*

The complex topography and varying atmospheric conditions of the Aegean and Eastern Mediterranean regions create the proper conditions for internal waves to exist. However, the frequency, location, and causes for internal waves are mostly unknown. By examining visible images from the MODIS (Moderate Resolution Imaging Spectroradiometer) instrument on NASA's Terra and Aqua satellites and comparing these with high-resolution QuikSCAT wind data and infrared SSH (sea surface height) data, we hope to find a statistical description for when and where internal waves are most likely to occur in the Aegean Sea. The images examined were obtained from the red channel of the MODIS sensor with a resolution of 250 m. Data was collected from the summer months (June and July) of 2000-2004. Images from other times of the year were unsuitable due to the presence of cloud cover and the lack of sunlight. In most cases, internal wave sightings occurred on the south or lee side of the islands. This, in combination with a consistent southward wind direction in the summer, indicates a link between wind direction, island topography, and internal wave formation. A frequency map of internal wave sightings also confirms the region around the island of Santorini (36°N, 25°E) to be the most common location for internal waves to occur.

### **Controlled Electrophoretic Deposition of Surface Treatments on Porous Tile Thermal Protection Systems**

*Jay Jongjitirat, Senior, Materials Science and Engineering*

*Mentor: Rajendra K. Bordia, Materials Science and Engineering*

*Mentor: Mairead Stackpoole, NASA Ames Research Center*

Controllable ceramic coatings are of interest for the treatment of porous shuttle insulation. Electrophoretic deposition (EPD) is a promising method for depositing such coatings, offering the production of uniform films on substrates of complicated shape and control of coating impregnation behavior. EPD has previously been used to prepare alumina coatings from isopropanol suspensions containing monochloroacetic acid (MCAA). In our study, Al<sub>2</sub>O<sub>3</sub> and silica suspensions in isopropanol and MCAA were prepared and deposited using EPD under 5 mA constant current conditions onto fibrous refractory composite insulation (FRCI), a porous tile substrate. The coatings were fired, sectioned,

and viewed under a scanning electron microscope in order to determine deposition and penetration behavior. It was determined that MCAA was needed to charge the particles for EPD. The silica particles had greater impregnation ability than alumina particles (with a 3.68 %/min higher rate of density change), and formed a dense layer near the anode. Optimization and further work is necessary to determine the effects of particle size, deposition time, and the effect of sedimentation on the coatings.

### **The abundance, distribution and energetic contribution of marine diatoms (Coccosphaera spp) during fall in the San Juan Archipelago, USA**

*Ann Jorgenson, Post-Baccalaureate, Oceanography*

*Mary Gates Scholar*

*Mentor: Jan Newton, Oceanography*

Abundance and distribution of *Coccosphaera* diatoms were determined at two locations in the San Juan Archipelago during flood and ebb tides from 11 October to 23 November 2004. During flood tides diatom abundance was over twice as high at the southern station relative to the northern station, suggesting a tidally driven oceanic influence. Two species of *Coccosphaera*, *C. wailesii* and *C. centralis*, were observed to shift in relative abundance throughout the sampling period. During the bloom, the abundance of *Coccosphaera* spp. reached 144,131 cells m<sup>-3</sup>, contributed 30.2 mg C m<sup>-3</sup>, and accounted for a large portion of the total chlorophyll a present in the water column. It is suggested that *Coccosphaera* diatoms play an important energetic role in the pelagic ecosystem of this region.

### **Human Activity Inferencing with Multiple Sensors**

*Megan Karalus, Sophomore, Pre-engineering*

*Mentor: Blake Hannaford, Electrical Engineering, Computer Science and Engineering*

*Mentor: Gaetano Borriello, Electrical Engineering, Computer Science and Engineering*

*Mentor: Ming-Ting Sun, Electrical Engineering, Computer Science and Engineering*

The field of ubiquitous computing explores the ability of different technological devices to interact seamlessly with each other and us. Computers are helpful but generally we adapt to them more than they adapt to us. Activity Inferencing could provide the context necessary for computers to adapt to us. Much work has been done with single sensors, namely accelerometers. The goal of this research is to improve the reliability of identifying common activities by increasing the number of sensors used. Our data collection system, contained in a backpack, included a shoulder mounted sensor board, web cam, external microphone, and laptop. The sensor board contained 7 sensors: microphone, barometric pressure and temperature, relative humidity and temperature, digital ambient light, analog ambient light, 3-axis accelerometer, and 2-axis digital com-

pass. We started with simple activities such as walking, jogging, climbing stairs, and riding in an elevator. The runs were annotated with the video and sound from the web cam and microphone. We found that many of the simple activities could be identified visually by plotting the sensor board information. Preliminary use of higher-level evaluation techniques indicates that the use of multiple sensors does not significantly increase reliability, although this work is still in progress.

### **Different *P. gingivalis* lipid A elicits varying host cell responses**

*Lisa Karimi-Naser, Senior, Wildlife science*

*Sarah Choe, Senior, Microbiology*

*Mentor: Richard P. Darveau, Microbiology*

*Porphyromonas gingivalis* is a gram-negative bacterium that is strongly associated with periodontitis, a chronic inflammatory disease of the tissue surrounding the tooth root surface. Gram-negative bacteria generate lipopolysaccharides (LPS), which are lipid-containing sugars that are part of the bacteria cell wall and are recognized as foreign by cells of the host's natural defense system. LPS obtained from *P. gingivalis* is unusual in that it can either stimulate or not stimulate cells of the host's periodontal tissues. Recently, it has been shown that *P. gingivalis* LPS displays an unusual amount of heterogeneity; that is, that there are multiple species with different chemical compositions. In this report, employing a combination of different *in vitro* culture media growth conditions and LPS extraction procedures, two different LPS preparations were obtained. One, designated PgLPS<sup>ETSB</sup> was enriched in LPS species containing lipids with either 3 or 4 fatty acid chains. The other preparation, designated PgLPS<sup>TYHK</sup> was enriched with LPS species containing lipids with 5 fatty acid chains. We tested these 2 preparations on human endothelial cells (cells that line blood vessels) and found that they demonstrated opposing effects on the production of E-Selectin, which is a critical molecule involved in inflammation. PgLPS<sup>ETSB</sup> was a potent stimulator of E-Selectin while PgLPS<sup>TYHK</sup> did not stimulate and in fact, inhibited the stimulatory ability of PgLPS<sup>TYHK</sup> when the two preparations were combined before applying to cells. The presence of two different structural types of LPS present in *P. gingivalis* with significant dissimilar effects on the E-Selectin response suggests that this organism is able to significantly modify, to its advantage, how it is recognized or not by cells of the host's defense system.

### **Evidence of Antimicrobial Peptide LL37/hCAP18 Localization and Its Mechanism of Release from Human Cystic Fibrosis Goblet Cells of the Respiratory Tract in Culture**

*Kelly Kettleison, Senior, Biology, Spanish*

*Mary Gates Scholar*

*Meena Padha, Recent Graduate, Biology*

*Mary Gates Scholar*

*Mentor: Pedro Verdugo, Bioengineering, Internal Medicine*

The human respiratory tract is continuously exposed to bacteria, dust and other particles found in the air. The airway is protected from this exposure by a clearance process called mucociliary transport (MCT). MCT works as a conveyor belt system where mucus forms a moving layer propelled up the respiratory tract by the ciliary activity of the epithelium. An additional defense mechanism is the presence of a specific family of antimicrobial peptides called cathelicidins. These peptides are known to be secreted by a variety of cells including neutrophils, acinae, and goblet cells. Although the specific cathelicidin LL37/hCAP18 has already been shown to be expressed in the airway epithelium, its storage and release have not been investigated. Many of the most prevalent diseases of the airway, including Cystic Fibrosis (CF), are associated with a lack of complete hydration of the exocytosed mucus. Mucus is stored in a condensed phase inside mucin granules and undergoes rapid swelling following exocytosis. There is evidence that mucus swelling is controlled by a Donnan equilibrium process that is driven by Na<sup>+</sup>/Ca<sup>2+</sup> ion exchange. Using immunocytochemistry and confocal microscopy we designed experiments to show that LL37/hCAP18 is contained in and secreted by cultured goblet cells. By increasing extracellular Ca<sup>2+</sup> to retard post-exocytic mucus swelling kinetics, we further verified that LL37/hCAP18 moves out of the exocytosed mucus matrix by diffusion, requiring full swelling of the matrix for its release to the airway surface. These observations suggest that deficient swelling of mucus like observed in cystic fibrosis might in addition prevent the proper release of LL37/hCAP18 and increased risk of airway infection.

### **Ex-vivo Generation of Stratified Corneal Epithelial Cell Layer on Temperature Responsive Polymer Surfaces**

*Sariah Khormae, Senior, Neurobiology, Biochemistry*

*Mary Gates Scholar*

*Mentor: Tueng T. Shen, Ophthalmology*

As the most anterior portion of the eye, the cornea possesses protective and refractory characteristics crucial for sight. Damage to the cornea, often due to disease or injury, may result in corneal blindness, the second most common form of treatable blindness worldwide. Currently, corneal blindness affects more than six million people, and another 150 million people are at risk. Although full thickness corneal transplant surgery is a viable treatment for some, the success of this procedure is limited by the availability of human donor tissue. In recent years, in order to increase the number of successful outcomes and reduce healing time post-operatively, surgeries to replace single layers of the cornea as opposed to the entire cornea are being explored. The objective of this project is to construct a corneal epi-

thelial layer for treatment of corneal epithelial damage as an alternative to full thickness corneal transplant. To accomplish this goal, a stratified corneal cell epithelial layer from an immortalized cell line will be cultured on a temperature responsive surface of plasma polymerized (N-isopropylacrylamide) or ppNIPAM covering Tissue Culture Polystyrene. These surfaces promote normal epithelial cell sheet growth and adhesion in standard 37 degree Celsius culture conditions. More importantly, the adhered cells can be spontaneously detached from the polymer surface at temperatures below the lower critical solution temperature for ppNIPAM, providing an intact corneal epithelial layer for transplant surgery. Specific to this project, human corneal epithelial cells will be cultured directly onto ppNIPAM surfaces at 37 degrees Celsius, using an air-water interface to encourage stratification. At the end of the culture period, the temperature of the cultured surface will be reduced to room temperature below the lower critical solution temperature for ppNIPAM) and the stratified corneal epithelial sheet will be harvested and analyzed for transplant feasibility.

#### **Impact of Early Pubertal Timing on Family Relations: Psychosocial or Hormonal?**

*Cindy Meerim Kim, Senior, Psychology, Pre-Medicine*

*McNair Scholar, Mary Gates Scholar*

*Mentor: Sybil Carrere, Family and Child Nursing*

Early pubertal timing for girls is associated with a variety of negative outcomes. Research indicates that early maturing girls are at a greater risk later in life for breast cancer, higher rates of teen pregnancy, disturbances in self-esteem, and engage in more problematic behaviors such as aggression, early dating, and substance abuse. Additionally, early pubertal timing is also associated with problematic family conflict and relations. The present study will test the two predominant theories and determine the best fitting model that predicts higher parent-child conflict amongst early maturing girls. The two theories applied to this issue are the psychosocial model and the hormone level model. The psychosocial model theorizes that girls whose experiences with their family are characterized by relatively high levels of stress, such as scarcity of resources, father absence, and negative and coercive family relations, are hypothesized to develop in a manner that speeds rates of pubertal maturation and sexual activity. On the other hand, the hormone level model indicates that girls who experience high-forage level of estradiol and cortisol (stress hormone) tend to show greater sexual maturation and early adrenarche. Therefore, parent-child conflict may simply reflect disequilibrium in biological processes stemming from the rapidly increasing hormone levels during puberty. The psychosocial model will be examined by salivary measures of cortisol during parent-child interaction at naturally occurring dinnertime home visit to the participants' homes. Levels of familial and environmental stress will be measured by marriage quality questionnaires, crime statistics of their neigh-

borhoods and socioeconomic and educational levels of parents. The hormonal levels will be determined by endocrine measures of salivary and urinary analysis of cortisol, estradiol, dehydroepiandrosterone, and catecholamines via salivary immunoassays and liquid chromatography. This research is in progress; therefore, concrete conclusions cannot be made.

#### **Gene Expression of Otoferlin in *Ciona intestinalis***

*HeeSun Kim, Sophomore, Biology*

*Mary Gates Scholar*

*Mentor: Billie J. Swalla, Biology*

We are studying the role of ferlins during development in the sea squirts, *Ciona intestinalis* and *Ciona savignyi*. Ferlins are a family of calcium binding proteins that have multiple roles in developmental processes in other species. Human otoferlin has six C2 Calcium-binding sites, which interact with phospholipids and proteins, and 1 transmembrane domain. A mutation in otoferlin is responsible for DFNB9, a type of autosomal recessive deafness in humans. We found in the Genome Database that *Ciona intestinalis* has a protein that is homologous to mammalian otoferlin that is expressed in its larvae. We analyzed the amino acid sequences to predict the location of C2 Calcium-binding domains and found that the ascidian sequence has 6 C2 domains. A *C. intestinalis* cDNA was obtained for a partial EST clone encoding otoferlin and sequenced. We are now carrying out experiments to determine the timing and spatial expression of otoferlin in *C. intestinalis* embryos, larvae and adults by in situ hybridization. We expect that expression may be in the gonads, as ferlins have been shown to be necessary for fertilization in *Drosophila melanogaster*. We hope to further examine the function of the protein by knocking out the expression of the gene and seeing the effect that it has on development in ascidians.

#### **Function of Rac in Zebrafish Embryos during Embryogenesis**

*Ju Youn Kim, Senior, Biochemistry, Biology*

*Mentor: Merrill Hille, Biology*

Cell motility plays a significant role during the embryogenesis, which is associated with massive cell movements. Cell motility involves several different proteins: Rac (GTPase), which produces lamellipodia, is one of them. Due to the significance of the cell motility in the embryogenesis as well as the involvement of Rac in the motility process, I am determining the function of Rac within zebrafish embryos during the embryogenesis. I first hypothesize that Rac is expressed at the edges of epithelial cells and/or deep cells where it functions in their motility. To test the hypothesis, I subcloned the recombinant of GFP-Rac to PCS2+ vector, which contains the promoter sites as well as the poly-A site for in vitro mRNA production. The constructs that I have are wildtype GFP-Rac, dominant-

negative GFP-Rac and constitutively-active GFP-Rac in PCS2+ vector and in mRNA. I microinjected the wildtype, dominant-negative and constitutively-active mRNAs (synthesized *in vitro*) into 1-cell stage zebrafish embryos. Thus far, I obtained several suggestive results. Using a confocal microscope, I observed increase in the expression of GFP along the edges of the epithelial cells from the constitutively-active GFP-Rac microinjected embryos. I did not observe significant expression of GFP in wildtype GFP-Rac microinjected embryos or in the dominant-negative GFP-Rac microinjected embryos. Based on the data, I conclude that active GFP-Rac with GTP bound is probably expressed along the edges of the epithelial cells. To confirm the results, I am repeating the experiment with the different GFP-Rac solution concentrations as well as with the greater number of embryos. To determine the function of Rac during the embryogenesis, I am microinjecting concentrated wildtype, dominant-negative and constitutively-active GFP-Rac mRNA's and analyzing the mutant (abnormal) phenotypes resulted from the concentrated GFP-Rac microinjection.

### **Is There a Relationship Between Parental Perfectionism and Suicidal Behavior in Young Adults?**

*Blair Kleiber, Junior, Pre-Major Arts and Sciences*

*Joanna Eland, Junior, Psychology*

*Amber Cawley, Junior, Psychology, Sociology*

*Ursula Whiteside, Post-baccalaureate, Psychology*

*Mentor: Mary Larimer, Psychiatry and Behavioral Science*

High perfectionism (a.k.a., clinical perfectionism) has been linked to numerous psychological problems, including depression, suicidal behaviors and suicidal plans. Studies have shown that adolescents and young adults who are highly perfectionistic are also likely to have perfectionistic parents, as well as being more likely to attempt or complete suicide. The link between perceived perfectionistic parents and suicidal behaviors and plans has yet to be established. This study's aim is to determine whether this relationship exists, and whether it is modified by a young adult's level of emotion coping skills. It would make sense that the greater access to emotion coping mechanisms (i.e., emotion regulation skills) an individual has, the less vulnerable they would be to the influences of a highly perfectionistic parent or parents. We would like to assess whether emotion coping abilities has a moderating effect on the relationship between suicidality and perfectionism as well as perfectionistic parents.

### **Nooks for NT**

*Eric Kochhar, Senior, Computer Engineering, Physics*

*Mary Gates Scholar*

*Micah Brodsky, Senior, Computer Engineering*

*Mentor: Hank Levy, Computer Science and Engineering*

*Mentor: Mike Swift, Computer Science and Engineering*

Today's computer users can expect their computers to fail

frequently, forcing restarts, loss of data, and loss of time. On commodity systems such as Windows, 85% of failures are caused by bugs in device drivers, which are privileged software modules that control devices, such as disks and audio cards. Device drivers are extremely complex. Unfortunately, that complex code is often written by inexperienced programmers at device companies, rather than experienced kernel programmers in the company that wrote the OS. The goal of Nooks for NT is to greatly reduce the number of Windows system failures by inserting a new protection layer between device drivers and the main operating system kernel. We create a new environment for driver execution, using memory isolation to ensure that driver bugs do not corrupt the rest of the system. Once Nooks detects a driver failure, it unloads the failed driver and reloads a working version of the driver without any user intervention. The original version of Nooks was implemented in Linux. We built a version of Nooks for Windows 2000, which has a much more complex driver and memory management model. This taught us important lessons about the interactions between reliability and complexity. Future work is focused on increasing isolation between the operating system and device drivers to get even tighter assurances about the performance and reliability of the system after driver restarts. We are also analyzing the performance of the system to understand if Nooks could be integrated easily into future systems.

### **Inter-Domain Genetic Transformation by *Agrobacterium tumefaciens***

*Liz Koontz, Junior, Microbiology*

*Mary Gates Scholar*

*Mentor: Paul de Figueiredo, Microbiology*

From the great blue whale to the smallest bacteria, living creatures can be categorized into three domains: the Eubacteria, the Archaea and the Eukarya. These three domains differ greatly in their physical characteristics and genetic material. Although it is common to see genetic transfer between members of the same domain, it is rare to see inter-domain genetic transfer. *Agrobacterium tumefaciens* is a well studied, but unique Eubacterium that transfers its DNA to many plant species, *in vivo*. This unique characteristic has led to the hypothesis that *A. tumefaciens* is also capable of transferring its DNA to a member of the domain Archaea. To test this hypothesis, I have created two plasmid vectors (circular pieces of DNA) containing different markers for selection. Using restriction enzyme digestion, fragments of DNA were cut from these vectors and new genes inserted. One of the vectors created contains a gene that encodes for resistance to the antibiotic puromycin. When selected for on media containing puromycin, these organisms grow. The other vector contains two regions of DNA that are homologous to regions of DNA in the Archaea, *Methanococcus maripaludis*; therefore the DNA will integrate into the Archaea genome via homologous recombina-

nation. This integration will disrupt the production of an enzyme that is toxic to the organism when combined with the base analog 8-aza-2,6-diaminopurine, so only organisms with this gene interruption will grow. Each of these two vectors will be transformed into each of *A. tumefaciens* and *E. coli*, members of the Eubacteria. These Eubacteria will then be incubated with *M. maripaludis*, an Archaea. Using the modes of selection provided by these two vectors, the presence or absence of growth on selective media will be determined. I predict the Eubacteria will successfully transfer their DNA to *M. maripaludis* and the DNA will be incorporated into its genome.

### **Expression of Vesicular Glutamate Transporters in the Developing Mouse Brain**

*Tom Kowalczyk, Junior, Neurobiology*

*Mary Gates Scholar*

*Mentor: Robert Hevner, Pathology*

Glutamate is the major excitatory neurotransmitter in neurons of the mammalian brain. Vesicular Glutamate Transporters (VGLUTs) transport glutamate from the cytoplasm into synaptic vesicles for release by exocytosis. Two subtypes, VGLUT1 and VGLUT2, are expressed in the developing brain. We are interested in studying the development of glutamatergic pathways in the mouse brain using VGLUTs as markers. Using immunohistochemistry and in situ hybridization, we stained embryonic and postnatal mouse brain sections to determine the developmental pattern of expression of these proteins and their mRNA. VGLUT1 was found in cortical efferent fibers, while VGLUT2 was expressed in cortical afferent fibers of the forebrain. Further separation of the two subtypes was seen throughout the brain. We also wanted to establish a correlation between the VGLUTs and *Tbr1* and *Tbr2*, two T-box transcription factors important for neuronal differentiation. Our hypothesis was that *Tbr1* and *Tbr2* are expressed by specific groups of glutamatergic neurons. Double labeling with *Tbr1* showed co-localization with VGLUT1 mRNA in cerebral cortex and with *Tbr2* in deep cerebellar nuclei. These preliminary results suggest the VGLUTs may play a role in developing the major glutamatergic axonal pathways in the brain.

### **Captive Magellanic penguins follow patterns seen in the wild**

*Vit Kraushaar, Senior, Biology*

*Carla Geyer, Senior, Zoology*

*Dan Okamoto, Senior, Biology*

*Mentor: P. Dee Boersma, Biology*

The San Francisco Zoo's outdoor exhibit for Magellanic penguins had fifty-two penguins at the start of 2003, which were hand fed twice a day until satiated. In 2003, keepers monitored what each penguin ate, its molting status, breeding status, and any medicine given. Using these data, we

analyzed how many fish each penguin ate and how their eating habits changed through the year. In 2003, penguins "migrated," swimming approximately 50 days from January 1 to February 17. Females ate significantly more than males (*t*-test,  $p = 0.002$ ). Females ate an average of 3.82 kg/day of herring, capelin, and smelt, and males 3.61 kg/day. Captive penguins molted following breeding, with juveniles molting before young adults and older adults molting last, the same pattern as in the wild. Juveniles began molting in the later half of July, with the oldest penguins starting around the beginning of September. Beginning molt dates increased with age until penguins were about five to ten years old, when it stabilized. Penguins bred in spring and summer in San Francisco, the same seasons in which they breed in the southern hemisphere. The six-month shift in breeding from the southern to the northern hemisphere suggests photoperiod is the ultimate cue for reproduction.

### **Automated Image Simplification and Braille Placement in Tactile Graphics Images**

*Satria Krisnandi, Senior, Computer Science*

*Mary Gates Scholar*

*Mentor: Professor Richard Ladner, Computer Science and Engineering*

Tactile graphic conversion is a process of translating visual images into tactile format such that a blind person can understand the information within the image. Currently, the conversion is a meticulous and time-consuming manual process. The Tactile Graphics Project's goal is to automate this conversion process and reduce the time it takes to produce the tactile graphic. One of the challenges in automating this process is image simplification. A majority of images in textbooks have high resolution, intricate details, and multiple colors. While these features might be visually appealing, they complicate a blind person's perception. To resolve these issues, the images must be modified for tactile format. We use steps like removing colors, replacing colors with texture, and edge detection to simplify the image for a blind person. Another challenge is translating text into Braille. Unlike regular fonts, Braille is significantly larger and fixed in width. Thus, simply replacing the fonts with Braille would not suffice; some modifications to the text are needed to avoid overlapping of text with image and other text. To take into account the larger Braille size, we have to enlarge the image. Then, for each text label, we have to find its alignment, i.e. find whether it is left, center, or right justified. By doing this, we can determine the placement of the Braille text so that they don't overlap with the image or other text.

### **The Effects of Global Warming in High Latitudes: Reduction of Sea Ice**

*Marta Krynytzky, Senior, Oceanography*

*Mary Gates Scholar*

*Mentor: Cecilia Bitz, Atmospheric Sciences*

Global climate change is likely to alter many habitats and environments on earth, but some areas will be affected more than others. Many coupled atmosphere-ocean general circulation models (AOGCMs) predict 2-4 times as much warming in the high latitudes as compared with global averages. Changes to these unique areas could hold serious consequences to global circulation patterns as well as local environments. Global warming and climate change will decrease the thickness and extent of ice coverage in the Arctic Ocean. Reduction of sea ice reduces the amount of habitat available for many northern species and the extent of hunting grounds for northern residences. In addition to dramatic ecosystems shifts that will occur if global warming continues, new shipping routes might emerge, holding significant effects on worldwide economies. I will compare several different coupled AOGCMs to assess the rate and patterns of changes in ice extent, thickness, and snow fall in the Arctic Ocean. I am gathering my data from the models participating in the Intergovernmental Panel on Climate Change's (IPCC) 4<sup>th</sup> assessment report for 2007. This research is confined to the results of the emissions scenario A1B which predicts rapid economic growth and rapid introduction of new and more efficient technologies with a balance across all energy sources (fossil fuel and newer technologies).

### **Optimization of Chitosan-Alginate Composite Scaffold Mechanical Properties**

*James Kuo, Sophomore, Bioengineering*

*NASA Space Grant Scholar, Mary Gates*

*Scholar, Gates Millennium Scholar*

*Mentor: Miqin Zhang, Materials Science and Engineering*

Tissue loss due to injury or degenerative diseases such as osteoporosis afflicts millions of people every year. Current treatments focus on alleviating symptoms of tissue loss. Tissue engineering presents a promising alternative with the potential to regenerate lost tissue. Tissue engineering researchers are investigating scaffolds as a medium to promote tissue growth. In this process, scaffolds are seeded with cells and growth factors. After implantation, the scaffold degrades slowly while the cells continue to grow and form new tissue. Chitosan and alginate, both naturally occurring compounds, show great potential for use in scaffolds. Both materials are biocompatible, biodegradable, and non-toxic. By itself, chitosan is unstable because it quickly loses its structure due to swelling. When combined with alginate, composite scaffolds have exhibited much higher biocompatibility and mechanical strength. This study will investigate the mechanical strength of chitosan-alginate scaffolds through different concentrations of reagents and cross-linking mechanisms. The compressive strength of the scaffolds will be characterized with an Instron mechanical tester. The microstructure and porosity will be observed using a scanning electron microscope (SEM). Biocompatible scaffolds with strong mechanical properties will be more capable of withstanding implantation inside

tissues.

### **A Uniform Atlas of Nearby Galaxies**

*Laura Kushner, Sophomore, Astronomy, Physics*

*Mary Gates Scholar*

*Mentor: Julianne Dalcanton, Astronomy*

*Mentor: Andrew West, Astronomy*

A comprehensive digital catalog of research-quality images of nearby galaxies does not exist. There are many individual images of nearby galaxies, but the data are not collected uniformly. I present preliminary results from my work to create a uniform, digital galaxy atlas using data from the Sloan Digital Sky Survey (SDSS). The SDSS is an ideal dataset from which to extract homogeneous images, as the galaxies have all been consistently observed and reduced using the same tools and equipment. I first identified known galaxies in the SDSS using the New General Catalog (NGC), Impey Low Surface Brightness Catalog, and the Third Reference Catalog of Bright Galaxies (RC3). I downloaded the appropriate SDSS data and used existing software to create a consistent catalog of both research-quality images and accurate color representations. I have recently started analyzing various properties of these galaxies, including their colors, magnitudes, sizes and morphologies. These data represent the first comprehensive, homogeneous, digital catalog of galaxies in the nearby Universe.

### **Microfluidic Dynamics: Effects of Surface Modification on Electroosmotic Flow**

*Eric Lam, Senior, Bioengineering, Electrical Engineering*

*Mentor: Albert Folch, Bioengineering*

Microfluidic devices use microscale channels for controlled transport of small amounts of liquid. Advances in this field became the basis for many biological micro-electromechanical systems (BioMEMS) and for micro-environmental biological research. An attractive strategy for routing fluids from one portion of a BioMEMS chip to another is the use of electroosmotic flow, or fluid flow driven by strong electrical fields. It has been found that electroosmotic flow can only occur in ionic solutions and the dynamics of electroosmotic flow are thought to be due to a layer of stationary ions between the channel walls and the moving liquid known as the Debye Layer. It has been hypothesized that modifying the surface properties of the channel walls may have an effect on this Debye Layer and thus it could ultimately be used to modulate electroosmotic flow for flow control or biosensor purposes. Using microfabrication and soft lithographic techniques, elastomeric nanochannels featuring a cross section of 100nm x 100nm and a length of either 50 $\mu$ m or 100 $\mu$ m were constructed to test this hypothesis. The surfaces were modified and the resulting changes in the channels' electrical resistances were measured. Two types of surface modifications were used to test the hypothesis: protein physisorption and surface

charge modification via electrical capacitor principles. The findings from this study will hopefully be applied to the future development of a microfluidic flow regulator and molecular sensor.

### **Determining Muller Glia Progenitor Potential**

*Tess Lang, Senior, Neurobiology*

*McNair Scholar*

*Mentor: Deepak Lamba, Neurobiology*

*Faculty Mentor: Thomas Reh, Biological Structure*

The retina develops as an outgrowth of the neural tube known as the optic vesicle which gives rise to five basic types of neurons and the Muller glia. Several studies indicate that Muller glia share a common lineage with retinal neurons. Past studies have shown that lower vertebrates such as fish and amphibians are able to regenerate a considerable amount of neural retina following retinal damage, while higher vertebrates like birds and mammals cannot regenerate. In spite of a considerable amount of research, the reason for an absence of regeneration in mammalian adults has not been found. The mature retinas possibly lack necessary factors that allow the progenitor proliferation and differentiation into neurons and glia. It has been shown elsewhere in the CNS that when immature spinal glia are placed into the hippocampus, new neurons are able to grow from the glia. This is an example where a change in environmental factors was able to change the fate of glia to neurons. The goal of this study is to determine whether mice Muller glia have precursor potential and will form neurons given an appropriate environment. Initial experiments will involve co-culturing the wild type embryonic retinas with Muller glia from GFP transgenic mice for varying time intervals and analyzed for cell infiltration and transdifferentiation. Ultimately, we will inject mouse GFP glia into eyes of newborn wild type mice. Since postnatal day 0 mice eyes have retinal progenitors constantly forming neurons, this environment is suitable for looking into the regenerative capacity of Muller glia. If the mammalian retina were to undergo regeneration, the most likely candidate would be the Muller glia due to their direct descendants of neuronal progenitors as well as common lineage with neurons. This study would help to provide evidence for the hypothesis that muller glia have regenerative potential.

### **Hyper-Rayleigh scattering studies of electro-optic chromophores with two aromatic bridge rings**

*David Lao, Sophomore, Chemical Engineering*

*Mentor: Philip J. Reid, Chemistry*

In electro-optic (EO) materials, the refractive index of the material changes when an electric field is applied. EO materials have wide applications in information technology. While these materials are traditionally inorganic (e.g., LiNbO<sub>3</sub>), organic EO materials hold many advantages over

their inorganic counterparts: facile processability for device fabrication, higher bandwidths, faster switching speeds, molecular architectures that may be tailored for specific applications, and higher EO activity. Possibly the most promising organic materials are “charge-transfer chromophores,” dye molecules consisting of an electron-rich “donor” moiety connected to an electron-deficient “acceptor” moiety through a p-conjugated bridge. In the presence of an electric field, the electron density shifts within these molecules resulting in a refractive index change. The EO coefficient of the bulk material is linearly proportional to a molecular non-linear behavior expressed as the first-hyperpolarizability, or  $\beta$ . Hyper-Rayleigh scattering (HRS) is a technique commonly employed to measure  $\beta$ . The cross-section for HRS, related to the likelihood that two-photon elastic scattering will occur, is proportional to  $\beta^2$ . This work focuses on using HRS to characterize charge-transfer chromophores of novel architecture. Five chromophores, with different combinations of groups serving as the bridge between the electron donor and acceptor groups were examined to determine which architecture resulted in the highest  $\beta$ . Measurements were acquired at five excitation wavelengths to ensure that practical  $\beta$  values were obtained, minimizing resonant enhancement, which inflates  $\beta$  values at wavelengths corresponding to molecular absorption bands. This work emphasizes “off-resonant” studies at 1000-nm and 1900-nm. Additional efforts were directed toward studying how chromophore concentration affects the measurement of  $\beta$ . By determining effective structures for chromophores and optimizing methods for measuring  $\beta$ , this work will allow chemists to design the next generation of EO chromophores for use in telecommunications.

### **The Auto Industry’s Opposition to Electric Vehicle Legislation**

*Hans Larson, Senior, Law, Society and Justice*

*Mentor: Patrick Rivers, American Ethnic Studies*

The auto industry has fought legislation that promotes the mass production of electric vehicles and the lowering of emissions in general for decades. Previously scholars have conceded to the auto industry’s claim that electric vehicles would constrain ‘vehicle choice.’ Others scholars have argued for alternatives to electric vehicles including hybrids and hydrogen-powered vehicles that would make a wider range of vehicle types possible. Scholars in these categories have been limited by a lack of technical knowledge about these specific technologies. Recent advances in technology and a more comprehensive analysis of the different technologies have allowed me to begin from the standpoint that electric vehicles are equal to or better than any other vehicle propulsion system in virtually every area—especially in environmental justice. Vehicle pollution accounts for about 25% of pollution nationwide, 50% within cities, and much higher along freeways and congested roads. These roads bring affluent commuters from white suburbs

to their jobs in the city. The pollution from their cars lowers the value of the adjacent land where minorities and the poor are forced to live. The dangerous levels of air quality cause serious, sometimes fatal illnesses—especially to children. This injustice warrants legislation that encourages electric vehicles as a matter of human rights and environmental justice. In order to make my case I will use books, scholarly articles, the media, and interviews with experts in electric vehicle legislation activism as well as in electric vehicle technology, and online information from organizations such as the Union of Concerned Scientists. The purpose of this project is threefold: 1) to explain why automakers fight legislation that supports electric vehicles; 2) how they do so; and, 3) to present the best strategy for making electric vehicles available to the public through government legislation.

### **High Energy Cosmic Ray Direction Analysis with WALTA**

*Benjamin Laughlin, Senior, International Studies*

*Mary Gates Scholar*

*Mentor: R. Jeffrey Wilkes, Physics*

*Mentor: Rik Gran, Physics*

The Washington Area Large-scale Time-coincidence Array (WALTA) is a project that hopes to learn more about the fundamental nature and origin of the highest energy cosmic rays by building a large area cosmic ray air shower detector array in western Washington. We have spent the past two years designing and testing a data acquisition card that provides 0.75 nanosecond timing accuracy between the four detectors at each site and, with a GPS unit, timing accuracy to within 1 microsecond between sites. This timing resolution allows the arrival direction of events to be reconstructed. An algorithm has been worked out and software to perform the arrival direction reconstruction has been written. Estimates of the errors of each determined arrival direction have also been found.

### **Discourse that Promotes Mathematical Reasoning: An Analysis of an Effective Algebra Teacher**

*Lynne Lawson, Senior, Mathematics, Spanish*

*Mentor: Ilana Seidel Horn, College of Education*

Mathematical reasoning involves the effective use of representations, the formation of convincing justifications, and the communication of patterns and relationships through generalizations. The development and combination of these processes lead students toward deeper conceptual understanding. Based on pre/post test data of student math learning and student interviews, we selected one particularly effective teacher and transcribed six videotaped sessions of her ninth grade algebra class. Our research has two objectives: 1) to explore ways in which the mathematical practices of representing, justifying and generalizing interconnect in her classroom; and 2) to analyze how this intercon-

nection is visible within the classroom discourse. After a period of open coding of the transcripts, we determined our units of analysis as teacher-initiated exchanges in which the teacher prompted students' engagement in multiple mathematical practices and exchanges in which these activities were sustained. Specifically, we examined the teacher's strategic and powerful questioning to better understand the relationships between teacher prompts and student math thinking. We found the teacher's word choice, specific sentence and prompt structures all contributed to support students' engagement in multiple mathematical practices. Such discourse further exemplifies the existence of strong relationships between the various practices. This research may also be used as a basis for professional development for both pre-service and in-service teachers.

### **Novel Synthesis of NIR Porphyrin Sensors: meso-Tetra(pentafluorophenyl) dilactone and Trilactone**

*Christal Lee, Senior, Chemistry, Biochemistry*

*Mary Gates Scholar*

*Mentor: Gamal Khalil, Chemistry*

The near infrared (NIR) spectrum consists of the wavelengths of light in the region 700-2500 nm, which is beyond the visible spectrum (400-700 nm) and cannot be seen by the human eye. Sensors operating in the NIR generally utilize the 700-1100 nm range and have various industrial applications including food quality control, forensics, and moisture determination. The motivation behind this project is the development of NIR dyes to be incorporated into NIR sensors for pressure, temperature and pH. Current efforts are concentrated on the synthesis of these phosphorescent dyes. Specifically, our studies concern derivatives of porphyrin compounds known as dilactone and trilactone. These compounds are synthesized through the oxidation of two or three of the pyrrole rings constituting the porphyrin. Our preference of working with porphyrin derivatives stems from their general stability and versatility in the number of substituents available for addition to the compound. In particular, our choice of the tetra(pentafluorophenyl) substituent is driven by its effect of further stabilizing the porphyrin complex. At the inception of this project, the intention was to follow the "Khalil" synthetic procedure, in which tetra (pentafluorophenyl) porphyrin was reacted with silver nitrate to yield the lactone species. However, this one-pot reaction method resulted in low yield of the desired dilactone product, no evidence of trilactone, and multiple unidentified side products. Consequently, an alternative synthetic method is currently being pursued. This procedure involves synthesis of monolactone through oxidation of the porphyrin using osmium tetroxide followed by potassium permanganate. While this specific reaction has been documented in literature, the subsequent step of converting the monolactone (one ring oxidized) to dilactone, and from there to the trilactone has not been previously performed. Initial dilactone synthesis experiments have been successful and the next step is to attempt to oxidize a third

ring to make the trilactone species.

### **Coordinated alternation in mitochondrial DNA content and plant development**

*John Lee, Senior, Biochemistry*

*Mentor: Delene Oldenburg*

*Mentor: Arnold Bendich, Biology*

Mitochondrial DNA (mtDNA) has long been thought to remain constant throughout a plant's life cycle. A preliminary experiment in the Bendich lab, using pulse field gel electrophoresis, showed that the mtDNA content was high at the base of the stem (dividing cells), but was barely detectable in the expanded leaf blade (non-dividing cells) of maize. This result suggests a novel mechanism by which the content of mtDNA may degrade during leaf maturation, but before leaf senescence. My objective is to isolate mitochondria from young and old leaves from various plant species and to determine whether the loss of mtDNA with plant development occurs in other plant species. Fluorescence microscopy technique will be used to determine DNA content in the isolated mitochondria, which are identified with a mitochondria-specific stain, Mitotracker Green FM. The DNA-specific dye, DAPI, is used to stain the DNA and allows us to quantify fluorescence intensity and measure the DNA. My research will focus on species from three main areas: monocots and dicots (maize and pea), deciduous and evergreen plants (azalea and rhododendrons), and thermogenic plants such as voodoo lily and skunk cabbage. This project investigates the connection between the inheritance of mtDNA content and a plant's overall growth pattern and attempts to determine whether mtDNA degradation is a common phenomenon for all plants.

### **Tools for the identification of novel peroxin homologues in *Trypanosoma brucei***

*June Lee, Senior, Biology*

*Mentor: Peter S. Kessler, Seattle Biomedical Research Institute*

*Mentor: Marilyn Parsons, Pathobiology*

*Trypanosoma brucei* are single celled protozoans that cause African sleeping sickness in humans and N'gana in domestic cattle. When these parasites are in their mammalian host, all of their energy is derived through glycolysis. Procyclic (insect form) parasites can utilize both glucose and amino acids as an energy source. *T. brucei* contains a unique organelle, the glycosome, which compartmentalizes metabolic functions such as glycolysis,  $\beta$ -oxidation of fatty acids and ether-lipid synthesis. Proteins involved in the biogenesis of the glycosome are referred to as peroxins (PEX) because of their evolutionary relationship to peroxisomal biogenesis proteins. Studies of PEX proteins in *T. brucei* have demonstrated that this organelle is essential for parasite viability. At the same time, there is significant primary sequence variation between the parasite and human homologues suggesting that these proteins may be good targets

for drug therapies. Immunofluorescence microscopy is typically used as part of the initial characterization of newly identified PEX homologues in *T. brucei*. A punctate staining pattern scattered throughout the body of the parasite is typical of glycosomal staining, which distinguishes it from nuclear staining, or the diffuse staining seen for cytosolic proteins. However, raising antibodies against specific proteins is a time consuming and costly endeavor. Here we report on the design and construction of plasmids for the creation of fusion constructs of potential PEX genes to a fluorescent reporter gene. By subsequent cloning of a putative glycosomal gene into this plasmid, we can generate fusion proteins to a fluorescent marker, allowing for the visualization of our protein of interest by fluorescent microscopy without the use of antibodies. By using different colored fluorescent molecules, we can show co-localization of known glycosomal proteins with novel target molecules thereby facilitating the analysis of glycosomal biogenesis proteins in *T. brucei*.

### **GPR54 and its Regulation upon Puberty in the Male Mouse**

*Kathy Lee, Senior, Neurobiology*

*Mary Gates Scholar*

*Mentor: Robert Steiner, Physiology and Biophysics*

On a macroscopic level, our research seeks to understand the neuroendocrine regulation of puberty and reproduction. Currently, we are performing experiments to determine the role of a G protein-coupled receptor, GPR54, in the regulation of gonadotropin-releasing hormone (GnRH). Mutations or targeted disruptions in the GPR54 gene result in the failure to reach normal pubertal development and subsequent hypogonadotropic hypogonadism, a result of impaired GnRH secretion. This suggests that the ligands of GPR54, kisspeptins, are important in the regulation of gonadotropin secretion. Our goal is to explain the mechanism by which GPR54 and kisspeptins play their role in puberty and reproduction. Kisspeptin-GPR54 signaling plays an important role in the hypothalamic circuitry that governs the secretion of GnRH. In brain slice preparations from adult male mice, a short bath application of kisspeptin induces a sustained depolarization in GnRH neurons. However, the most surprising result is that when this same experiment is performed in pre-pubertal mice (post-natal day (PND) 18), no depolarizing effect is seen. We hypothesize that GnRH neurons become more sensitive to the excitatory effects of kisspeptins due to an up-regulation of GPR54 in GnRH neurons at puberty. Using double label *in situ* hybridization, we compared the expression of GPR54 mRNA in GnRH neurons among groups of intact PND 18, intact adult, and castrated adult male mice. If our hypothesis is correct, and puberty is correlated with an up-regulation of GPR54, we expect to see a significant increase in the number of GnRH neurons co-expressing GPR54 in the adult intact animals compared to PND 18 animals. Results from castrated animals will enable us to determine whether the in-

crease in GPR54 is a testosterone-mediated event. These studies are currently underway.

### **Identification of a Novel Deletion Mutation in a French Family with IPEX (Immune dysregulation, Polyendocrinopathy, Enteropathy, X-linked inheritance) Syndrome**

*Avriel Linane, Senior, Biology, Psychology*

*Mary Gates Scholar*

*Mentor: Troy Torgerson, Pediatric Immunology*

*Mentor: Hans Ochs, Pediatric Immunology*

IPEX (Immune dysregulation, Polyendocrinopathy, Enteropathy, X-linked inheritance) is a fatal hereditary disease caused by mutations in the *FOXP3* gene on the X chromosome. This gene consists of 11 exons that encode a protein only expressed in specialized regulatory T-lymphocyte cells in the immune system. Affected boys, who receive the defect from their mother's genes, have autoimmune enteropathy leading to severe watery diarrhea and failure to thrive, infantile onset diabetes, and severe eczema. Our lab was sent samples from two brothers in France who exhibited the clinical features of IPEX. Interestingly, the sequence of the coding region of the *FOXP3* gene was normal in these patients, but they were found to have very low expression levels of *FOXP3* mRNA by quantitative real-time PCR (Polymerase Chain Reaction). I focused my efforts on using PCR to sequence the upstream non-coding portion of *FOXP3*, including the promoter. I identified a 1388 base pair deletion that encompasses a 3' portion of the -1 non-coding exon and a portion of an intron. I have subsequently characterized all living relatives of these boys for the presence of the deletion and found all but one of the females to be carriers of the mutation and all affected boys to be homozygous for the mutation. The deletion includes the splice site of the -1 exon, which may lead to abnormal mRNA splicing and more rapid mRNA degradation, or this region may include important areas of the DNA where regulatory proteins bind in order to stimulate mRNA production. Experiments are underway to differentiate between these two possibilities in order to learn about how levels of this mRNA and protein are regulated in the immune system.

### **Exploring Spin: Motion on the Boundary of Two Theories**

*Angela Little, Senior, Physics, Seattle Pacific University*

*Mentor: Stamatis Vokos, Physics, Seattle Pacific University*

One of the deepest questions in physics is how to solve the apparent inconsistencies that arise in combining quantum field theory and general relativity. Is there a Grand Unified Theory? There are many interesting areas in which the two theories overlap that should give hints toward a theory that encompasses both. One such case is the motion of spin 1/2 particles in the background of a gravitational field. The two theories are combined through the fact that the dynamics of spin 1/2 particles is described by quantum field theory, while their motion is governed by Einstein's general relativity. The motion of classically spinning objects in gravitational fields will first be presented. We will then show progress toward analytically solving the motion of a spin 1/2 particle "wavepacket" in the background of a plane

gravitational wave. Despite predictions that quantum mechanical properties of bodies moving in gravitational fields have no effect on their motion, we hypothesize that the motion of the particle will, in fact, reflect its quantum characteristics.

### **Biochemistry of Novel SNX10**

*Annie Liu, Sophomore, Bioengineering*

*Mary Gates Scholar*

*Mentor: W. Tony Parks, Pathology*

The sorting nexin (SNX) family, which consists of 29 members, is a diverse group of intracellular trafficking proteins that are unified by the presence of a phospholipid-binding motif — the PX domain. The ability of these proteins to bind vesicle-enriched phospholipids, as well as their propensity to form multi-subunit protein-protein complexes, points to a role for these proteins in membrane trafficking and protein sorting. Recent studies have shown that sorting nexins influence the expression of a number of growth factor receptors, which are tremendously important to the maintenance of normal cellular functions. Overexpression of sorting nexins promotes the degradation of these receptors, altering the strength of signals in several pathways and resulting in lower expression of receptors on the cell surface. These alternations may very likely lead to a wide range of diseases, including atherosclerosis and cancer. In particular, SNX1 has recently been found to be lost in early colon cancer. This study is focused on the characterization of a novel sorting nexin, SNX10. Using transfection of DNA constructs, immunoprecipitation and Western blotting, I have shown that SNX10 forms protein complexes with SNX1, 2, 6, and 7. Immunofluorescence studies have confirmed the association data, and have additionally provided evidence that SNX10 can translocate to the nucleus. These translocation data have been confirmed using nuclear extraction. Moreover, the translocation was found to be regulated by serum (and the growth factors it contains). My next approach is to clone a truncated copy of SNX10 with its carboxy-terminal nuclear localization site clipped off to test the possible changes in its translocation and associations. These studies in the biochemistry of sorting nexins will allow us to better understand the function of these proteins in the cell and may permit a better understanding of the role SNXs play in disease development.

### **Structural Genomics of Pathogenic Protozoa**

*Colleen Liu, Senior, Biology*

*Mentor: Christopher Mehlin, Biochemistry*

The pathogenic protozoa are responsible for an enormous disease burden worldwide, including causing malaria, leishmaniasis, and African sleeping sickness. This structural genomics project is aimed at high-throughput cloning, expression, purification, and X-ray structure determination of proteins from these protozoa. In addition, project members are able to utilize newly developed technologies for

structural genomics, including innovative protocols for protein expression and purification. It is hoped that this research will help to develop a better understanding of parasite proteins and, ultimately, discover cures for the diseases they cause. I am currently utilizing the newly completed genome sequences of *Leishmaniasis major* to clone, express, and purify proteins from this organism, the causative agent of leishmaniasis. Using polymerase chain reaction (PCR), ligase independent cloning, and gel electrophoresis, I have cloned and sequenced several hundred predicted open reading frames for soluble expression in *Escherichia coli*. This has led to the sequencing and purification of ten different proteins on a multi-milligram scale. These proteins have been submitted for crystallization trials and will hopefully result in target structures.

### **Creating a Systematic Framework to Simulate and Predict the Outcomes of Chemical and Biological Reactions**

*Katherine Liu, Senior, Bioengineering*  
*Jenny Lo, Senior, Electrical Engineering*  
*Jessica Smith, Sophomore, Chemistry*  
*Mary Gates Scholar*

*Mentor: Mani Soma, Electrical Engineering*  
*Mentor: Agnieszka Miguel, Electrical Engineering*

It is useful for scientists and engineers to have a way to easily access and understand the products and side effects of certain chemical reactions without having to perform the reactions themselves. The specifics of particular reactions, such as required catalysts, by-products and safety procedures, need to be readily available to researchers outside of chemical fields. The program being developed will allow a user to search a database of chemical reactions and gain easy access to all pertinent information specific to that reaction. One focus of this project is to characterize the by-products (heat output, light, etc.) in detail since these by-products, especially in biological reactions, are of critical importance in other system applications. The program will also permit a user to input specific chemical reactions into the database, so that it can one day serve as a comprehensive database, a tool that will allow for the easy integration of chemical processes into other fields of study. This program also has implications on the academic front, and could allow students of chemistry to evaluate in advance what they will need in terms of chemicals, volumes, catalysts for the reaction to work and to predict the results of the reaction. By running the experiment first on the computer the students will be better prepared for the lab experience and also will avoid wasting expensive chemicals. The program is being developed in Matlab, and currently models around 40 simple organic and inorganic reactions.

### **Characterizing Leaf Curvature in Maize Hybrids**

*Xiang Li, Junior, Forest Ecology*  
*Mentor: E. David Ford, College of Forest Resources*

*Mentor: Elizabeth Van Volkenburgh, Botany*

Crop yields of maize (*Zea mays*) grown in the US Corn Belt have continually increased since the 1930s. Experiments have shown that this increase in productivity is related to the ability of modern varieties to thrive under denser plantings. One morphological feature correlated with the increase in productivity is that the leaves of the modern hybrids stand more upright and are also less curved along their length than leaves from the older hybrids. The ultimate goal of this research is to quantify morphological differences in leaf curvature across genotypes. These differences have direct effects on light interception and photosynthetic activity. Therefore, quantification of leaf curvature may guide physiological explanations for the ability of the modern hybrids to thrive under denser plantings. Our research focuses on the differences in leaf posture between different genotypes. We have determined that it is more appropriate to use differences in leaf curvature rather than simply considering leaf angle. We have investigated the leaf curvature of twelve genotypes by measuring the angle of declination from the stalk every 5cm along the length of the 3<sup>rd</sup> and/or 6<sup>th</sup> leaves. Leaf curvature was then calculated by fitting a non-linear regression model and an exponential saturating function to the measured leaf declinations. Preliminary analysis indicates a correlation between year of hybrid release and leaf curvature. We will show that leaf angle and curvature changes during leaf development, and that that these characteristics vary across genotypes.

### **Surface Modification of Superparamagnetic Nanoparticles for Use as MRI Contrast Agents**

*Christian Lloyd, Senior, Materials Science and Engineering*

*Mary Gates Scholar*

*Mentor: Miqin Zhang, Materials Science and Engineering*

Superparamagnetic magnetite (Fe O ) nanoparticles are useful as MRI contrast agents; however<sup>3,4</sup>, they are often synthesized in the presence of stabilizing, non-biocompatible surfactants. In this experiment, these oleic acid and oleylamine surfactants were removed through a process of washing with 1-butanol and ammonium hydroxide. The resultant bare nanoparticles were then coated with a biocompatible self-assembled monolayer, Polyethylene Glycol (PEG) Silane. With the addition of PEG-Silane, the nanoparticles could be injected into the bloodstream, as they present a biocompatible surface. Transmission Electron Microscopy (TEM) has shown that the particles are monodispersed with a size of  $11 \pm 1$  nm. The particles were characterized by FTIR spectroscopy to verify the surfactant removal and the PEG addition.

### **High-Resolution, Short-Term, Lead Isotope Variability within the 1677 Eruption of Cumbre Vieja Volcano, La**

## **Palma, Canary Islands**

*Jennifer Locke, Senior, Earth and Space Sciences*

*Mentor: Bruce Nelson, Earth and Space Sciences*

The subsurface dynamics of an active volcano and its conduits can only be determined indirectly by geochemical or geophysical means. I will investigate the compositional differences in magmas erupted over very short time periods -on the scale of weeks- to determine whether magma chambers may be open to multiple fluxes of distinct magma types on this time scale. I expect to find that it is possible to have multiple influxes of magma, as opposed to a continuous flow from a single magma source. The 1677 eruption in southern La Palma, Canary Islands, is known to have erupted over a short time period, about several weeks. I have collected multiple samples from one vent, where mineralogic changes are seen through the eruption. The varied composition raises the possibility that there was a more complicated magmatic process than the continuous flux of a single magma composition. Microscopic evidence for multiple influxes of magma is found in thin sections. They show that the flows contain clinopyroxene crystals that have green corroded cores with zoned overgrowths, which suggests that magma mixing occurred. I will test the hypothesis of multiple magma influx with lead (Pb) isotope analyses. Pb isotopes do not change during fractional melting or fractional crystallization, so if the entire eruption came from the same source it will all have the same Pb isotopic ratio. However, if the ratios varied over the course of the eruption, it will indicate that there were multiple influxes of magma from different sources during the eruption. Few studies have documented the very short time scale variability in volcanic eruptions; however, they provide a unique perspective on the dynamics of volcanic systems.

## **The Outdoor Classroom: Parks as Outdoor Learning Laboratories**

*Jennifer Low, Senior, Landscape Architecture*

*Mary Gates Scholar*

*Mentor: Nancy Rottle, Landscape Architecture*

*Mentor: Julie Johnson, Landscape Architecture*

I am working with Professors Nancy Rottle and Julie Johnson to develop a set of principles and design strategies that can help influence the redesign of Magnuson, as well as other local parks, to function as environmental learning laboratories and promote ecological literacy, particularly in support of middle school curriculum. The formulation of these theories and strategies intends to inspire and guide the creation of places that can simultaneously facilitate environmental learning, creativity, and exploration beyond the limitations of the classroom and into the dynamic nature of our outdoor environments. The Seattle Parks and Recreation Department is currently redesigning Magnuson Park in order to accommodate the recreational demands and ecological imperatives of a growing city. A series of new wetlands and ponds will be constructed to provide habitat for a wide range of local plant and wildlife species and accommodate the park's environmental education programs such as Magnuson Park's Outdoor Learning Laboratory (MOLL). MOLL is a science and service-learning program,

which gives middle school students the opportunity to apply investigative science activities in an outdoor laboratory using the District's inquiry-based curriculum. A MOLL pilot program consists of a series of three field days during the school year, with lessons and activities that focus on student-designed science experiments, and works to promote ecological literacy and environmental stewardship through wetland education and service learning. The research includes observing students during the MOLL field days, conducting literature reviews on environmental learning and outdoor learning laboratories, facilitating participatory workshops with students to design their own ideal learning environments, and conducting interviews with lesson leaders. The observations, literature investigation, and workshop results will be used to develop grounded theory and design guidelines for outdoor learning environments, which will be applied to the redesign of Magnuson Park's new wetland complex.

## **Assessing Tsunami Hazards Using GIS: Potential Impacts on the Puget Sound Region**

*Jeremy Lucas, Senior, Environmental Science*

*Jeff Krause, Senior, Urban Studies*

*Mentor: Tom Carlson, Geography*

Our study examines the potential devastation to coastal communities caused by a tsunami in the Puget Sound Region. Geographic Information System analysis was used to map the inundation of coastal areas and to estimate damage using local and regional demographic information. In order to assess potential impacts, a combined bathymetry and digital elevation model (DEM) of the Puget Lowlands was brought into ArcGIS. Then the spatial analyst extension was used to calculate the range of inundation from 0 to 20 feet (0m to 6m). Through a multiple scale analysis, the impact on the Puget Sound Region as a whole, as well as Seattle, Tacoma and Olympia, were assessed. It was one of the goals of this project to create a spatially explicit display of potential tsunami impact. This, in turn, will be shown to local decision makers and potentially affected communities.

## **Mutagenesis and genetic screening of *erecta erecta-like* 2 double mutants in *Arabidopsis* plants**

*Darlene Lu, Junior, Biology, Statistics*

*Mentor: Keiko Torii, Biology*

In the *Arabidopsis* plant, the *ERECTA* gene codes for a receptor kinase that regulates plant size and epidermal patterning. It is thought to mediate cell-cell communication, which is required for coordinated cell proliferation and organ growth. However, critical components of the *ERECTA* signaling pathway are still unknown. The goal of this project is to determine and locate specific mutations within this signaling pathway, which allow us to utilize the data obtained to gain a greater insight to each individual compo-

ment of the pathway. Recently, the Torii lab discovered that complete knockout mutants for *ERECTA* and its two closely-related paralogs *ERECTA-LIKE-1 (ERL1)* and *ERECTA-LIKE-2 (ERL2)* confer not only severe dwarfism, but also epidermal patterning defects: the epidermis of *erecta erl1 erl2* triple mutant develop clustered stomata. By mutagenizing *erecta erl2* double mutant seeds, planting the seeds, and plating those seeds onto agarose plates, a specific mutant phenotype can be screened. I look for mutations that enhance the epidermal patterning defects of *erecta erl2* double mutant. My effort is directed toward analyzing whether the newly identified mutants have mutations in the *ERL1* locus or whether they represent new loci. To test these hypotheses, the *ERL1* locus is amplified by PCR from each mutant and subjected to DNA sequencing to discover variances within the sequence. So far, five new alleles of *ERL1* have been discovered and their molecular lesions were determined. We are currently in the process of finding more mutants, which display this phenotype.

### **The Effect of RepA-Tagging on Protein Production**

*Yi-Ching Lu, Senior, Biochemistry, Bioengineering*

*Mary Gates Scholar*

*Mentor: Francois Baneyx, Chemical Engineering*

Proteins rearrange themselves from linear polypeptide chains into a three-dimensional structure in a process called “folding,” which is aided by molecular chaperones. Only proteins of the correct conformation can function normally. Recombinant proteins of mass production in *E. coli* could misfold and aggregate into an insoluble mass. The current method for protein production is to solubilize protein aggregates and refold them *in vitro*. However, this process causes nuisance for protein production. A solution to this problem will have practical consequences in biotechnology. The goal of our project is to verify that proper folding of proteins in *E. coli* can be significantly enhanced by targeting them to molecular chaperones. The host *E. coli* strain will be constructed by using  $\lambda$  red-mediated recombination to integrate the bacteriophage T5 promoter into *E. coli* chromosome upstream of *dnaKJ* and *groESL* genes, and to remove *clpP* gene that degrades proteins. The *clpA* gene will be placed under transcriptional control of the *trc* promoter. The model protein is human leptin gene that fused with first 15 amino acids of *repA* gene and placed under transcriptional control of the  $P_{BAD}$  promoter. Plasmids encoded *clpA* and RepA-tagged leptin will be transformed into the host *E. coli* strain. SDS-PAGE fractionation of soluble and insoluble cellular fractions will be used to evaluate the performance of ClpA-targeting on protein solubility. We hypothesize that misfolded proteins fused with the ClpA-targeting tag will be directed to ClpA chaperones. Once ClpA unfolds the proteins, DnaK-DnaJ and GroES-GroEL chaperones will refold these proteins into their native conformation. Therefore, we should see the production of soluble proteins increase, compared with the wild-type strain.

### **Attachment Styles vs. Attachment Dimensions: Two Measures of Adult Attachment Break-up**

*Yarun Luon, Senior, Psychology, Informatics*

*Gates Millennium Scholar*

*Mentor: Vivian Zayas, Psychology*

The theory of adult romantic attachment provides a framework for understanding individuals’ thoughts, feelings, and behaviors within intimate relationships. One way to advance adult attachment theory and research is by developing effective methodologies to assess individual differences in adult attachment. In 1998, Brennan, Clark, and Shaver proposed that individual differences in adult attachment reflect differences in avoidance and anxiety and can be assessed by the Experiences in Close Relationships (ECR) questionnaire. More recently, Fraley and Shaver (2000) proposed that the anxiety and avoidance dimensions of the ECR correspond to the four adult attachment styles identified by a different adult attachment measure, the Relationship Questionnaire (RQ) (Bartholomew & Horowitz, 1991). The present paper suggests that this procedure may be theoretically problematic. Specifically, Fraley and Shaver (2000) propose that individuals with a preoccupied attachment style are low in avoidance, similar to individuals with a secure attachment style. They also propose that individuals with a dismissing attachment style are low in anxiety, similar to securely attached individuals. The present study tests the validity of these assumptions. Structural Equation Modeling (SEM), a more powerful means to calculate multiple regressions, was used to analyze the relationship between the avoidance and anxiety dimensions of the ECR and the four known adult attachment styles of the RQ. Results show that the avoidance and anxiety dimensions do not relate to adult attachment styles in the ways prescribed by Fraley and Shaver (2000). Implications for the assessment of individual differences in adult romantic attachment are discussed.

### **Deletion analysis examination of Bir1p in *Saccharomyces cerevisiae*.**

*John Lyssand, Senior, Biochemistry, Microbiology*

*Mentor: Trisha Davis, Biochemistry*

Mitosis is completed with a single round of DNA replication followed by high fidelity chromosome segregation. Errors in this process result in aneuploidy, cancer, or death. Survivin in mammalian cells is a protein involved in both chromosome segregation and apoptosis. It is only expressed in replicating cells and appears to be overexpressed in cancerous cells. Bir1p is the yeast homolog of survivin. It is also an essential protein involved in chromosome segregation, but its function in this process is not fully understood. We performed a deletion analysis of Bir1p in order to find the regions necessary for proper chromosome segregation. The N-terminus of Bir1p is not essential and an allele with the N-terminus deleted does not affect the rate of chromo-

some loss. The middle region is not essential, but an allele with the middle region deleted shows a 20-fold increase in chromosome loss. The C-terminus is essential, and a strain carrying a truncated allele is not viable. Furthermore, a strain carrying an allele of BIR1 with a small deletion in the C-terminus shows a 50-fold increase in chromosome loss. The C-terminus of Bir1p interacts with another essential kinetochore protein Sli15p, and we are currently exploring the interaction.

### **Corona Air Pump Project: Efficient Electronic Cooling**

*Brian Ma, Senior, Electrical Engineering, Computer Engineering*

*Mary Gates Scholar*

*Philip Zhang, Senior, Electrical Engineering*

*Mentor: Alexander Mamishev, Electrical Engineering*

Electrostatic air propulsion is a promising technology with potential applications such as energy-efficient ventilation, cooling of electronics, and dehumidification. The challenges of existing designs include the need to increase air speed, backpressure energy efficiency, heat exchange capability, and longevity. Numerical simulations have been conducted for the electrostatic air pump for the purpose of optimizing device characteristics through controlled inner pump electric field profile. A sharp-edge-to-parallel-plane electrode geometry with unipolar positive corona is used to generate linear electric field distributions and minimize energy loss. Multiple simulations have been performed, including those for multiple collector electrodes, voltage distributions, as well as research into the scalability of the technology. The ultimate goal is to create multi-channel energy efficient ionic pumps extending it to both the macroscale and microscale.

### **Effects of Annual and Monthly Age on Weight, Length, and Gonad Area in Five Year Classes of Cultured Geoduck Clams (*Panopea abrupta*)**

*Cyrus Ma, Senior, Aquatic and Fishery Sciences*

*Mentor: Carolyn Friedman, Aquatic and Fishery Sciences*

Geoduck aquaculture is a growing industry in Washington State, where interest in both intertidal and subtidal culture for commercial and fishery enhancement purposes exists. The geoduck is an important native species with economic, social, and ecological significance in our state. While the culture of a native species reduces risks often associated with exotic species, it is important to investigate potential interactions with wild counterparts. Should geoducks cultured in the field become reproductively mature and spawn during the 5-7 year culture cycle, the potential arises for the introduction of cultured genotypes into wild populations. We are interested in evaluating the reproductive ca-

capacity of cultured intertidal geoducks. On a monthly basis, we sampled 12 individuals from each of 5 year classes outplanted intertidally on northeast Hartstene Island in south Puget Sound. Individuals were weighed, measured, and analyzed histologically to detect trends in gonadal production. Significant variation in wet weight, shell length, and gonad area were detected among year classes, and in some cases, among sampling dates. Future studies will include investigations of gamete age and viability, geoduck age and fertility. Even though the ecological significance of genetic interactions between cultured and wild geoducks is unclear, it is prudent to implement broodstock management in this nascent industry with an eye towards maximizing genetic diversity. Genetic management will also benefit the culture industry by providing the genetic variation in outplants, a necessity for populations to contend with environmental variation inherent in intertidal and subtidal habitats.

### **Vegetation Dynamics in a Mountain Meadow: Effects of Conifer Encroachment**

*Ziyu Ma, Junior, Forest Ecology*

*Mentor: Charles B. Halpern, Forest Resources*

Mountain meadows play an important ecological role in the largely forested western Cascade landscape. Expansion of conifers into these meadows is a recent, but widespread phenomenon that has led to loss of meadow habitat and to replacement of the meadow flora by forest. Knowledge of the dynamics of these systems is needed to guide management strategies for restoring meadow composition and structure. In this study I use a “chronosequence” approach to examine changes in the diversity and composition of ground-layer vegetation in a grass- and forb-dominated meadow that has experienced recent encroachment of lodgepole pine and grand fir. The study site, Bunchgrass Ridge, Oregon, supports a mosaic of meadows and patches of coniferous forests of varying age and density. Ground-layer vegetation and forest overstory data were collected in sample plots representing a broad range of encroachment histories (open meadow to old forest). Ground-layer species were classified as “forest” or “meadow” based on habitat preference. For each of these groups, and for the total pool of species, I calculated richness, Shannon-Wiener diversity index, and total plant cover. Relationships were explored between these response variables and measures of overstory structure (canopy cover, tree densities, and tree basal area). Meadow species declined and forest species increased in abundance and diversity with canopy cover, but relationships with tree density and basal area were not as strong. Similar comparisons of plant composition and diversity will be made among sets of plots with similar age structures representing the chronosequence of conifer encroachment. I expect a peak in total species diversity during the early stages of encroachment as meadow species are gradually replaced by forest species.

## **Mexico's Dependence on Oil Revenue**

*Alexander MacKnight, Senior, Economics, Mathematics*  
*Mentor: Neil Bruce, Economics*

Since the discovery of large amounts of oil in Mexico in the 20th century, the resource has been one of the country's most important exports. The export of Mexican oil, especially to the United States, has provided large amounts of revenue for the state owned oil monopoly called Pemex. Taxes and fees paid by Pemex to the federal government have accounted for a large proportion of the level of annual federal tax revenue collected in Mexico. The problem with this system becomes apparent when the price of oil fluctuates. When the price of oil rises, revenues at Pemex increase, as do the taxes and fees collected by the federal government from Pemex, but when the price falls, the opposite happens and the government is forced to either raise taxes or cut spending in order to make up for the loss. Since the price of oil often does fluctuate, sometimes greatly, this provides a very unstable source of revenue for the federal government, which is especially important since Pemex taxes and fees account for such a large proportion of what is collected by the government. Knowing this, my research will focus on government spending in Mexico over the past 27 years and how it has been affected by a change in the revenue collected from Pemex. I hope to answer questions such as: Are changes in the Mexican government's spending level correlated with changes in the volatile level of taxes and fees collected from Pemex? If so, has the government pursued a consistent policy of spending largely based on this source of revenue? The implication of this work will be to raise questions as to whether the government should broaden its tax base in order to safeguard its tax revenue against the volatility of oil revenue.

## **Social Competence, Self-Cognition, and Aggression in Young Children**

*Jennifer Mallory, Senior, Psychology*  
*Mary Gates Scholar*

*Mentor: Stephanie Carlson, Psychology*

The well-established relation between executive functioning (EF) and theory of mind (ToM) in the preschool period requires further examination of how these processes exist differently between children's real-world settings and the laboratory. We assessed 73 4-year-olds (at age 54 months) on EF measures including delay of gratification, resisting interference, and controlling attention and motor responses and on social competence tasks to assess ToM. Their parents completed the Social Skills Rating System in which the child is rated on social skills in everyday situations as well as problem behaviors. Data indicate that individual differences in overall EF are positively related to social skills and negatively related to problem behaviors. However, social skills were significantly more related to EF tasks in-

volving delay of gratification. We hypothesize that non-affective tasks of EF are more likely to predict academic competence in kindergarten. Preliminary findings suggest there may be some types of EF associated with competencies in children's real-world settings. The longitudinal nature of this study examines the stability of EF and prediction of social and academic skills from 2 to 5 years of age. This same cohort is currently being followed up in kindergarten to further assess their self-control and perspective-taking skills and two new aspects that may interact with EF and ToM: attachment relationships and the development and onset of aggression (i.e., problem behaviors). The question of focus is what differentiates children who have low EF skills and perspective-taking skills, but do not have behavioral or aggression problems from those that do? Is the influencing factor the attachment style between child and caregiver? This is important in regard to social competence as these children are forming peer relationships. Discovering whether or not these processes affect aggression and behavior problems in children will be of great importance in developmental psychology.

## **Modern Traditionalists**

*Shantel Martinez, Sophomore, History*

*Mentor: Steve Woodard, Early Identification Program,*  
*McNair Scholars Program*

From 1890 to 1950, Japan morphed from an isolationist nation to a booming, consumer driven power player. One of the main forces behind this transformation was the influence of Western culture and society. Though this influence aided in the modern transformation of many aspects in Japanese civilization, it also almost brought an end to one of Japan's most prestigious icons, the geisha. My research focuses on the impact of modernization on the role of Japanese geisha as entertainers in Japan from 1890 to 1950, and how geisha had to become modern traditionalists in the quest for survival. The time period is crucial because 1890 marks the beginning of the modern transformation of Japan, when geisha were adored and respected, and 1950, after WWII, marks the time when they were fighting for their survival. I have sectioned my research into six chronological parts. The first part will be historical background of the geisha, how the geisha evolved in history. The second part explores the beginnings of modernization and Westernization (1890-1919), how did Westerners compare geisha and compared them to Western women. The third section deals with pre-WWII Japan (1920-1937), how the rise of the dancehall girls and Hollywood changed entertainment in Japan. Section four discusses the ban on pleasure during WWII, when Japan closed down many geisha districts and houses, forcing geisha to work in factories. Section five evaluates post WWII Japan and the aftermath of the destruction brought upon geisha by imitators and their waning desirability. Finally, section six will sum up the importance of this research and my continuing efforts

in regards to conducting research for this project.

### **StarNet: Student-Scientist-Teacher Research Network Investigating the Effects of Genes and Environment on Smoking Behavior**

*Ce'Nedra Martin, Sophomore, Microbiology*

*Mentor: Maureen Munn, Genome Sciences*

The StarNet Project, an Educational Outreach Program in the Department of Genome Sciences, is developing a curriculum that will teach high school students about clinical studies and involve them in an assay linking genetics and smoking behavior. However, current genotyping assays are not accessible to high school students due to prohibitive equipment cost and reagent toxicity. I am working with Dr. Maureen Munn to develop a genotyping assay that alleviates both problems. This assay identifies Single Nucleotide Polymorphisms (SNPs) found in the phenylthiocarbamide (PTC) receptor gene TAS2R38 (Gen Bank Accession Number AC073647.9), which encodes for a member of the TAS2R bitter taste receptor family. The ability to taste the substance PTC typifies classic Mendelian inheritance patterns and the phenotype is known to vary among human populations. We have chosen to use the PTC gene to test and modify the reverse dot blot protocol. In the reverse dot blotting technique, hybridized allele-specific oligonucleotide probes are bound to a nylon membrane. PTC genes amplified to include a biotin molecule are then hybridized to the appropriate probes and visualized via a colorimetric detection process. In correctly fitting the reverse dot blot technique to the high school classroom, my goal is to show that the protocol was accessible to students and gave accurate results. The high school curriculum will use this assay to determine the genotype of several individuals, potentially linking several genes yet to be identified with smoking behavior.

### **Analysis of Resistance to Viral Oncolysis in Primary Ovarian Cancer Cell Cultures**

*Sonia Marwah, Senior, Physiology*

*Mentor: Andre Lieber, Medicine, Pathology*

Many medical treatments, such as chemotherapy and radiation, are highly advanced in the treatment of cancer, but there is still a need for more effective approaches. Gene therapy provides an alternative for tumor treatment. In previous gene therapy strategies, replication-defective viruses have been used to express therapeutic genes in tumor cells. Recently, the idea of using replication competent viruses to eliminate transfected cells has become a viable strategy in tumor gene therapy. Oncolytic adenoviruses have been genetically modified to kill tumor cells and have been previously tested *in vivo* and *in vitro* on established tumor cell lines, including ovarian cancer cell lines (e.g. SKOV-3). Due to repeated passaging, tumor cells often become genotypically and phenotypically different from the tumor they

originated from. I will be investigating the effect of a modified oncolytic vector (Ad5/35. IR-E1a/Trail) on primary ovarian cancer cells. Tumor cell cultures derived from 25 biopsies and 6 ascites fluids from ovarian cancer patients will be generated and single cell clones will be obtained by limited dilution of the tumor cells. Tumor cell clones will be expanded and tested for susceptibility to apoptosis by our oncolytic adenovirus. Preliminary data indicate variability of tumor cell clones in response to the oncolytic adenovirus. Mechanism of resistance to viral oncolysis will be analyzed using a variety of assays, including quantitative RT-PCR to detect mRNA levels for selected genes. It is crucial to study the genes or pathways that mediate resistance to apoptosis or lysis to better improve anti-tumor therapies. In future studies, DNA arrays will be used to analyze the gene expression profiles of our resistant clones versus susceptible clones to identify the differentially expressed genes involved.

### **Monitoring Moisture Distribution and Aging in Cookies**

*Abhinav Mathur, Senior, Electrical Engineering*

*Mary Gates Scholar*

*David Seater, Senior, Electrical Engineering,*

*Mary Gates Scholar, Space Grant Scholar*

*Valerie Inclan, Senior, Electrical Engineering*

*Mentor: Alexander Mamishev, Electrical Engineering*

To facilitate the development and sales of new types of cookies in the commercial market, real-time non-invasive moisture content sensing techniques are necessary. To accomplish this, a dielectric spectroscopy based system is used to measure the distribution of moisture in store-bought, pre-baked cookies. This information can be used in the factory to ensure that cookies are uniformly manufactured, and in stores to maintain necessary levels of quality. An inter-digital fringing electric field (FEF) sensor can be used to gather data in real time, without affecting the cookie itself. Previous experiments have demonstrated the ability of the FEF sensor to detect changes in moisture distribution and mass over a period of several hours, across frequencies from 10 Hz to 30 kHz. Recent work has included designing a novel multi-channel electronic system that uses FEF sensors to detect these changes on a rapid, real-time basis. The system is currently being tested for use in both online moisture measurement and shelf life studies of cookie samples. Future work in this project includes implementing this system within an industrial environment.

### **Non-Destructive Estimation of Physical Properties of Material Using Fringing Electric Field (FEF) Sensors**

*Abhinav Mathur, Senior, Electrical Engineering*

*Mary Gates Scholar*

*David Lu, Senior, Electrical Engineering*

*Valerie Inclan, Senior, Electrical Engineering*

*Diana Cheng, Junior, Electrical Engineering*

*Mentor: Alexander Mamishev, Electrical Engineering*  
*Mentor: Kishore Sundara-Rajan*

Fringing electric field (FEF) sensors present a novel approach to in-line monitoring and control of industrial products. The single-sided, non-destructive, non-contact sensor is an ideal solution for quality control in various environments, including the paper pulp and pharmaceutical industries. In this poster, current experimental results, analysis of data obtained, estimation algorithms, and a direction for future work in both applications will be presented. In the U.S. alone, the paper industry consumes 2.7 quadrillion joules of energy every year. A significant part of this energy is used to de-water pulp. Current manufacturing procedure involves validating moisture levels of paper after the drying process. At this stage, should there be an anomaly in the moisture level, the materials are often discarded resulting in a waste of energy and material resources. Therefore, the paper pulp industry requires a feed-forward system controlling precise levels of moisture in paper products to reduce the costs in energy and material resources wasted. The FDA's PAT (Process and Analytical Technology) Initiative reflects the need for a technology that can monitor multiple tablet properties, such as the coating thickness, hardness, roughness, and the concentration of active pharmaceutical ingredients non-invasively on a real time basis. FEF sensors can be used to obtain a dielectric profile of the material under test. Information pertaining to the parameters of interest can be extracted from this profile. The ability for FEF sensors to efficiently monitor every tablet within a batch, rather than sampling only a few representative ones, results in a safer product to consumers as well as less waste when defects are found. Initial findings and simulations in both applications have shown promising repeatable and reproducible trends. Furthermore, as a part of our ongoing research with FEF sensors, parameter estimation algorithms have been developed to process the data and estimate material properties with high precision.

### **Synthesis and Characterization of Amide-Polycarboxylates**

*Douglas Matje, Junior, Chemistry, Evergreen State College*

*Mentor: Peter J. Pessiki, Chemistry, Evergreen State College*

Photochemical systems that can efficiently convert sunlight into an energy form that is suitable for conventional uses has been a sought after goal for some time. As demand for the remaining historical sources of energy increases the goal becomes more urgent. Researchers have employed a number of approaches in their design of molecular devices that can utilize light as the initial energy source. Porphyrins have been an attractive component for many of these light harvesting solar cells do in part to the photochemical prop-

erties of these molecules. An important aspect of any molecular device meant to utilize sunlight, as the source of energy is the initial harvesting of photons. We have previously synthesized molecules having chromophores such as vulpinic acid covalently linked to the meso position of a porphyrin ring. Furthermore, we have shown that these molecules have the ability to absorb light over broader wavelength range than either chromophore independently. In an attempt to increase the absorption capabilities of these systems we have set out to prepare compounds that increase the number of sites for chromophore attachment. One method we employed involved the synthesis of a porphyrin with four chromophores, one in each of the meso positions. This molecule did have increased absorption capabilities yet lacked the flexibility needed for the attachment to utilize this captured energy. Another related strategy would be to utilize only one meso position of the porphyrin but make it possible for more than one chromophore to be attached at this site. Our approach to achieve this goal is to build molecules utilizing amide bonds that have terminal carboxylic acids. These dendrite arms will have the capability of holding multiple chromophores. This poster will describe our progress towards this goal in both porphyrin and non-porphyrin molecules.

### **Factors Affecting "Fight or Flight" and "Tend & Befriend" Responses to Stress**

*Jackie Matthews, Senior, Women Studies*

*Advisor: Marie-Annette Brown, Family and Child Nursing*

For decades research with animals and humans has suggested that the "fight or flight" response is essential to dealing with stress. New research posits that gender issues may influence the stress response. Recently Taylor (2000) described the "tend and befriend" response to stress that may be more typical of females than males. She offers the following conceptualizations that are central to her theory. "Fight or flight" occurs when confronted by stress, individuals either react with aggressive behavior, such as verbal conflict and more drastic actions (the "fight" response), or withdraw from the stressful situation (the "flight" response). "Tend and befriend" occurs when subjects respond to stressful conditions by protecting and nurturing themselves and their "young" (the "tend" response) and by seeking social contact and support from others (the "befriend" response). This is a descriptive study to contribute knowledge about stress responses. Participants will be recruited via email from UW faculty, staff and students, as well as sign language interpreters in the community. They will be invited to respond to a survey questionnaire on Catalyst that was created by the investigator and offers the opportunity for anonymous responses. Human subject approval has been received and data collection is anticipated to begin shortly. SPSS will be used to analyze the data collected. My project's focus is: 1) to develop an instrument to mea-

sure stress responses based on Taylor's theoretical framework of stress responses. 2) To describe respondents stress level most common specific responses to stress and their perceptions of "fight or flight" or "tend and befriend" stress responses. 3) To explore possible relationships among gender, age and type of stress responses.

### **Citizenship and Political Activism in the Era of Internet**

*Jenny Mauro, Senior, Communication*

*Mentor: Lance W. Bennett, Political Science*

Media activism arguably seems to be the last frontier of political participation. The introduction of new ICTs (Information and Communication Technologies) has truly revolutionized society in my lifetime. The world is smaller than ever before, the dimensions of space and time have shrunk to a degree that borders are no longer barriers. People are now able to communicate and interact in a multitude of different forms and in a variety of standards. Given these changes, the concepts of citizenship, social identity and political participation, which can be now designed and shaped by each person according to his/her own interests and needs, should be rethought. A possible result is a manifold identity, which encourages the creation of new relationships and self-organization between different people with similar interests. However, the actual effects of this technological revolution, from a sociological point of view, are uncertain and difficult to pinpoint; nevertheless, certainly many scholars and activists consider the Internet a powerful tool for those groups that have historically been unable to have their voice heard. My study thus aims to systematically analyze the phenomenon of the Internet as an instrument for political engagement and social identity construction. Specifically, I compare the Internet to the traditional mass media structure in order to better understand the most effective political strategies. My goal is to identify some media activism guidelines to utilize ITCs for civic purposes, such as promoting political participation in the citizenry.

### **Developing Web Design Guidelines Through Internet-Based Studies**

*Brandon Maust, Senior, English, Biochemistry*

*Mentor: Jan Spyridakis, Technical Communication*

The currently accepted guidelines for Web design are primarily derived from common practice, conventional wisdom, or small-scale, lab-based usability studies. Our research group maintains that future guidelines must be derived from research conducted with large groups of users interacting with Web sites from their native environments in order to develop guidelines that can meet the needs of Web site designers who are attempting to serve varied Internet users with their unpredictable needs and motivations. While the concept might seem simple, the conduct of remote Web-based experiments has presented significant difficulty to researchers. Based on previous work in which members of our group had difficulty in acquiring reliable and valid survey data, and in extracting meaning-

ful information concerning user's paths through a Web site, our team has been developing a tool set and methodology for conducting remote Web-based experiments of Web design features. We have used the tool set and refined methods to conduct an experiment on the effect of informative and intriguing hyperlink wording on user comprehension, perceptions, and behavior with results that demonstrated a significant effect on browsing behavior (as measured by the number of pages visited) and comprehension. Our next study, which we are currently instrumenting, focuses on creating remote experiments to assess some design features of an e-health Web site sponsored by the UW Department of Orthopaedics. We are conducting two studies in which we examine the effect of navigation design and heading semantics and syntax on comprehension, perceptions, and browsing behavior. We hope that our methods, in addition to the experimental results, will be useful to other researchers attempting to conduct empirical studies to support Web design guidelines.

### **Organ Rudiment Formation within the Zebrafish Tailbud**

*Matt McCarthy, Senior, Biology*

*Mary Gates Scholar*

*Mentor: Mark S. Cooper, Biology*

In an effort to understand more about the developmental mechanics and gene pathways of bony (teleostean) fish, our laboratory has studied the three germ layers and developing cell structures in the tailbud region of the developing zebrafish, *Danio rerio*. As a part of many related projects in the lab concerning the developmental dynamics of zebrafish, I have focused primarily on the mechanisms and processes involved in reshaping the embryonic germ layers into organ rudiments. An embryonic organ known as Kupffer's Vesicle, has recently been shown to be involved in the establishment of left-right asymmetries in the zebrafish embryonic body axis. As an endodermal embryonic organ, Kupffer's Vesicle must communicate with the presomitic mesoderm in order to establish the chemical gradients and signaling asymmetries that give rise to asymmetric organ formation. To specifically study the cell interactions involved in embryonic development, we use imaging and visualization techniques to examine the genesis of organ rudiments that compose the embryonic tail. In particular, we have examined the social interactions of mesodermal stem cells within the zebrafish tailbud, as they form the posterior limit of presomitic mesoderm. An understanding of the morphogenesis in the zebrafish tailbud helps provide important insights into the evolution of germ layer differentiation within the tail rudiments of other vertebrates.

### **Effect of Environmental Enrichment on Cell Proliferation in the Hippocampus Following Traumatic Brain Injury in Rats**

Courtney McNamara, Junior, General Studies  
Mentor: Ramona Hicks, Rehabilitation Medicine

Traumatic brain injury (TBI) produces a wide range of behavioral impairments, including deficits in memory and learning. Although many people who sustain a TBI will remain significantly disabled for the remainder of their lives, others make partial or full recovery. Little is known, though, about these posttraumatic recovery processes. Previous studies have demonstrated that environmental enrichment improves cognitive recovery following TBI. Therefore, we hypothesized that enrichment would also be associated with an increase in cell proliferation in the hippocampus following brain injury. We subjected animals (n=5/group) to a TBI or a sham injury, followed by either standard housing or 1 hour of daily environmental enrichment for 3 weeks, followed by brain perfusion. Employing a marker for cell division, we counted labeled cells in the dentate gyrus of the hippocampus. Cell counts revealed no significant differences across groups. In conclusion, our data does not support the hypothesis that improvements in recovery associated with environmental enrichment following TBI are related to increases in ongoing cell proliferation in the hippocampus.

#### **Beta-Plane Altimetry**

Alexander Mendez, Sophomore, Mathematics, Physics  
Mary Gates Scholar

Mentor: Peter Rhines, Oceanography  
Mentor: Eric Lindahl, Oceanography

This past Summer I started working in the Geophysical Fluid Dynamics (GFD) Lab on the Rotating Beta-Plane. The Beta-Plane is an experimental device designed for studying the fluid dynamics of the atmosphere and ocean waves. My work has focused upon the measurement of the free surface height deviations caused by induced waves. The resulting altimetry data recorded as a function of time of the surface will allow us to quantify our measurements in order to more accurately model and thus predict the weather-induced perturbations caused by the analogous ocean and atmospheric waves. I have been using and developing MATLAB analysis code to process the slope information contained in experimental video images into quantitative data that is further processed by an integrated analysis tool, Particle Image Velocimetry (PIV), that converts 2D image data into 3D topography. I have also worked the construction of 2D projections of these topographies to give altitude-enhanced models of micron scale surface waves.

#### **Automatic Cerebral Embolus Detection during Coronary Artery Bypass Graft Surgery**

Thomas Mera, Senior, Bioengineering  
Mary Gates Scholar

Mentor: Mark Moehring, Bioengineering

Mentor: Donny Likosky, Dartmouth College

Coronary Artery Bypass Graft Surgery (CABG) is a common procedure used for relieving angina (chest pain). A portion of patients undergoing CABG may subsequently develop a stroke or measurable decline in cognition. These injuries are hypothetically related to the surgical intervention. In an effort to reduce the risk of these injuries, we have developed and implemented a model for linking clinical interventions with concurrent monitoring of cerebral blood flow using Doppler ultrasound to detect foreign particles or bubbles. These particles or bubbles, called emboli, have previously been associated with the creation of these neurologic injuries. Emboli may arise from dislodgement of plaque in and around the heart, or from introduction of air or lipid bubbles into the circulation. Embolic signals may appear individually or in “showers”, depending in part on the clinical intervention. The purpose of my research is to create a software platform to standardize the detection and quantitative grading of cerebral embolic signals during CABG with Power M-mode Doppler (Spencer Technologies, Seattle, WA). Using LabView, I constructed a software platform for reviewing Power M-mode Doppler (PMD) recordings. The program displays two important readings: a spectrogram (blood flow velocity versus time at a particular depth) and a PMD image depicting blood flow signals along the ultrasound beam axis. The embolic signals that are manually noted by an observer using this software will be used to groom an automatic detection and grading algorithm. Statistical analysis of embolus detection performance (sensitivity, specificity, false alarm rate and false negative rate) will be used to assess possible improvements to the automatic detection algorithm. This work will provide researchers with an improved platform for supporting efforts aimed at redesigning CABG surgery to reduce the occurrence of these embolic signals.

#### **Development and Characterization of an Alginate-Based Porous Scaffold for Tissue Engineering Applications**

Norman Mezmarich, Senior, Bioengineering  
Mary Gates Scholar

Mentor: Buddy Ratner, Chemical Engineering, Bioengineering

Alginate-based porous scaffolds have been previously shown to exhibit superior biocompatibility and increased angiogenesis *in vivo* when compared to other scaffold materials such as poly-vinyl alcohol (PVA). The scaffolds used in this project were produced by foaming an alginate and amino-acid solution in a colloidal gas aphon mixer to create a porous structure, which was then captured and made permanent by freezing and subsequent crosslinking of the alginate polymers. The aim of this project is to create a second-generation scaffold that improves upon the previ-

ous design while still keeping or surpassing the original scaffold's biocompatibility and mechanical characteristics. Improvements to be implemented include the replacement of toxic reagents with non-toxic alternatives, and reducing the number of reagents needed to create the scaffold. The net result will be a scaffold that comes into contact with as few toxic reagents as possible, in order to minimize the chance of producing a cytotoxic scaffold, while keeping the production cost and complexity at a minimum. Once the second-generation protocol has been developed, mechanical and biological characterization of the scaffold will be performed, in order to compare the properties of the new scaffold with the old. Elastic modulus and swelling ratios will be among the mechanical characteristics to be studied. Biocompatibility and cytotoxicity tests will be run *in vitro* in order to estimate the performance of the new scaffolds in physiological conditions. *In vitro* stability and leaching assays will also be performed in order to characterize the scaffold's long-term behavior in an implant.

### **Object Oriented Finite Element Analysis of Porous Ceramics**

*Ravi Mikkelsen, Senior, Materials Science and Engineering*

*Mary Gates Scholar*

*Joseph Schmeller, Senior, Materials Science and Engineering*

*Kaishi Wang, Senior, Materials Science and Engineering, Sichuan University*

*Mentor: Raj Bordia, Materials Science and Engineering*

Object Oriented Finite (OOF) Element Analysis (a software package developed at the National Institute of Standards and Technology) is a powerful technique to model the effect of the microstructure on properties of multi-phase materials. The analysis begins by importing the digital image of a material's microstructure into the software package. A mesh is then created to best analyze that microstructure. Once the mesh has been generated, finite element analysis is conducted on the microstructure. From this analysis, desired properties can be predicted or different virtual experiments can be conducted. Current research focuses on using OOF to model the thermal and mechanical properties of metal impregnated porous ceramic foams to be used in high performance disc-brake applications. This is done in collaboration with a team from Ehrlangen, Germany and Toronto, Canada who are preparing the physical samples. I will present the data thus far collected from the modeling and how it corroborates with the testing done on the physical samples.

### **An Automated Device for the Dissociation of Barrett's Esophagus Biopsies for Flow Cytometry**

*Andrew Miller, Senior, Mechanical Engineering*

*Mary Gates Scholar*

*Mentor: Marc Holl, Electrical Engineering*

Preparation of Barrett's Esophagus biopsies to create a suspension of cell nuclei for cancer tests currently takes a significant amount of time by a trained technician before the cells can be analyzed. This time used by the technician is expensive, and can be better put to use in other areas. We present a semiautomated method that holds promise to significantly reduce the time and cost required to prepare these cells. The device works by first increasing the exposed surface area of the tissue to a lytic reagent and then applying viscous shear. Mechanically this is achieved by placing a biopsy between rotating disks with hundreds of microfabricated razor sharp protrusions. The protrusions are photolithographically etched into glass wafers, producing the razor edges with precisely controlled heights. Rotational motion tears and slices the tissue biopsy apart resulting in individual cells, and after exposure to shear and lytic reagent, released cell nuclei. After the cells have been dissociated and nuclei released a microperistaltic pump dispenses the nuclei to a receiving tube for subsequent flow cytometric analysis. The research is being conducted in collaboration with the Reid Lab at the Fred Hutchinson Cancer Research Center. An automated prototype has been fabricated, and we are working to optimize its performance. Recent tests have shown our prototype exceeds in yield and quality the best current method by producing a suspension of cell nuclei with very little debris. We are currently testing and further validating these results to allow us to identify primary sensitivities and move towards optimal settings for use in research settings, and to develop a next generation device that implements the process within a disposable cassette. The ultimate project objective is to transition this research to hardware that can be widely disseminated to cancer biology and pathology laboratories.

### **The Importance of Predicted Genes Tb08.12O16.300 and Tb08.12O16.320 in Trypanosomabrucei**

*Hodo Mohamud, Junior, Biology*

*Mentor: Marilyn Parsons, Pathobiology*

*Trypanosoma brucei* (*T.brucei*) is a parasite that is transmitted to humans via its host tsetse fly. Once transmitted, flu like symptoms will appear, anytime from a couple of weeks to several months depending on the subspecies. At which time it will cross the blood brain barrier and attack the central nervous system. Today, about one third of the population of Africa lives in tsetse fly-infested areas. My research is to determine whether the two regions Tb08.12O16.300 and Tb08.12O16.320 are genes and, if so, what proteins they express and their function. The predicted genes are related in sequence to Nopp 44/46, which are trypanosomatid-specific nucleolar phosphoprotein involved in biogenesis processing events specific to this species. Using RNAi, a process of taking double stranded RNA and triggering the degradation of a homologous mRNA transcript specific to a gene, will reduce the abundance of any proteins they express. So far I have done PCR on the two

regions and cloned them into PGEM- Teasy, a vector designed for growing in e-coli. I have then isolated the two regions from the plasmid and sequenced them. After I made sure the sequence was correct, I placed the two regions in another plasmid, PZJM, which is designed to express them in *T. brucei*. I have already transfected Tb08.12016.320 into the *T. brucei* parasite. I have not yet transfected the Tb08.12016.300 strain into *T. brucei*. I have not done enough transfections of the 320 strain to obtain meaningful results. Since these predicted regions are related in sequence to Nopp 44/46, which are proteins involved in biogenesis specific to the *T. brucei* species; we predict that depletion of the mRNAs for these genes may lead to a ribosome biogenesis defect.

### **Bacterial Colonization of Marine Polymer Gels**

*Andres Moon, Junior, Biology*

*Mary Gates Scholar*

*Angela Oviedo, Recent Graduate, Biology*

*Charlene Ng, Recent Graduate, Biology*

*Mentor: Pedro Verdugo, Bioengineering*

*Mentor: Ivan Quesada, Bioengineering*

Ninety-seven percent of the ocean's organic carbon is found in the form of dissolved organic carbon, and 10% of this compound (~70 gT) is in the form of gels. Bacteria degrade particulate organic matter (POM) into short chains of organic molecules. An important part of this POM is in the form of gels, self-assembled or from marine organisms. The depth at which the carbon present in POM is converted back to CO<sub>2</sub> by bacteria is crucial in understanding whether the ocean acts as a source or sink of carbon. Although the interactions between bacteria and marine gels are known to occur and have important implications, they are not completely understood. In this study, the numbers of polymer gels and the colonization of bacteria in marine gels were recorded for different depths. A colonization ratio was determined, comparing the concentrations of bacteria inside of gels to bacteria in the surrounding seawater. It was found that this ratio was in the order of magnitude of 10<sup>7</sup>. Also, the drastic decrease in bacteria below the euphotic zone was consistent with previous studies, while contrary to implications made by earlier studies, there was an increase in available gel concentrations. Since gels are found in a patchy distribution, the high concentration of bacteria within gels could explain the presence of colonies of bacteria found in the water.

### **Proteomic Investigation of HIV Infection in T-Cells**

*Karam Moon, Senior, Biochemistry*

*Mary Gates Scholar*

*Mentor: Norm Dovichi, Chemistry*

Therapeutic intervention in HIV infection is currently being studied on multiple fronts. Modern antiretroviral therapy techniques have substantially increased the lifespan of infected individuals and impacted the management of

HIV disease. In particular, therapy aimed at inhibiting HIV activation of the cellular transcription machinery has been of interest due to accumulating mechanistic evidence of HIV infection. Therefore, by studying protein expression changes induced by HIV-1 infection, proteomic analysis can identify new therapeutic targets and avenues of potential treatment. In this project, our goal will be achieved by mapping gene and protein expression changes by single cell analysis of CEM and SupT1 T-cell lines. Since proteins are critical to all biological regulatory pathways, environmental changes can induce changes in cellular phenotype by regulation of gene expression, producing differential expression of proteins. Thus, study of the heterogeneous nature of HIV-1 target cells will require single cell analysis. Jorgenson et. al. [1] first reported using modern analytical techniques for the chromatographic analysis of a single neuron and numerous methods have been developed since then for the study of single cells. Capillary electrophoresis (CE) has emerged as a potent analytical tool for the analysis of peptides and proteins in single cells due to cell-to-cell variation in protein expression. Dovichi et al. [2] have already demonstrated many uses of capillary SDS-DALT electrophoresis, such as its role in the analysis of a single HT29 human colon adenocarcinoma cell. While CE has, in past decades, primarily been used for genomic research, its proteomic applications will be further demonstrated by these studies, especially in light of the potential for fully automated CE instruments that may, one day, displace cumbersome slab-gel electrophoresis for protein analysis.

[1] Kennedy, R.T., Oates, M.D., Cooper, B.R., Nickerson, B., Jorgenson, J.W. *Science* 1989, 246, 57-63

[2] Hu, S., Zhang, L., Cook, L.M., Dovichi, N.J., *Electrophoresis* 2001, 22, 3677-3682

### **The Role of p120ctn in Zebrafish (*Danio rerio*)**

#### **Embryonic Development**

*Claire Muerdter, Senior, Biology*

*Mary Gates Scholar*

*Terry Chen, Senior, Biochemistry, Biology*

*Mentor: Merrill Hille, Biology*

Cell migration and adhesion create embryonic form. This crucial process is mediated by several proteins, including p120 catenin (p120ctn), a protein with a molecular weight of 120 kiloDaltons. p120ctn is found in all animals and regulates cadherins, a transmembrane protein that binds neighboring cells together in polarized epithelial sheets. However, p120ctn's exact role and the mechanism of its function are unclear. To better understand p120ctn's function, we would like to manipulate p120ctn expression in zebrafish embryos. To do this we must obtain the sequence of the p120ctn gene. p120ctn has been fully sequenced in humans, but only partially sequenced in zebrafish; the 5' and 3' ends of the zebrafish p120ctn gene are not fully known. In order to obtain the sequences for these sections of the gene, we are attempting to amplify the 5' and 3' ends

of p120ctn from zebrafish cDNA libraries using PCR. Finding the sequences is difficult because of the presence of four different start sites within the gene, which generate different isoforms of the protein during different stages of development. When we know the full sequence of the gene in zebrafish, we will be able to “knock-out” p120ctn expression so that no protein is present in a developing embryo. Alternatively we can increase p120ctn presence in embryos by injecting a *Xenopus* p120ctn gene. When these manipulated embryos are compared to control groups of embryos, we will gain a picture of how specific parts of the embryo are affected in different stages of development. Hopefully this knowledge will help us to elucidate the mechanisms by which p120ctn works on all animals during development, as well as to understand the transition of epithelial cells to tumor cells.

### **Applications of Reverse Osmosis Membranes for the Isolation and Detection of Organics in Drinking Water**

*Jon Murray, Freshman, Pre-Engineering,  
Mentor: Gregory Korshin, Civil and Environmental Engineering*

Safe drinking water is a commodity that is often taken for granted in industrialized nations. However, due to increasing populations and industry, drinking water sources are becoming more and more susceptible to pollution and degradation. It is vital to conduct further research into the nature of water quality and the detection of pollution. Specifically, it is important to look at how the levels and properties of organic species can indicate the quality of a water source. The goal of the study is to investigate the performance of reverse osmosis membrane processes in the isolation of organic pollutants. Reverse osmosis, often abbreviated RO, is most often applied in water treatment, as it is highly effective at removing dissolved particles and colloids. However, because reverse osmosis efficiently removes excess water and retains pollutants, RO can also be used to isolate organic species in drinking water for study. Specifically, we will be looking at organic chemicals, which are precursors to those with carcinogenic properties. Testing the samples will be done with a variety of methods. UV spectrophotometry and fluorescence will be used to test the effectiveness of our membrane at concentrating the sample. Dissolved carbon testing will indicate how reliably organic molecules are being retained. To isolate and characterize specific compounds and pollutants, ion exchange and other preparatory chromatographic and separation techniques will be used. The goal is to get a very precise picture of what species are present and what are their effects. Progress made so far includes the concentration of a tap water sample using a commercially available membrane system and testing of this sample to investigate the effectiveness of the system. Our goal is to use the reverse osmosis system to characterize the organic pollutants in the Potomac River in Washington DC. This will give us

a chance to investigate real world pollution that is affecting a major city.

### **Constructing High Profile Crimes: A Case Study of the Laci Peterson Murder**

*Crystal Nam, Senior, Communication  
Mary Gates Scholar  
Mentor: Michael Henderson, Communication  
Mentor: Valerie Manusov, Communication*

Sensational trials and compelling crime stories create media frenzy and captivate audiences across the nation. There is significant research done on crime in the media; however, the study of high profile crimes is a burgeoning area of study. High profile crime stories must be studied in order to understand the lasting implications they have on the legal system, journalism, and public sentiments of fear. The national coverage of Laci Peterson’s murder is no exception and will be remembered as one of the most infamous crimes of our time. There are, however, other crimes identical to this story that did not receive this level of news coverage, namely because the news coverage is a highly selective procedure. My research focuses on the process of how Peterson’s story received national publicity by studying its “newsworthiness,” or its level of importance to the public. The primary focus lies in how journalistic values shape newsroom practices and determine what is considered newsworthy material. A comparative case study between Peterson and an identical crime of Evelyn Hernandez is used in this theoretical-based study to understand how newsworthiness played a role in the rise of Peterson’s story as a national, high profile crime. By applying newsworthy criteria set by previous studies, Peterson’s story meets more of the values than Hernandez, therefore making it more newsworthy on a theoretical level. Although Peterson’s story contains more news values, this study concludes that newsworthiness alone does not create high profile crimes. Eternal factors specific to the nature of each case determine the level of recognition.

### **Downregulations of RON Expression and its Effect on JSRV Infection**

*Jeremy R Nance, Senior, Biology  
Howard Hughes Scholar  
Mentor: Dusty Miller, Human Biology, Fred Hutchinson Cancer Research Center  
Mentor: Neal Van Hoesen, Human Biology, Fred Hutchinson Cancer Research Center  
Mentor: Sarah Wootton, Human Biology, Fred Hutchinson Cancer Research Center*

Jaagsiekte Sheep Retrovirus (JSRV) is a betaretrovirus that causes ovine pulmonary adenomatosis (OPA) in sheep. Infection by JSRV causes neoplastic transformation of secretory epithelial cells leading to loss of alveolar function and ultimately death. JSRV uses hyaluronidase 2 (HYAL2), a

glycosylphosphatidylinositol (GPI)-anchored cell-surface protein as a cell surface receptor. In the human lung epithelial cell line BEAS-2B, HYAL2 binding to a receptor tyrosine kinase (RON) results in inhibition of signal transduction by RON. Recent research has shown that overexpression of RON decreases the infectivity of JSRV pseudotyped virus but does not interfere with virus binding (N. Van Hoeven, personal communication). We hypothesize that decreasing RON expression using a RON-specific siRNA will lead to increased infectivity of JSRV pseudotyped virus. A flow cytometry assay will be used to determine if RON expression is reduced in cells expressing the siRNA. Once RON expression is reduced in the cells they will be challenged with JSRV pseudotyped virus. If the infectivity of JSRV pseudotyped virus increases, as predicted, this suggests that RON is an important interacting protein that normally blocks JSRV transduction. Previous data supports this hypothesis. However, if JSRV infection is unaltered by a decrease in RON expression then RON plays an unidentified role in limiting virus infection.

#### **Prevalence of *Renibacterium salmoninarum* infection among juvenile Chinook salmon in North Puget Sound and implications for disease interactions**

*Shelly Nance, Senior, Biology*

*Mentor: Linda Rhodes, Northwest Fisheries Science Center*

*Renibacterium salmoninarum* causes bacterial kidney disease (BKD), a chronic and sometimes fatal condition of salmon and trout. This bacterium is transmitted both horizontally and vertically, and high prevalence in a population can lower overall fitness. The purpose of this study was to determine infection prevalences of *R. salmoninarum* among near shore juvenile chinook salmon in North Puget Sound. The central questions were whether the prevalence rates would vary by fish origin (marked or hatchery vs. unmarked or feral), by season, or by geographical area. Juvenile chinook salmon were collected between April and October in 2002 and 2003 in 32 near shore habitat sites by surface trawl (townet). Kidney tissue samples were collected and analyzed microscopically by counting bacterial cells stained with an anti-*R. salmoninarum* polyclonal antibody conjugated to fluorescein isothiocyanate. Differences in infection prevalence were observed by geographical area and by seasons. Although seasonal differences were observed among the distinct geographical areas, no overall seasonal trend was found throughout the North Puget Sound. There was no difference in infection prevalence between marked and unmarked fish in all regions in the North Puget Sound. Our findings implicate potential disease interactions between the feral and hatchery fish.

#### **Multilateralism and Maritime Security: Anti-terrorism in the midst of Globalization**

*Riley Newman, Senior, International Studies, Economics*

*Mary Gates Scholar*

*Mentor: Wolfram Latsch, Jackson School of International Studies*

My research project is an honors thesis for the Jackson School that focuses on the importance of international maritime security in the 'War on Terror' and the effects of recent US and UN security requirements on international trade flows and developing countries. With increased globalization, international trade, which is primarily conducted in the maritime sector, has substantially increased. Many corporations now rely on ever more efficient global supply chains for competitive advantage. However, the demand for efficiency has left many of the world's critical trade ports exposed to potentially catastrophic attacks. My research attempts to answer why, in an effort to belay this threat at American ports – through initiatives such as the Maritime Transportation Security Act (MTSA), Container Security Initiative (CSI) and "24 Hour Rule" – the US has effectively exported the cost of securing the homeland to developing countries, seriously affecting their economies as well as traditional flows of international trade.

#### **Polymer Derived Ceramics for Corrosion Resistant Coatings**

*Mai Ng, Senior, Materials Science and Engineering*

*Mentor: Rajendra K. Bordia, Materials Science and Engineering*

As the search for new sources of energy continues, candidates such as hydrogen have received much attention. In order to meet the demand, the hydrogen production industry will need to grow significantly. As with any industry, the development of increasingly efficient components is always of primary interest. One such component that may benefit from improvement is the pipe system used in gas transport. As methane and oxygen are transported through the system, the purity of materials is essential. Thus, a transport pipe that is corrosion-proof and thermally resistant is desired. The corrosion resistant pipe would resist reaction with the gases as well as provide a degree of thermal resistance that would allow the system to operate at higher temperatures and thus higher efficiencies. One approach to designing such a pipe would employ a protective inner coating. As a material choice ceramics immediately come to mind as it would provide both corrosion and thermal resistance. However, ceramics are relatively difficult to form into a uniform thin coating. Given the processing issues, Polymer Derived Ceramic (PDC) siloxane systems may be an ideal candidate as it is a polymer in its initial state. The polymer could be easily coated within the pipe and then converted into a uniform ceramic coating. PDCs also offer significant advantages including ease of processing, low temperature pyrolysis, and control over the composition. In this presentation, results on the processing of the ceramic coatings, produced microstructure and properties will

be described. In addition, the mechanical properties including hardness, toughness, and modulus of the coatings are determined through indentation testing at various loads. The goal of this research is to produce a ceramic coating that experiences low shrinkage, especially during pyrolysis, and is mechanically strong, for protection against particle impacts.

### **Comparison of farming and non-farming mothers in Thai Nguyen, Vietnam**

*Lisa Nguyen, Senior, Neurobiology*

*Mary Gates Scholar*

*Kelly Bui, Senior, Psychology*

*Mary Gates Scholar*

*Mentor: Michelle Williams, Epidemiology*

**Objective:** In Vietnam, past research has demonstrated that female farmers are at a three times increased risk for delivering a low birth weight (LBW) infant. Nevertheless, there have not yet been studies focused on the characteristics of female farmers that may predispose them to LBW deliveries. **Methods:** Using secondary analysis, this cross-sectional study compared the characteristics of 103 farming and 253 non-farming women in order to identify possible factors that could lead to the differences observed in pregnancy outcomes. Exposure was defined as having the occupation of a farmer while non-exposure was classified as having occupations other than farming. These two groups were derived from the control group of the original LBW study, excluding cases (women who delivered LBW infants). **Results:** This study's results indicated that female farmers were more likely to be less educated (OR: 7.7, 95% CI: 3.7, 16.1), have partners who were also less educated (OR: 4.0, 95% CI: 1.9, 8.5), be unmarried (OR: 3.7, 95% CI: 0.8, 17.8), and reside in a rural location (OR: 14.7, 95% CI: 8.4, 26.0). In terms of anthropomorphic characteristics, farmers had lower pre-pregnancy weight (OR: 2.0, 95% CI: 1.1, 3.7), BMI (OR: 1.8, 95% CI: 0.9, 3.6) and rate of gestational weight gain. Compared to non-farmers, more farmers also had not intended for this pregnancy (OR: 4.7, 95% CI: 1.6, 13.7). During the pregnancy, farmers utilized less antenatal visits and had a shorter duration of folic acid intake ( $2.8 \pm 1.8$  months versus  $3.4 \pm 1.4$  months in non-farmers). **Conclusions:** Our results highlight the possible factors that may influence the elevated incidence of LBW deliveries among farming women, providing a preliminary direction for the policies and programs which need to be implemented to assist the needs of this unique population.

### **Self-esteem and Perfectionism: A Correlational Study of Self-esteem and Perfectionism in Asian-Americans College Students**

*Thach (Franchesca) Nguyen, Junior, Psychology*

*Tracy Lo, Post-Baccalaureate, Psychology*

*Robert Palmquist, Senior, Psychology*

*Mentor: Mary E. Larimer, Psychiatry and Behavioral*

*Sciences*

*Mentor: Ursula Whiteside, Psychology*

Studies investigating self-esteem and perfectionism have focused mainly on its relationship to psychological problems such as depression, suicide, and eating disorders. There are few existing studies that examine the relationship between self-esteem and perfectionism in non-clinical samples, and no studies investigating these variables specifically in Asian-American college students. The present study explores self-esteem and perfectionism in Asian-American college students. Three questions will be addressed in this poster. The first question is whether Asian-American college students (as compared to students of different racial backgrounds) are more, less, or equally likely to experience low self-esteem. Second, among Asian-Americans, what is the relationship between perfectionism and level of self-esteem? Finally, we would like to examine whether low self-esteem in Asian-Americans is related to perceptions of parent expectations of perfectionism. The scales of interest were the Multidimensional Perfectionism Scale -Hewitt and the Multidimensional Perfectionism Scale - Frost, as well as the Rosenberg Self-Esteem Scale.

### **Water Pillows as a New Coupling Method for High Intensity Focused Ultrasound Transducers**

*Thuc Nghi Nguyen, Senior, Bioengineering*

*Mentor: Shahram Vaezy, Bioengineering*

High-intensity focused ultrasound (HIFU) has great promise as a mode of non-invasive surgery, but it also has challenges that include efficient coupling and cooling methods. Current coupling methods such as gel couplers do not have cooling effects, and water cone couplers induce air bubble formations, causing undesirable ultrasound signal reflection. Without concurrent cooling during sonication, a transducer can only be powered for 10-20 seconds before it must be turned off to cool. A protocol of short sonications with cool-down intervals is inconvenient and limits certain therapies, such as attempts to stop internal bleeding by occluding large blood vessels. I have been designing, producing, and testing water pillows, a new method of coupling that can couple the acoustic signal and cool the transducer simultaneously. These pillows consist of two thin polyurethane film membranes that are heat-sealed around the edges with openings for an inlet and outlet port for water circulation. Efficiency of heat removal by the pillow is being determined by measuring water temperature at the inlet and outlet and using an energy balance equation to calculate the amount of heat removed. Comparisons will be made for a 3.5 MHz and 5 MHz transducer, operated at varying power levels and varying flow rates. In addition, water flow patterns in the pillow are being characterized to verify uniform circulation and to determine the optimal locations for inlet and outlet ports. Flow patterns are captured on video by injecting ink into the water stream, and the video clips

are image-processed using Matlab. Further investigations will include determination of optimal membrane thickness and quantification of the membrane's attenuation coefficient, sound speed, and impedance. The pillows have been used in several animal studies with overall success. We expect this new method of coupling to reduce time limitations in HIFU therapy due to overheating.

### **Structure and Functional Studies on Mammalian $\alpha$ B-Crystallin**

*Satoshi Mark Noguchi, Senior, Biology, Music*

*Mary Gates Scholar*

*Mentor: Ponni Rajagopal, Biochemistry*

The mammalian protein  $\alpha$ B-Crystallin ( $\alpha$ B) has various biological roles in the eye lens and muscle tissues. It is involved in the ubiquitin/proteasome pathway, apoptosis, desmin-related myopathy, and neuro-degenerative diseases.  $\alpha$ B is a member of the small Heat Shock Protein (sHSP) family and displays chaperone activity *in vitro*. Chaperones protect partially or fully denatured proteins and help refold them to retain their biological activity. The molecular structure of  $\alpha$ B has not been solved, and this limits our understanding of its functional mechanisms. Like many sHSPs,  $\alpha$ B forms a polydisperse oligomer with a high molecular weight, which has hindered structural studies in the past. We are using high-resolution, solution-state nuclear magnetic resonance (NMR) to solve the structure of smaller functional domains of  $\alpha$ B. By constructing smaller functional domains and incorporating various amino acid point mutations, we are acquiring NMR spectra more amenable for structural studies. To gain insight into functional mechanisms, we are also investigating the structural consequences of various post-translational modifications and mutations on the smaller domains of  $\alpha$ B. For example, the mutant R120G has been associated with desmin-related myopathy. We are investigating the structural consequences of such mutations.

### **Researching Foxa Interactions with GTFs *in vitro***

*Mari Obara, Junior, Biology*

*Mary Gates Scholar*

*Mentor: Alison Crowe, Biology*

This project's aim is to better understand the mechanism by which a group of transcription factors called Forkhead box (Foxa) regulates the expression of genes involved in liver formation during human embryonic development. Past studies have shown Foxa to activate these genes by stabilizing the preinitiation complex (PIC) formation needed to promote gene transcription, but the mechanism by which Foxa does this has yet to be elucidated. We hypothesize that Foxa directly interacts with general transcription factors (GTFs) to promote and stabilize PIC formation. In order to test Foxa's capability to bind GTFs *in vitro*, we first had to find a protocol that allowed us to isolate Foxa from

suspension and visualize it. Because our *in vitro* work will be done using Foxa that had been recombinantly expressed in *E. coli* (rFoxa), we used nickel-agarose to bind the histidine tag on rFoxa to isolate it from suspension. Our Western blots have shown this to successfully purify rFoxa. Our task now is to study Foxa-GTF interactions by incubating rFoxa with purified TATA binding protein (TBP), which is a GTF, then precipitating rFoxa with nickel-agarose, and finally visualizing the proteins pulled down in association with rFoxa by probing with Foxa and TBP antibodies in Western blot analysis. If indeed rFoxa and TBP interact, our next step will be to evaluate Foxa's ability to bind GTFs *in vivo*. rFoxa will be added to extracts of various cell types, then immunoprecipitated. The proteins associated with rFoxa will be visualized by silver staining. We will look for Foxa-GTF interaction by identifying cell type-independent interactions. If rFoxa shows no indication of binding TBP, we will proceed with the same immunoprecipitating and silver staining experiment and look for interactions between rFoxa and other proteins conserved across different cell types.

### **Authoring Tools for Web Based Surveys: A Descriptive Study**

*Jeff Okada, Junior, Neurobiology*

*Mentor: Donna Berry, Biobehavioral Nursing and Health Systems*

The past decade has found more and more researchers utilizing web-based surveys in their data collection efforts. Parallel increases in the number of commercial vendors who offer web-based survey tools enables non-technical people to build sophisticated surveys through their web browsers obviating the need for an in-house programmer. This trend toward outsourcing of survey construction and administration responsibilities is problematic in that researchers may be unaware of what qualities to look for in a web-based survey authoring tool. Inappropriate choices in a survey tool can potentially lead to negative outcomes such as poor data security, questionable data ownership, confounding psychometrics, inaccessible forms for people with disabilities, lost measurements, and lack of data portability. The purpose of this research study was to establish and define the critical success criteria for evaluation of a survey-authoring tool and to review the top five most commonly used commercial tools. A review of the literature was conducted and resulted in a preliminary list of critical success criteria that included issues pertaining to security, data ownership, survey tool usability and portability, and psychometric design. Next five experts with backgrounds in survey methods and healthcare informatics reviewed the criteria before coming to consensus on a final list. The last stage of this research involved evaluating the five most commonly used commercial web survey tools against our final list of critical success criteria. We will present the pending results in graphic and textual format.

### **Simulation and Prediction: Expanding the Tools for Genetic Engineers**

*Dave Orendorff, Senior, Computer Science, Biology*  
*Mentor: Howard Chizeck, Electrical Engineering*

This research represents a sub-cellular biological system using mathematical modeling and computer simulations. A set of molecular species are given, each of which may interact with others to produce an entity of another species. For example, DNA and RNA polymerase may interact to form a particular messenger RNA; which may then interact with a ribosome to produce a protein. One way to mathematically model spatially homologous discrete entity systems uses a set of deterministic differential equations, based on interaction rates and *assuming continuous reactions*, to produce a solution. However, this does not capture the discrete nature of entity-entity interactions. A second approach uses stochastic models to account for inherent fluctuations by modeling entity-entity interactions probabilistically. Unfortunately, this class of model is mathematically intractable for most systems, requiring computer simulations. This research expands the Gillespie algorithm (1977) to spatially homogenous systems where the assumption that reactions occur instantaneously is not valid, such as where protein folding is a factor. A modification of the Gillespie algorithm is derived to stochastically model biological systems with delayed reactions. This is programmed and used for a specific system involving the expression of the gene cassette (LUX) for chemiluminescence. Results predict how modifications of the biological system will impact LUX expression for ongoing wet lab experiments at Cogent Laboratories.

### **Priority Concerns Obtained by a Computer Survey**

*Hitha Palepu, Senior, Biochemistry, History*  
*Mentor: Donna L. Berry, School of Nursing*

During a health care interview between a patient and a clinician, the “chief complaint” (CC) is the traditional opening, solicited from the patient, upon which a clinician builds a focused patient history. The CC helps clinicians in determining the final diagnosis as well as pursuing a succinct history. In ongoing or chronic care, the CC can set the focus of each follow up visit. Current healthcare practice has seen an emphasis on patient-centered care and a shift in communication strategies. My research evaluated responses to an open-ended text box screen embedded in a computerized quality of life and symptom survey delivered to patients with cancer. The phrase “Please tell us the 2 most important concerns or issues you’d like us to deal with or address first today” is displayed on the screen, with space below for the patient to write his or her answer. The print-out is made available to the interviewing clinician consisting of color-coded symptom and quality of life information and the priority concerns and comments in the text box. The use of the computer may allow patients to express

their main concerns without fear or embarrassment as well as introduce the clinician to the priority concerns of patients. This presentation will illustrate the categories of concerns written by 107 patients with cancer, as they were about to consult a cancer specialist in Radiation Oncology. We found 10 categories of priority concerns: appearance, cause, communication, death, future cancer, pain, pain/treatment, recovery, side effects, and treatment possibilities.

### **Explaining the Impact of Immigrants and the Second Generation on American Music and Perceptions of American Culture**

*Geoff Palmer, Senior, Sociology*  
*Mentor: Charles Hirschman, Sociology*

Disentangling the process through which culture is created poses a complex problem. Multiple questions are involved in this process. One question seeks to uncover who contributes to culture. I analyzed data from National Public Radio on major musical contributors of the twentieth century, which shows that immigrants and their children are well represented in twentieth century culture. If this is the case, then what impact have these immigrants and their children had on American culture in general, and on music specifically? A second question regarding the process of culture creation asks why some individuals are represented while others are not. I compared Merton’s work on Anomie and Strain Theory alongside Network Theory to interpret the findings from the NPR data set. Merton’s work suggests that due to unequal access to socially acceptable means to success, immigrants and their children often seek to achieve success in unconventional ways. As a result, these demographics ought to be equally, if not over-represented, among successful innovators. Finally, comparisons between these findings and the scholarship on assimilation and networks suggest that assimilation could be a two-way process.

### **Collaboration and Source Monitoring in Preschool Age Children**

*Jessica Palmer, Senior, Psychology*  
*Mary Gates Scholar*  
*Mentor: Jessica Sommerville, Psychology*

33 children were placed into one of four conditions: high collaborative first person perspective, low collaborative first person perspective, high collaborative third person perspective and low collaborative third person perspective. All children were trained on how to build 6 toys each of which consisted of 6 parts, using pictures of the sequences to aid in the construction. In the high collaborative conditions the child and adult took turns at the level of the step, whereas in the low collaborative conditions the child and experimenter took turns at the level of the toy. Children were shown the pictures and asked to recall who (they or the experimenter) performed each step, and were then asked to rebuild the toys all by themselves. Results showed that children in the high collaborative conditions over claimed

actions performed by the experimenter as self-performed, and this seemed to be correlated with better memory for reconstructing the toys in the first person perspective condition. Implications of this information are discussed.

### **Absolute Quantification of NMR**

*Lauren Palmer, Sophomore, Biology*

*Mentor: Martin J. Kushmerick, Radiology, Physiology and Biophysics, Bioengineering*

Nuclear Magnetic Resonance (NMR) is an extremely useful clinical tool in the diagnosis and monitoring of metabolic disorders. Unfortunately, most NMR measurements are calculated based on standardized values of certain metabolites, but an ill patient is not likely to have the standard levels of those metabolites. Therefore we are developing a method to measure the metabolites absolutely, without relying on comparisons to standardized and not necessarily appropriate values. We have been developing two methods for this absolute quantification, one using a synthetic NMR signal, and the other using a known-concentration “phantom” sample similar to the muscle. The synthetic signal is injected into the NMR signal line at the time of data acquisition by the use of a very small inductively coupled coil near the main RF coil. The phantoms are designed to interface with the RF coil identically to muscle. Both methods can be implemented together to assure greater accuracy. We hope this research will eventually improve clinical NMR.

### **Automatic Classification of Protein Crystallography Images**

*Shen Pan, Senior, Computer Science*

*Mary Gates Scholar*

*Mentor: Richard Ladner, Computer Science and Engineering*

*Mentor: Linda Shapiro, Computer Science and Engineering*

*Mentor: Eve Riskin, Electrical Engineering*

Protein crystallography labs have been performing an increasing number of experiments of crystal growth. Better automation has enabled researchers to prepare and run more experiments in a shorter time. However, the problem of identifying which experiments are successful remains difficult. In fact, most of this work is still being done manually by humans who have to examine thousands of images for each experiment. Automating this task is therefore an important goal. As part of the ACAPELLA project, we have been developing a new image classification subsystem to greatly reduce the number of images that require human viewing. This system must have extremely low rates of false negatives (missed crystals), possibly at the cost of an acceptable number of false positives. Our system consists of three stages. During the first stage, the system preprocesses the images. In the second stage, for each image, the system finds the solution drop area in the image, divides

the area into 2020 pixel blocks, and computes a set of numeric features for each block. Finally, during the third stage, the system utilizes a support vector machine (SVM) for classification of the blocks. The input to our SVM classifier, which is computed for each block, is a set of numeric features such as the mean and variance of intensity values, textures, and perceptual groupings that capture high-level structures like parallel and perpendicular lines. If an image contains one block that is classified as containing a crystal, then the system classifies the image as being positive. We have achieved significant results, reducing false positives by roughly 60%, while maintaining the false negative rate under 10%. We expect that these results can be significantly improved by applying multiple classifiers and using the combined output. In addition, we are investigating ways to significantly speed up the processing time.

### **The Changing Nature of the Healthcare Agenda: A Case Study of Children’s Healthcare in Congress**

*Mara Patashnik, Senior, Political Science, Philosophy*

*Mary Gates Scholar*

*Mentor: Bryan Jones, Political Science*

There is evidence that increasing issue complexity in policy areas leads to a corresponding decline in policy effectiveness. As many interests compete to occupy policy “niches,” policy fragmentation necessarily results. Healthcare has many competing interests, which have contributed to the inadequacy of children’s healthcare plans in the United States. It is difficult for attention to be focused on one issue at a time and therefore, problems such as those related to children’s health needs are overlooked. I am interested in examining why bills promoting children’s healthcare have failed and why other healthcare issues appear to occupy more agenda time in Congress. In my project I will examine data from the Policy Agendas Project, which includes Congressional hearings and bills from 1946 to 2003. I plan to use the Policy Topics Codebooks to code the bills according to their title and synopsis of the issue. I am going to use the major topic code of health (300) and subtopics that fall under the health domain, and then assign each bill or hearing to a subtopic. For the qualitative portion of my project, I will compile my research surrounding children’s healthcare legislation and use a frequency distribution to understand where corresponding appropriations, and congressional attention, is being directed. This research will improve our understanding of why effective legislation addressing children’s healthcare has yet to be passed and implemented.

### **Nutrient Cycling in the Ocean: Gene Expression in *Prochlorococcus* Grown in Different Phosphorous Environments**

*Biswajit Paul, Sophomore, Biology*

*Mentor: Gabrielle Rocap, Oceanography*

The marine, unicellular cyanobacteria *Prochlorococcus*

make up a large proportion of photosynthetic biomass and are thereby very important primary producers in ocean ecosystems. They have far-reaching impacts on global nutrient cycling and climate. Successful utilization of phosphorous in phosphorous-limited zones may give populations of *Prochlorococcus* a competitive advantage over other organisms. My research is concentrated on the strain *Prochlorococcus* MED4, whose genome was recently sequenced in entirety. I am studying two genes: the *pstS* gene and the *phoA* gene. The *pstS* gene is needed to transport inorganic phosphorous into the cell. The *phoA* gene is capable of scavenging organic sources of phosphorous and making it available for use by the cell. The goal of my research is to use reverse transcriptase-polymerase chain reaction (RT-PCR) to determine the levels of gene expression in response to a) different concentrations of phosphorous and b) the presence of organic and inorganic phosphorous sources. In order to create standards for the RT-PCR I have used PCR techniques to amplify the specific genes from the genomic DNA and then proceeded to clone them using recombinant cloning techniques. I will next expose axenic cultures of MED4 to the experimental conditions outlined above and extract RNA from them to be used in RT-PCR. The results from this project will allow field samples of *Prochlorococcus* to be analyzed for level of gene expression thereby determining whether that particular oceanic zone is phosphorous-limited and also whether the samples were utilizing organic or inorganic phosphorous or a combination of both.

### **Three-Dimensional Particle Image Velocimetry and Thermometry Camera Design**

*Noel Pelland, Senior, Aeronautics and Astronautics*

*Mary Gates Scholar*

*Mentor: Dana Dabiri, Aeronautics and Astronautics*

In order to understand any type of fluid dynamics problem, it is essential to have an understanding of the geometry and temperature of the fluid flow. One technique for experimentally determining the flow patterns in laboratory situations involves immersing small particles, each coated in paint whose color changes with temperature, in the fluid and studying their movement and temperature through high-speed photography, a method known as Digital Particle Image Thermometry and Velocimetry (DPITV). In the past, DPITV technology has primarily focused on two-dimensional flow analysis, so that the pattern of fluid movement can only be studied in one plane. Recently, the advent of three-dimensional DPITV has allowed small-scale cameras to study the movement of flow in all three spatial directions. My research has focused on the design and construction of a large-scale three-dimensional DPITV camera assembly capable of taking color pictures of fluid volumes on the scale of a cubic inch. When completed, this assembly will be used to analyze the flow inside a laboratory water tunnel that passes water over a heated backwards-facing step. For an apparatus of this size, three separate

cameras are required to focus on a single focal plane in order to produce the images necessary for three-dimensional analysis. Due to the small size of the immersed particles, and the necessity of extremely accurate images in order to produce reasonable results, my main focus thus far has been procuring a mechanical positioning system capable of precisely locating each individual digital camera so that the system can be calibrated. As my research progresses, I will move towards designing the physical frame of the camera apparatus and experimenting with calibration techniques, with the hope of operating the functional assembly by the end of the school year.

### **Impulsive Stimulated Scattering in Albite**

*Scott Pendleton, Senior, Physics*

*Edward Chang, Senior, Physics*

*Mentor: Michael Brown, Earth and Space Sciences*

*Mentor: Evan Abramson, Earth and Space Sciences*

Albite is a member of the feldspar mineral group that comprises a significant portion of Earth's crust. Due to the rarity of pure, untwinned samples, the physical properties of this anisotropic crystal remain poorly determined. Our research focuses on measuring the elasticity of Albite using Impulsive Stimulated Scattering (ISS). From speed of sound measurements as a function of direction, the elastic constants are derived. The ISS technique allows measurements on available small Albite samples (of order 100 microns). Crystals are oriented using x-ray diffraction. The oriented samples are ground flat and smooth and coated with 40 nm of aluminum. Crossed infrared laser pulses stimulate an acoustic surface wave. A green probe laser pulse is diffracted from the ripples associated with the acoustic wave. The frequency of the acoustic wave is determined from the time evolution of the diffracted signal. The acoustic wavelength is determined from the incident angle of the infrared pulses. Velocities follow from the measured frequencies and wavelengths. The elasticity of Albite is described by 21 elastic constants. Thus, velocities in many directions of propagation must be measured. Seismic velocity data provide the highest resolution image of Earth's deep interior. Knowledge of mineral elasticity is prerequisite to interpretation of the seismic data. The results for Albite provide essential new insight.

### **Writing Education: Standards, Testing, and Performance Outcomes in American Public Schools**

*Joaquin Perez, Senior, Latin American Studies*

*Mentor: Gary Troia, Education*

How do state standards for writing education influence student writing proficiency and success? Are the ways in which states assess student writing well aligned with their standards? What are the similarities and differences in standards and assessment frameworks among states, and do these affect how students perform in writing? This study examines these questions in a geopolitically diverse sample

of states (Washington, Connecticut, Maryland, Texas, Indiana, Virginia, and Florida). Using information from each state's Department of Education web site, the K-12 writing curriculum standards, testing and scoring formats, and writing test results were identified, recorded, and compared. The preliminary findings from a comparative analysis revealed substantial differences in how well standards were specified for each grade level, and the content and sequence of those standards. Additionally, some states had very detailed writing assessment frameworks and scoring procedures, whereas others had no state-sponsored assessment of writing at all. There appeared to be a relationship between the specification of curriculum in writing and the thoroughness of the testing and scoring formats. For the writing assessment outcomes, data from the 2001-2002 or 2002-2003 school years were used, and only data reported for high school students were analyzed in order to make equivalent comparisons across the target states. Although notable differences existed with respect to curriculum standards and assessment frameworks between these seven states, the writing performance of the students was fairly similar across the states. Furthermore, an alarming proportion of students (up to one half) did not meet standards for writing achievement.

#### **ICAM-1 Binding by *Plasmodium falciparum* infected erythrocytes**

*David Phippard, Senior, Biology*

*Mary Gates Scholar*

*Mentor: Joseph Smith, Pathobiology*

Cytoadherence is a major cause of disease symptoms associated with malaria. *Plasmodium falciparum* erythrocyte membrane proteins (PfEMP1), encoded by *var* genes, are expressed on the surface of *P. falciparum*-infected erythrocytes and bind to host ligands, thereby causing the infected erythrocyte to adhere to the endothelium. PfEMP1 proteins are structurally variable, and can bind a wide variety of ligands. Binding of ICAM-1 has been linked to cerebral malaria, a highly lethal form of the disease. The adjacent DBL $\beta$  and c2 domains of PfEMP1 have been shown to bind ICAM-1 in the A4-tres strain. I seek to determine whether the presence of contiguous DBL $\beta$  and c2 domains necessarily indicates the capacity for PfEMP1 to bind ICAM-1. Of approximately 60 *var* genes in the IT4 strain's genome, 9 contain a DBL $\beta$  domain followed by a c2 domain. Polymerase Chain Reaction (PCR) generated constructs of the DBL $\beta$ -c2 region from the genomic DNA of the IT4 strain were cloned into the T8 12CA5 mammalian expression vector. The constructs will be transfected into COS-7 mammalian cell culture. Using an immunofluorescence assay, the transfected cells will be tested for surface expression of DBL $\beta$ -c2 and the ability to bind ICAM-1. Insights into the relationship between PfEMP1 and ICAM-1 could lead to new treatments that could prevent this interaction and arrest the development of severe disease.

#### **Measuring Atomic Size Objects on Electrically Insulating Surfaces in Ultrahigh Vacuum**

*Christina Polwarth, Senior, Physics, Mathematics*

*Mary Gates Scholar*

*Mentor: Sam Fain, Physics*

Atomic Force Microscopy (AFM) is a technique that uses forces resulting from interactions of the tip with the sample to create three-dimensional topographic images. A particular advantage of this form of microscopy is its ability to image insulating samples on the atomic-scale in the ultrahigh vacuum (UHV) environment necessary for the fabrication of devices by molecular beam epitaxy. Noncontact AFM (ncAFM) utilizes tip-sample interactions to image the surface of the sample without contacting the sample. Our research concentrates on problems encountered when using ncAFM to image atomic size objects on flat surfaces. Using a simplified model of the tip-sample system in ncAFM, we have calculated the apparent shape of very small particles in idealized experiments. We used a Lennard-Jones potential to calculate the forces between an idealized (spherical) AFM tip and the sample, consisting of a metal particle on a continuum substrate. The results produced by this simulation exhibit dimensional distortion comparable to that observed in actual ncAFM experiments.

#### **Researching the Evolution of the Gimap Family**

*Jeffrey Posadas, Junior, Biochemistry*

*Mary Gates Scholar*

*Mentor: Ake Lernmark, Medicine*

*Mentor: Elizabeth Rutledge, Medicine*

The Gimap family is a group of similar genes characterized by GTP binding domains, similar protein sequences, and expression in immune related organs, systems, and cells (thymus, lymph nodes, T cells). In BioBreeding rat studies, it was found that a single base pair deletion in the gene Gimap5 results in a truncation of a significant portion of the protein. Consequently, lymphopenia and type 1 diabetes develops in the rat. This suggests that Gimap genes may play a role in autoimmune diseases such as type 1 diabetes. However, the Gimap family remains largely uncharacterized. The research I am conducting investigates the evolution of this gene family through phylogenetic analysis of Gimap genes of rat, mouse, human, and *Arabidopsis* among other organisms. I have derived protein sequences for rat from RNA sequenced in the lab. Mouse, human, and *Arabidopsis* sequences are from online databases. Using phylogenetic programs ProML, ProPars, and Neighbor from the PHYLIP package, I have been able to create trees and form preliminary evolution models based on three different phylogenetic algorithms. Knowing the evolution of the Gimap family will help characterize the individual genes and allow better understanding of how Gimap genes play a role in type 1 diabetes.

### **Retarding Field Analyzer/High Powered Helicon Analyses**

*Gregory Quetin, Senior, Aeronautical and Astronautical Engineering*

*Mentor: Robert Winglee, Earth and Space Sciences*

The High Power Helicon (HPH) is an innovative electrodeless in-space propulsion concept. Plasmas are being researched by NASA as space propulsion because of their greater efficiency compared to standard chemical rockets. The goal of the HPH is to produce an energetic high-density plasma beam with input power on the order of 50 – 100 kw. Driving current in the helicon at high frequencies creates an electromagnetic field that propagates down the axis. Injected Argon gas is partially ionized by an arc and then accelerated by the helicon field. Studies of the plasma propagation down the axis are important in understanding the mechanism of energy coupling to the plasma from the HPH. The dynamic nature of plasma and the vacuum environment it is studied in make measuring plasmas difficult. The goals of the HPH study are to investigate how the plasma is driven by the oscillating electric field, how the magnetized plasma follows the magnetic field lines in the tank and what the ejected plasma characteristics are. To study these effects special diagnostics have to be manufactured, tested and studied. One diagnostic used to study the characteristics of the plasma is the Retarding Field Energy Analyzer (RFEA). Using a series of fine metal grids that repel electrons and accept ions of the correct energies the RFEA is able to measure the distribution of ion energy in the plasma. Ions allowed through the discriminator grid of the RFEA strike a conductive plate and create a current. By varying the potential of the discriminator grid the different ion velocities of the plasma can be measured. The goals of the project are to design, build and run tests for a RFEA and use it to measure the characteristics of the plasma velocity at various distances along the axis and radius.

### **How does the Latino family environment influence children's school achievement?**

*Wendy Radillo, Junior, Psychology*

*Mary Gates Scholar*

*Mentor: Sybil Càrrere, Family and Child Nursing*

In this study I will analyze the Latino family's influence on children's school performance by using the Peabody Individual Achievement Test (PIAT). I will ask questions as to whether Latino parents tend to prioritize work more than educational goals. I will look into the notion of gender differences in terms of what is expected for each sex; females as housewives and mothers, rather than acquiring their own education and males carrying on the role of provider. Furthermore, I will look into the importance of parents' income and educational levels and how they affect the priority they place on their child's education. Using case study methodology, I will address these questions through obser-

vation and data of four Latino children and their parents from the Puget Sound area. These children ages range from eight and nine years, they live in a two-parent household, in which both parents are married. I will conduct this study by analyzing questionnaire data from the parents, children, and teachers, as well as interviews with individual family members, and videos of family interactions.

### **Hip to the Racial Hop: Are Rap Videos Harmful in the Battle Against Racism?**

*Andrew Ralston, Senior, Communication, Political Science*

*Mentor: Philip Howard, Communication*

Racial stereotyping, in the media, has long been a standard problem in America. Specifically, Rap music videos have been blamed for creating negative social views and behaviors in the American youth. Although numerous studies have addressed the antisocial impacts Rap videos have on audiences (i.e. sex and violence). There has been very little research focused on the possible racial stereotyping that may be occurring from the images and lyrics in Rap music videos. I will investigate the hypothesis: that heavy exposure to Rap music videos, and their harsh lyrical and imagery content, can have negative cognitive and social effects; primarily including a strong reinforcement of Black racial stereotypes to a White audience. Paralleling past research about music video content, I will code the frequency and severity of racial stereotypes in music videos. The most common negative Black stereotypes that will be used are based on summarized definitions by T. L. Dixon (1997). This study will include reviewing 40 videos, including music videos from country, rock, soul, etc. The intent of this study is to determine if Rap music videos continue to foster racial stereotyping in comparison to other music video genres. With this increased awareness, the immense social impact that Rap music videos have on the American youth can be better understood. As a result, people will be better equipped to tackle and prevent the possible negative racial influences of Rap videos.

### **The Relationship of Language Learning Abilities and Non-Linguistic Cognitive Abilities in 9- to 11-Month-Old Infants**

*Josie Randles, Senior, Speech and Hearing Sciences*

*Caryn Deskines, Senior, Speech and Hearing Sciences*

*Mentor: Patricia Kuhl, Speech and Hearing Sciences*

*Mentor: Barbara Conboy, Speech and Hearing Sciences*

The focus of our research is how performance on several classic Piagetan cognitive measures is related to speech perception and early language acquisition in infants. Our work involves a series of studies that examines individual differences in the ability of 9-to-11-month-old infants to learn to perceive phonemes and recognize words. We are exploring how these language-learning abilities relate to other non-linguistic abilities, specifically problem-solving

and social cognition. We are interested to learn how levels of goal-directedness and intentionality, as measured by classic Piagetian means-end tasks, relate to first language development (experimental measures of speech perception and word recognition; parent-report measures of language and communication development). We are also looking at performance on an object retrieval task which is thought to measure both memory and inhibition; the relationship between this task and phoneme perception has not yet been clearly demonstrated. Our hypothesis is that each of these underlying cognitive abilities correlates with early language abilities.

### **Chemical Phenotypes of Ripe Fruit: The Importance of Microbial Pathogens**

*Karen Reagan, Senior, Biology*

*Mary Gates Scholar*

*Mentor: Joshua J. Tewksbury, Biology*

Secondary metabolites, chemicals in plants that have no obvious function in primary growth, are present in many plants, but the importance of these chemicals is still poorly understood. Secondary metabolites in ripe fruit may function to increase the effectiveness of beneficial fruit consumers, or to deter fruit consumers that are consistently harmful to the seeds. While many vertebrates are beneficial seed dispersers, others are seed predators; and, differences in vertebrate physiology make targeting of vertebrate consumers by means of secondary metabolite production difficult. Under the hypotheses known as Defensive Tradeoff, secondary metabolites may instead target microbial fruit consumers since they are always detrimental consumers of the fruit and never, under any circumstances, act as seed dispersers. The genus *Capsicum* (family Solanaceae) presents an ideal model for the study of secondary metabolites in fruit. *Capsicum* species produce capsaicin as a secondary metabolite, the fiery tasting chemical that is responsible for pungency and gives chili peppers their spicy flavor. Utilizing *C. chacoense*, a chili plant that is polymorphic for characteristics of pungency, the viability of both pungent and non-pungent seeds affected by the microbial seed predator *Fusarium* was tested. Each seed was then assigned a score for the level of *Fusarium* infection ranging from 1-10 and subsequently tested for viability using a 0.05% tetrazoleum solution. The results of this experiment will help illuminate previously uninvestigated interactions between secondary metabolites in fruits and microbial seed predators that have potentially affected the fruits' evolutionary state.

### **Digital Control for Submerged Power System (NEPTUNE)**

*Justin Reed, Senior, Electrical Engineering*

*Mary Gates Scholar*

*Mentor: Mohamed A. El-Sharkawi, Electrical Engineering*

The focus of this research is the development of a digital controller for use in the NEPTUNE undersea power system to enhance system reliability. A digital Branch Unit (BU) controller utilizing an FPGA is to be designed for NEPTUNE as a backup for the analog BU controller. Functionally equivalent to substations in terrestrial power systems, BUs and BU controllers perform the operations of switching cables, sectionalizing the network, and identifying and isolating faults. These functions are essential to NEPTUNE's operation. Moreover, the devices must operate consistently and predictably in harsh underwater environments where repair is extremely costly. Thus, they must be designed with reliability as a primary concern over a 30-year lifetime. The digital controller target architecture is an Actel antifuse FPGA chip, programmed in Verilog. Using voltage and current sensors attached to analog-to-digital converters, the FPGA will determine if a cable fault exists and clears all such faults during system startup to ensure a stable power source for all of NEPTUNE's scientific equipment.

### **Crystallographic Studies of Aryl Isothiocyanates**

*Donald Responde, Sophomore, Bioengineering*

*Crystal Chang, Junior, Biology, International Studies*

*Mentor: Werner Kaminsky, Chemistry*

The goal of our project is to determine the structures and optical properties of aryl isothiocyanates and ultimately develop useful optical materials. We have already crystallized several different aryl isothiocyanates bonded to ethanol. After we successfully crystallize a compound, we use x-ray diffraction to determine the molecular structure and morphology of each crystal. Then we grow larger crystals and measure a basic optical property of each crystal: the refractive index. To observe the second harmonic generation, electro-optic effect and optical rotation of the crystals, we need to bond a chiral ligand to the aryl isothiocyanates (the compounds containing ethanol are achiral). We are currently in the process of synthesizing and crystallizing aryl isothiocyanates that are bonded to a chiral ligand like glyceraldehyde or 2-phenyl-1-propanol. We have found that the glyceraldehyde reactions produce dimers when exposed to water, so we are now repeating these reactions under anhydrous conditions. After we have acquired a series of structurally related chiral crystals, we can measure various properties including the optical rotation. These measurements along with calculations based on the dipole-dipole interactions between atoms will allow us to correlate the optical features of crystals to the molecular structures. Subsequently, we will be able to rationally design compounds with desired optical characteristics.

### **Thin Filament Regulatory Protein Influence on the Cross-Bridge Cycle in Muscle Contraction**

*Justin Ricaurte, Freshman, Pre-Engineering*

*Space Grant Scholar*

*Jamie Bishop, Senior, Bioengineering*

*Mary Gates Scholar*

*Mentor: Michael Regnier, Bioengineering*

Our research group studies the thin-thick filament protein interactions that control the level and rate of contraction in cardiac and skeletal muscle. In a recently published paper (Homsher, et.al 2003), evidence was presented that the thin filament regulatory proteins (troponin/tropomyosin) control the rate of ADP release during the cross-bridge cycle involved in muscle force production and shortening. Homsher's experiments used skeletal actin and myosin in combination with cardiac regulatory proteins in an in vitro system, from which he measured isolated filament speed and force as well as protein biochemical kinetics. While providing evidence that regulatory proteins can affect the cross-bridge cycle, the influence of protein isoforms (skeletal vs. cardiac) was not considered. We recently reported that cardiac and skeletal troponin and tropomyosin differentially affect both sliding speed and force production of actin on skeletal myosin covered surfaces, suggesting differences in how contraction is regulated in these two muscle types. If so, then experiments need to be done using homogeneous sets of contractile and regulatory proteins. Our project this summer and school year involved learning how to run an in vitro motility assay, followed by a study of the influence of pure skeletal assays vs. pure cardiac assays on the cross-bridge cycle and the control of muscle mechanical (force and speed) properties.

#### **Impacts of DV on the Poverty of Black Women**

*Natasha Rivers, Senior, American Ethnic Studies, Geography*

*Mary Gates Scholar*

*Mentor: Patrick L. Rivers, American Ethnic Studies, Law, Societies and Justice*

In this paper, I will assess the relationship between structural power and domestic violence and how they link to poverty for black women and children. Impoverishment resulting from these abuses of power is a backlash to the lack of affordable housing available. To live within the borders of the United States, most families need a dual income, especially if they are without higher education, social networks or financial resources. Usually, households headed by single black women are in desperate need of developing community support to help aid their transition from financial need to financial security. After leaving an abusive partner, these black mothers go through a process of finding ways to provide for children quite differently in comparison to white women. This difference is mainly in terms of experience, available help and aid assistance. Many communities of color are low-income and lack diverse representation in domestic violence fields and resource centers. Many of these families are just recycled through a housing system in which gender bias, racial exclusivity, and lack of accommodation to the working poor are commonplace. Further research can help aid in the deconstruction of social structures and in their being rebuilt to better support those in need of accommodation. Methods consists of Feminist Methodology, interviews and

a discourse analysis on Washington State community and legal advocacy programs, housing and domestic violence laws for their effectiveness in terms of curbing poverty and the problem of domestic violence for this ethnic group and other hard to research reach populations.

#### **Airborne Pressure Sensitive Particle use for Dynamic Pressure Measurements**

*Miguel Rodriguez, Senior, Aeronautics and Astronautics*

*Mentor: Dana Dabiri, Aeronautics and Astronautics*

*Mentor: Gamal Khalil, Chemistry*

Pitot tubes have been instrumental in wind tunnel research by measuring the local pressure on the surface of an object. Due to this fact modern airplane design has been highly influenced by pitot tube measurements. With the recent advancement of pressure sensitive paint the entire surface pressure on a model can now be easily measured. My research focuses on creating a pressure sensitive aerosol which can measure not only the surface pressure on a body but the pressure in the flow surrounding that body. Past pressure sensitive dyes have been oxygen sensitive thus emitting at a greater intensity when a laser is shined on the dye. This method requires "flow on" and "flow off" images in order to measure the surface pressure. The dye that I am using uses this same pressure sensing approach but eliminates the "flow on" and "flow off" measurements by emitting dual wavelength one of which is pressure sensitive and the other, which is not. Currently we have coated 1-3mm mono-spheres with a pressure sensitive dye and created a pressure sensitive solution. Using this solution I have successfully made an aerosol through the use of a medical nebulizer and diffusion dryer. After pumping the aerosol into a static chamber and titrating the chamber with different oxygen percentages it was seen that indeed the cloud in the chamber does emit at different intensities depending on the oxygen content in the chamber. Using these methods I hope to adapt this procedure to a wind tunnel environment and measure the pressure shifts in a dynamic flow. The PSParticles could eliminate the use of expensive pitot tubes and perhaps provide a stepping-stone, using the mono-spheres as markers, for local velocity measurements.

#### **Cosmogenic Cl-36 Production Calibration for the Southern Puget Lowland**

*Heather Rogers, Senior, Earth and Space Sciences*

*Mentor: Terry Swanson, Earth and Space Sciences*

Terrestrial cosmogenic nuclides (TCN) have the potential to provide a wealth of chronological data regarding exposure age and erosion rates for previously undatable geomorphic surfaces. While the physics of TCN are well understood, calibration studies used to limit the respective production rates are widely varied. Inconsistencies in the calibration studies can be attributed to a number of factors

including uncertainty with scaling parameters, independent dating control of respective calibration surfaces, unknown burial or erosion history, and the reliance on single isotope measurements. The main objective of my research is to provide additional calibration data to better constrain the TCN production rates at a location, where potential latitudinal- and altitudinal-scaling error is minimized. The southern Puget Lowland is an ideal location to calibrate the production rates of TCN because of robust age constraints, availability of diverse rock types (target elements for Cl-36 production), accessibility, high geomagnetic latitude (47°), and close proximity to sea level. By sampling six to ten lithologically diverse glacial outburst flood boulders near Olympia, WA, it is possible to isolate one of the major production pathways for Cl-36 (spallation reactions with K and Ca or neutron activation of Cl-35) and determine its production rate without having to solve for all three of the production rates iteratively and simultaneously. The timing of deglaciation of this area is well constrained by radiocarbon dating, providing an excellent calibration surface with a known exposure age. Using this known exposure age, the production rate of cosmogenic Cl-36 can be determined accurately. Field research will be used to find additional datable organics deposited by streams impounded by the Vashon ice, and may provide even greater resolution to the timing of advance and retreat over of the Puget Lobe nearest its terminal moraine. Preliminary results from the Cl-36 analysis are expected during Spring Quarter 2005.

### **Perturbing Oxidation State to Determine the Site of Oxidative Phosphorylation Regulation**

*Joshua Rusk, Junior, Bioengineering*

*Mary Gates Scholar*

*Mentor: Martin J. Kushmerick, Radiology, Bioengineering, Physiology and Biophysics*

As muscle-related questions concerning both life on earth and long-duration space travel continue to rise, research is being devoted to the continued study of the primary cellular mechanism for energy generation: oxidative phosphorylation. Oxygen and electrons are two crucial players in this mammalian muscle system. ATP production requires an electron transport chain (ETC) moving electrons down a gradient to oxygen—the ultimate electron acceptor. Near infrared optical spectroscopy (NIRS) has allowed us to monitor three key molecules in this process: myoglobin—the primary transporter of oxygen, cytochrome oxidase—the end molecule in the ETC, and cytochrome C—an intermediate in the ETC. Our current work has been challenging the hypothesis that cytochrome oxidase remains in a constant oxidized state at all times, despite a lower partial pressure of oxygen inside the mitochondria than in the blood during rest and especially during exercise. We are currently trying to answer the question of how cytochrome oxidase reduction might affect the overall speed of mitochondria for the generation of ATP. Experimental proce-

dures include subjecting mouse EDL, extensor digitorum longus, and Soleus muscle to different aqueous chemical environments such as pyruvate, nitrogen, cyanide and antimycin. Each of these solutions has successfully perturbed the oxidative pathway, including both myoglobin and cytochrome oxidase oxidation states, without damaging the muscle. Analysis of raw data, via partial least squares analysis and current simple difference and second derivative spectra, has shown the possibility of characterizing oxidation state changes of myoglobin and cytochrome oxidase by extracting differences in spectra at specific wavelengths. Current results have shown that stimulation of the oxidative pathway via pyruvate might correlate with a reduction change in cytochrome oxidase. This evidence will help answer the question pertaining to exactly where oxidative phosphorylation is regulated.

### **Arsenic Mobility as a Function of Physical and Chemical Parameters in Lakes in South King County, Washington**

*Michelle Sage, Senior, Environmental Science*

*Mentor: James E. Gawel, Environmental Science*

The ASARCO plant in Tacoma, Washington was in operation from 1890 until 1986. This plant released metals, including copper, lead and arsenic, into the atmosphere. The plume from this plant reached from Pierce County into south King County. Recent studies have examined the amount of arsenic in the soils in this area, but relatively little research has been conducted on the mobility of arsenic in lakes under oxic and anoxic conditions. Angle Lake, Lake Killarney, Lake Meridian, and North Lake are located in King County, Washington. Sediment and water samples were collected from early July 2004 to late September 2004 in each of the four lakes. We chose these four lakes as they all had relatively high arsenic concentrations in the sediments (2003 data) and they span a large range of surface areas, volumes, and degrees of eutrophication. Each lake was tested for sulfate, sulfide, and iron concentrations as well as temperature, specific conductivity, dissolved oxygen, and pH. Our results confirm that there are higher levels of arsenic found in the hypolimnium in all four lakes. The relationship between physical and chemical properties and arsenic mobility will be discussed.

### **Mobile Monitoring of Underground Cable Systems**

*Alanson Sample, Senior, Electrical Engineering*

*Mary Gates Scholar*

*David Seater, Senior, Electrical Engineering*

*Mary Gates Scholar, NASA Space Grant Scholar*

*Will Biederman, Freshman, Pre-Engineering*

*Mentor: Alexander Mamishev, Electrical Engineering*

An autonomous robotic platform has been developed to carry diagnostics sensors for the purpose of inspecting underground power distribution cables. In this project the fea-

sibility of an autonomous inspection robot has been demonstrated as a means of replacing or supplementing conventional power cable aging status sensing methods. A mobile platform contains a control system capable of autonomous navigation, integrated with sensor and signal processing technology developed for the application. A combination of thermal, vision, dielectrometry, and acoustic sensors is used to effectively determine the aging status of power cable networks. Control and signal processing algorithms operating within a distributed processing architecture provide a flexible approach to control of autonomous inspection systems. The key advantage of this inspection method is the ability to sense distribution cable failure status with increased accuracy at a fraction of the cost of typical monitoring technologies.

### **The Search for Graviationally Lensed High-Redshift Quasars using the Space Telescope Imaging Spectrograph (STIS) aboard the Hubble Space Telescope (HST)**

*Shannon Schmoll, Sophomore, Physics, Astronomy*

*Mary Gates Scholar*

*Mentor: Scott Anderson, Astronomy*

Within the Universe there are many objects that are difficult to detect using light gathering telescopes and so other methods must be employed. The search for gravitational lenses is one method that is very useful for finding high-mass objects such as black holes. According to Einstein's general theory of relativity, these compact objects create a gravitational pull large enough that it will bend light of a distant luminous object as it travels towards Earth. My project uses images taken aboard the Hubble Space Telescope with the Space Telescope Imaging Spectrograph to find signs of bent light from distant quasars, also known as high redshift quasars due to the frequency shift of the light towards the red end of the spectrum due to the expanding universe. Distant quasars are used because they are extremely luminous and have a higher probability of being lenses. I use imaging software to change the color gradient in order to find the main signs that light from a quasar is being bent. The signs include multiple images of the same object or what is known as a halo effect, where there is a ring of light around the quasar image. Once all the images have been analyzed, I will use a ground-based telescope to image the same quasars to find the signs of the second image. If the multiple objects appear in the new image, spectrographs will be taken to determine if the two objects are composed of the same material and thus the same object. Using the software package, IRAF, I have looked at approximately 180 images so far with approximately another 150 images to look at. So far there are two very strong candidates that are not known as lenses to the scientific community that will need further investigation in the coming months using the ground-based telescope method.

### **Compositional variations in phonolitic xenoliths caused by interaction with basaltic magma, Cumbre Vieja Volcano, Canary Islands**

*Grace Schnebly, Senior, Earth and Space Sciences*

*Mentor: Bruce Nelson, Earth and Space Sciences*

As most magmas rise to Earth's surface, they absorb and assimilate varying degrees of the crust through which they pass. This process is especially important for large compositional contrasts between the magma and host rock. A historic (1585) basalt flow from the Cumbre Vieja volcano of La Palma, Canary Islands, contains a large number of xenoliths composed of phonolite (felsic, plagioclase rich, igneous rock), incorporated as the basalt was extruded near a large phonolite plug. The crystals within the basalt and the xenoliths show varying degrees of resorption and reaction, providing an excellent example of the geochemical and petrological effects of felsic crustal assimilation in basaltic lava. The goal of my project is to quantify this assimilation process. I will be analyzing feldspars, pyroxenes, and amphiboles within the basalt-phonolite system to develop a set of equations describing the formation, breakdown, and precipitation of minerals during xenolith assimilation. Crystal chemical data will be obtained by microprobe analyses to determine how mineral compositions vary with the degree of reaction. I will use wavelength dispersive spectrometry coupled with backscattered electron imaging to obtain high-spatial resolution chemical data for each mineral. Chemical zonation maps of the minerals will reveal the extent of assimilation. I hypothesize that there will be an increased concentration or growth of K<sub>2</sub>O-rich minerals among the basalt phenocrysts, corresponding to a breakdown of K<sub>2</sub>O-rich minerals within the phonolite. Based on these results I will be able to quantify this important process, which affects all ocean island volcanic systems.

### **The Institutional Definition of Volunteerism**

*Lindsay Scola, Senior, Political Science*

*Mary Gates Scholar*

*Mentor: Brian Jones, Political Science*

In his 1991 inaugural address, President George H. W. Bush stated that he was launching a national program to encourage citizens to do voluntary activities previously covered by government funding. The Thousand Points of Light program that he launched created a new culture of volunteerism. Prior to the 1980's, volunteerism, particularly civic volunteerism, included systematic government involvement, programs encouraging community action, commitment to political change, and inclusionary public volunteerism. In the late 1980's and early 1990's, we begin to see a new national rhetoric surrounding volunteerism largely encouraged by the introduction of the Thousand Points of Light initiatives. Volunteerism was soon encouraged as one-on-one, private symptomatic acts such as work in soup kitchens, clothing banks or planting trees. What is

the connection between the President and the changing definition of volunteerism? Additionally how does the public react to these changes in both its perception and participation in volunteerism? In order to investigate this connection, I have analyzed presidential policy on volunteerism, such as executive orders, presidential-recommended congressional hearings and state of the union addresses. To explore the changing attitudes of young people, I have analyzed youth involvement in volunteer and political activities. In the wake of an election that has had the largest registration effort to new voters in recent history, there have been many questions raised as to why young people have an aversion to being active in electoral politics. There is definitely notice being given to the willingness of young people to participate in "community service" activities such as soup kitchens; however, there is little interest in political campaigns or movements. Understanding the connection between the President and volunteerism opens opportunities to change the way we motivate young people to become involved with government activities.

### **Malaria Parasites Acquire High Frequencies of Resistance to Novel Antifolate**

*Anjulie Semenchuk, Senior, Sociology*  
*Mentor: Pradipsinh Rathod, Chemistry*

The malaria parasite *Plasmodium falciparum* infects 300-500 million people per year and kills approximately 1 million per year. Resistance has developed to cheap drugs such as chloroquine used for treatment of malaria, and there are few new drugs coming out of current research to counter the drugs whose effectiveness has been lost to resistance. The Rathod lab has characterized a new accelerated resistance to multiple drugs, or ARMD phenotype. These strains of *Plasmodium falciparum* become resistant much more quickly to new drugs than other strains. Because of this it would be useful to see how drug resistance develops. My research will investigate the mechanisms by which resistance occurs and whether the mutations are random or if they can be induced. My research has shown that the mutation rate for ARMD parasites treated with drug was higher than would be expected if the mutations came about randomly. The anticipated mutation rate for *Plasmodium falciparum* is  $10^{-9}$ , but the mutation rate of the treated parasites was  $10^{-5}$ , which is significantly higher than expected.

### **Inhibition of HIV Rev Protein by Peptide Inhibitors and its Interaction with RRE**

*Devika Shah, Junior, Biochemistry*  
*Mentor: Gabriele Varani, Biochemistry*

The pandemic disease of AIDS first appeared in the early 1980's and still proves to be a devastating threat to public health. Human Immunodeficiency Virus Type-1 (HIV-1) is the etiological cause of AIDS. HIV-1 is a retrovirus belonging to a group of viruses called Lentivirinae which have

common genetic structures and many genes that encode regulatory proteins. An example of an essential regulatory protein is Rev. Rev controls the export of viral mRNA from the nucleus to the cytoplasm and also controls the switch between viral latency and viral replication. It binds to RRE (Rev Responsive Element) at a high affinity binding site called RRE-IIb stem loop. After the Rev molecule has bound to a RRE high affinity binding site, additional Rev molecules oligomerize with lower affinity to RRE RNA. The Rev/RRE complex mediates the export of viral mRNA from the nucleus and also mediates the transport of viral mRNA to the cytoplasm. Once the viral mRNA has been transported to the cytoplasm, the translation of viral proteins is possible. By finding inhibitors of Rev there may be a high potential of blocking viral mRNA from being translated and thus of stopping the replication cycle of HIV-1. My project aims to discover inhibitors of the Rev protein by locating important residues of Rev for binding to RRE. A small library of peptides was designed initially as Bovine Immunodeficiency Virus (BIV) Tat peptidomimetic inhibitors. Binding assays and inhibition assays were done to test the affinity of the peptides to HIV-1 RRE and to test the ability for the peptides to inhibit the wild type Rev peptide/RRE complex, respectively. The results obtained from my project are important because it opens doors to create drugs with different mechanisms due to increasing resistance of HIV-1 strains to existing antiviral drugs.

### **Express Samina Memorial**

*Christine Shannon, Junior, Social Sciences, UW Evening Degree Program*  
*Mentor: Pierre Mackay, Classics*

In September of 2000, the Greek ferry, *Express Samina*, sank off of the coast of the Greek island of Paros, taking the lives of 88 people. On board were five Americans, including two Seattle women, Heidi Hart, and myself. I have been inspired by the events of September 2000 to create a memorial commemorating the *Samina*, her victims, and her survivors. The process of creating the memorial has been a cathartic expression of coming to terms with life after tragedy. Trying to create meaning for a singularly unique event in my life has been an important part of my own personal healing process. I have stood witness to the many fears and emotions that have arose following my return to the states. Through it all, the one thing that remained in my heart was the idea of building a statue to bring to Paros; a symbol of my gratitude, sorrow, love, and humility. I have been invited by the Hellenic Institute for the Study of Art (HISA) on Paros, to be an artist in residence. I will be spending the month of September 2005, building the statue. Before I embark on my trip to Greece, I will be researching the culturally rich history of Paros. This island in the Aegean Sea is rich in history, from ancient poets to philosophers. I will be incorporating my research into the design of the memorial. With the resources availed to me by the Classics department here at the University of Washington, I hope to

build a memorial statue that will serve as not only a personal source of strength, but will be a bridge between our two cultures.

### **Small Group Research Project at University of Washington, Bothell**

*Kimberly Shay, Senior, Interdisciplinary Arts and Sciences*

*Mary Gates Scholar*

*Mentor: Professor Diane Gillespie, Associate Director of Interdisciplinary Arts and Science*

I am part of an undergraduate qualitative research project on learning in small groups on the Interdisciplinary Arts and Sciences (IAS) program at the University of Washington, Bothell. The purpose of the project is fourfold: 1) to explore how IAS students describe their learning experiences in small groups, 2) to explore how faculty think about small groups in their classes, 3) to make results of the study available to other educators and students, and 4) to make recommendations for small group practices in the IAS program. Using grounded theory, I will explore the relationship between group formation and students' behavior in the group. In coding interviews, I have found that students respond differently based on how they are assigned to groups. I will present how I coded the interviews using Atlas Qualitative Data Analysis program; this will allow me to diagram the relationships between group formation and the various decisions students make about their level of participation. I hope to show that how an instructor puts students in groups has important implications for student learning in those groups.

### **Control, Modeling and Motion Tracking of a Microrobot**

*Anshuman Shukla, Senior, Mathematics*

*Mentor: Karl Böhringer, Electrical Engineering*

The microelectromechanical systems (MEMS) group in the Electrical Engineering Department introduced a walking microrobot based on two thermo-bimorph polyimide cilia chips. This microrobot provided 3-degree-of-freedom planar motion on a total of 512 cilia. A general model that relates thermal actuation to robot motion was also presented. This time we focus on developing a thermal model that is more accurate. This is achieved by simulating the cilia on ANSYS (a finite element modeling package). The simulation has given thoughtful insight on the relation between thermal actuation and cilia motion. The results from the simulations are being used in refining the current model. Extensive supporting data is also collected using an automated tracking system that supports the simulation results. The simulation has resulted in analyzing heat transfer at the microscale. We have also explored other energy-efficient locomotion control schemes by manipulating the power supply through the cilia. Finally with the help of

this simulation we hope to answer some of the fundamental heat-transfer problems posed by the development and processing of MEMS circuits.

### **Non-fouling surface based on the theory of long-range ordering of water**

*Enoch Shum, Senior, Bioengineering*

*Mary Gates Scholar*

*Mentor: Gerald Pollack, Bioengineering*

Our group speculated the solute-free zone consisted of organized water structure. In this theory, the gel's surface charge organized water molecules in a head-to-toe fashion according to their dipole moments. The character of the solute-free exclusion zone is fundamental for understanding how solutes interact with surfaces. Within this zone, the solutes sense features of nearby surfaces. This exclusion zone is thought to fall off within nanometers of the surface. Beyond this zone, surfaces are thought to be invisible to solutes. However, current theory has shown interactive potential over highly restricted distances, such long-range phenomena seem anomalous, and are not yet understood. In my project, I have used self-assembly monolayer (SAM) to explore the biological aspect of this theory. By using SAM, I have generated different types of protein-coated surfaces to simulate a biological environment. The solutes were over a range of sizes, starting from cells and large proteins to single ions such as sodium or potassium ions. According to the theory, solute-free zone should develop regardless of the size and charge of the solutes. Further, part of my project is to develop a model of the solute free zone. The solute-free zone is closely related to the non-fouling properties of artificial organs. A better understanding of this subject may prevent implanted organs from malfunctioning due to encapsulation.

### **Trojan War Subjects in Neoclassical Art As Manifested in the Work of Angelica Kauffman**

*Roberta Simpson, Senior, Art History*

*Mary Gates Scholar*

*Mentor: Susan P. Casteras, Art History*

Angelica Kauffman was a truly international artist who gained patronage and received acclaim throughout the Continent for her innovative paintings. Kauffman was unique in the Neoclassical art movement of the mid- to late- 18<sup>th</sup> century, both as a woman engaging in the challenge of history painting (deemed to be the highest form of art and an especially male-dominated genre) and as an artist who achieved great popularity as well as critical success. The focal point of my research is the investigation of the use of Trojan War subjects during the Neoclassical period, specifically subjects from the Homeric epics as manifested in Kauffman's art. The emergence of this theme escalated dramatically in mid-century after the discovery of the ruins of Pompeii and Herculaneum, where wall paintings and

decorations treated similar subjects. Kauffman was an artist who took to Homeric subjects with a distinctive fervor. In addition to the well-known themes from the Iliad and the Odyssey, e.g. Achille's tale (made famous by her contemporary Gavin Hamilton's paintings), Kauffman produced pioneering images of more atypical subjects such as the relationship of Penelope and Telemachus (especially in "The Return of Telemachus") in addition to that of Paris and Helen of Troy (in such paintings as "Venus Persuading Helen to Love Paris"). My research investigates how Kauffman, using Alexander Pope's translations of Homer's poem, created visualizations of pivotal moments in Penelope's saga of patient endurance. Overall, Kauffman's Penelopean series offers a marked contrast with other neoclassical paintings of the period partly because the artist endowed her female protagonists with both emotional strength and civic virtues. Nearly all the Penelopean series was executed during Kauffman's lengthy stay in England, and my hypothesis is that the contemporary, often turbulent, politics of this era influenced the popularization of the Trojan War epic.

### **Gravity**

*Devon Smith, Senior, Drama, Business Administration*

*Mary Gates Scholar*

*Mentor: Robyn Hunt, Drama*

*Mentor: Shanga Parker, Drama*

*Mentor: J. Steven Pearson, Drama*

*Mentor: Peter Kyle, School of Dance*

The Gravity project is an attempt to produce a theatrical piece developing the relationships between the principles of gravity and dramatic texts and actions. Gravity is defined as 1) the natural force of attraction between two massive bodies, 2) of extreme importance, 3) a solemnity of manner. This project particularly focuses on obtaining funding to produce the theatrical piece, dramaturgical research in the science and history of gravity and related dramatic texts, the building of a community of patrons who will support the project with their attendance, and the stage managing of the final production in rehearsal and performance. The project has already begun research on the science and history of gravity and possibly related dramatic texts, as well as potential avenues of funding and support from the surrounding community. In this next phase of the project, rehearsals will begin to develop the spoken and physical connections between the idea of gravity and the reality of spoken text and physical action. The focus will be on selecting and organizing texts which will further a deeper understanding of the implications of gravity on the natural world, as demonstrated on stage by a body of professional actors, dancers, choreographers, and artists. Documents being examined in this project include the theatrical works of Bertolt Brecht, and Anton Chekhov, and the scientific research of Brian Greene, Stephen Hawking, Alan Lightman, Charles Seife, as well as various other documents, plays, articles, and films. The expected outcome is

a personally, financially, and critically successful run of performances in May of 2005 in the Playhouse Theatre by a collection of professional performers which engages our surrounding community of artists, academics, and other interested persons.

### **Mechanisms of tumor suppression by CTCF: Loss of imprinting at the *Igf2/H19* locus?**

*Leslie Smith, Senior, Biology*

*Mentor: Steve Collins, Medicine and Human Biology Division, Fred Hutchinson Cancer Research Center*

*Mentor: Galina Filippova, Human Biology Division, Fred Hutchinson Cancer Research Center*

A common epigenetic occurrence in human cancer is loss of imprinting (LOI) via aberrant methylation, which can result in increased expression of growth promoting genes such as *Igf2*. Methylation-sensitive binding of the 11-zinc finger protein, CTCF, to the insulator domain at the *Igf2/H19* locus has been shown to be a critical mediator of imprinting at the locus, both by acting as an insulator against a downstream enhancer of *Igf2*, and by maintaining methylation of the DNA at this locus. In addition to *Igf2/H19*, other known CTCF target sites include known proto-oncogenes and tumor suppressors. We hypothesize that the loss of *Igf2/H19* imprinting is one of the major mechanisms of tumor suppression by CTCF. Homozygous knockout of CTCF is embryonically lethal in mice, while CTCF heterozygous mice exhibit enhanced tumor predisposition. In order to determine the mechanism of CTCF haploinsufficient tumor suppression, we examined tumor initiation, promotion, and progression in CTCF heterozygous mice with urethane induced pulmonary adenomas and adenocarcinomas. Compared to wild type mice, CTCF heterozygotes show decreased survival rates, as well as a greater number of larger tumors. To analyze whether the *Igf2/H19* locus is aberrantly methylated in CTCF heterozygous mice, methylation-mapping studies were performed using bisulfite sequencing at the locus in primary mouse embryo fibroblast (MEF) cells. Our hypothesis is that loss of one CTCF allele may predispose aberrant methylation of the target sites, resulting in loss of imprinting, and thus contributing to the malignant phenotype shown in our mice. The bisulfite sequencing and data analysis of methylation at the *Igf2/H19* locus are still in progress, as well as quantitative RT-PCR and Northern blots to analyze the expression levels of *Igf2* and *H19* in heterozygous MEFs.

### **Suppression of repair of N<sup>3</sup>-methyladenine-DNA glycosylase increases human glioma cell alkylator sensitivity**

*Nolan Smith, Senior, Biology*

*Mary Gates Scholar*

*Mentor: John R. Silber, Neurological Surgery*

The large majority of alkylator induced base changes occur at the ring nitrogens of purines. N<sup>3</sup>-methyladenine (N<sup>3</sup>-

meA) is a documented cytotoxic lesion that comprises ~10% of the base adducts produced by methylating agents used to treat malignant gliomas. N<sup>3</sup>-methyladenine-DNA glycosylase (3MAG) is a repair activity that initiates removal of N-alkylpurines by cleaving the glycosylic bond between the altered base and deoxyribose yielding an abasic site. To obtain evidence that 3MAG-mediated removal of N<sup>3</sup>-meA promotes resistance to methylating agents, we determined the effect of suppressing 3MAG activity with antisense oligonucleotides (ASO) on the sensitivity of the human glioma lines SNB19 and SF767 to methyl-lexitropsin (1-methyl-4-(1-methyl-4-(3-methoxy-sulfonylpropanamido) pyrrole-2-carboxamido)propane, me-lex), a sequence specific methylating agent which almost exclusively produces N<sup>3</sup>-meA. Suppression of 3MAG activity 2-fold was accompanied by an ~2-fold reduction in the me-lex dose required to reduce survival to 10% in both lines. Importantly, potentiation of cytotoxicity was accompanied by a comparable reduction in the abundance of abasic sites, suggesting that enhanced lethality reflected the persistence of N<sup>3</sup>-meA in DNA. Suppression of 3MAG activity also increased the sensitivity of both glioma lines to the clinical methylator temozolomide, indicating that the cytotoxicity of these agents is mediated, in part, by failure to repair N<sup>3</sup>-meA. These results suggest suppression of the 3MAG repair activity augments the cytotoxicity of clinical chemotherapeutic agents against glioma lines leading to effective treatment at lower dosages.

### **Stories Count: Children's Experiences across Mathematics and Literacy**

*Sarah Smith, Senior, English*

*Mentor: Elham Kazemi, Curriculum and Instruction*

Stories Count is an in depth study of one 4<sup>th</sup>/5<sup>th</sup> grade classroom, which centers around the relationship between children's experiences in literacy and mathematics. In particular, this project focuses on ways classroom structure influences a student's self-perception across these subjects. By examining video-taped class sessions, transcripts of class discussions and end-of-the-year interviews with the students themselves, we hope to learn how the students define themselves in relation to different subject areas as well as how classroom discussion may shape their definitions. We are especially interested in patterns of participation and interaction for different students and whether or not their involvement or participation in class influences their academic identity.

### **Lessons from Nature: Bio-Inspired Design of Composite Materials**

*Hyunmin Song, Senior, Materials Science and Engineering*

*Mentor: George Mayer, Materials Science and Engineering*

Nature has given us a unique way of designing new mate-

rials for the next age. Many of nature's designs of rigid materials are composite ceramics (including glass). Traditionally, ceramics are a family of materials known for their high strength and high stiffness (Young's modulus); however, their fatal flaw is their inability to plastically deform; in other words, brittle fracture, and low toughness, results. Nature has evolved over millions of years to develop building processes and has solved the problem of using ceramics as viable building materials. In this study, we go into detail of a specific organism known as *Euplectella aspergillum*, a.k.a. the Venus flower basket. The Venus flower basket is a deep-water sea sponge. Its mineralized skeleton consists of an intricate cylindrical cage-like structure woven with many hydrated SiO<sub>2</sub> (silica) fibers. Each fiber is composed of a central core with multi-layered rings of hydrated silica glass grown in between very thin protein (known as silicatein) matrices. The silicateins probably catalyze and otherwise control the growth of the silica rings; however, we hypothesize that the thin protein layers act as a crack deflection mechanism, thereby improving the toughness of the sponge fibers. Tensile tests have been done using an Instron machine to compare the toughness of *E. aspergillum* fibers to that of commercially made E-glass fibers. E-glass fibers have a cross-sectional area that resembles a solid rod of silica rather than concentric ring layers of silica observed in *E. aspergillum* fibers. Bending tests have also been scheduled using a dynamic mechanical analyzer to further investigate the nature of toughness in *E. aspergillum* fibers. Further tests still need to be done; however, current results show that while commercially made E-glass fibers exhibit a higher strength, *E. aspergillum* fibers have an overall higher work-of-fracture with comparable strength due to their telescoping failure behavior. That is, one layer breaks at a time, followed by extension of the thin layer between the rings, and on in steps, until fast fracture occurs. The failure, viewed by scanning electron microscopy depicts a telescoping shape. These bio-inspired designs from nature may allow us to one day fabricate materials that have both high strength and high toughness for high performance engineering applications.

### **Digital Notetaking in the Classroom**

*Rafa Sonnenfeld, Senior, Informatics*

*Aaron Smith, Senior, Informatics*

*John Oleinik, Senior, Informatics*

*Mentor: Melody Ivory-Ndiaye, Information School*

The traditional spiral-bound notebook and pencil are being replaced by laptops and tablet-PCs in some technology-focused classrooms. Some students' claim that with computers they can take notes faster, some like to not have to worry about their handwriting, and some like the ability to organize their notes on a computer-based system. Nonetheless, some students prefer taking notes by hand because of cognitive support and for monetary reasons. We are conducting a study with students here at the University of Washington to examine the various tradeoffs of taking notes

with a pen and paper, laptops, and tablet-PCs. Our methodology will include an in-class survey, an in-class note-taking experiment using the three main note-taking technologies, as well as a focus group session. We hope to find patterns across the different note-taking styles that could help designers design more usable note-taking software. In addition, we hope to better understand the preferences and feelings of students toward different note-taking styles.

### **Gene expression analysis of mouse prostate cancer models**

*Drew Stenesen, Senior, Biology, Biochemistry  
Howard Hughes Scholar*

*Mentor: Peter Nelson, Fred Hutchinson Cancer Research Center*

Prostate carcinoma is the second leading cause of cancer related death and the most common noncutaneous malignancy among men in the United States. Several model systems have been developed to mimic human prostate cancer in mice. This project has two objectives 1) to enhance the understanding of prostate cancer progression in the TRAMP, PTEN, and NKX mouse models; 2) to compare critical precancerous lesions between these model systems. These goals are being achieved by dissection of mouse prostate at sequential time points of disease progression including normal tissue, prostate intraepithelial neoplasia, primary tumor, and metastasis. Specific cells of interest are then isolated using laser capture microdissection, their mRNA amplified, and gene expression analyzed using the mouse prostate specific mPEDB microarray. In the future this project will help establish a comparative progression of cancerous prostate cell types and a catalog of genes expressed in the prostate with potential cross-species references to diagnosis and assess prostate cancer severity.

### **A Review of the Literature on Grief and Miscarriage: Addressing Women's Emotional Needs**

*Yolanda Stetson, Senior, Nursing, Seattle Pacific University*

*Mentor: Kathleen Stetz, School of Health Sciences, Seattle Pacific University*

*Mentor: Theresa Granger, School of Health Sciences, Seattle Pacific University*

A miscarriage is defined as the termination of a pregnancy before 20 weeks gestation. Approximately 20% of clinically recognized pregnancies will end in miscarriage. Often, the loss of a pregnancy results in a range of disturbing feelings for the woman, and healthcare professionals need to become informed regarding the emotional impact of this significant event. The purpose of this review is to gain a clearer understanding of the lived experience of miscarriage, as described in the current literature, in order to offer appropriate interventions in a caring, sensitive manner. The Cumulative Index to Nursing and Allied Health Literature

and PsycInfo databases were used with the keywords miscarriage, spontaneous abortion, grief, coping, support, and perinatal loss to generate the study sample. Twenty-two research articles from multiple disciplines including nursing, medical, and psychology journals published within the last 6 years were included. Of these 22 studies, 16 were phenomenological or descriptive, and 6 used an experimental or quasi-experimental design to evaluate the effectiveness of interventions to improve coping. Findings from descriptive studies indicate that women who experience miscarriage are at risk for clinical depression, Post-Traumatic Stress Disorder, and an increased anxiety level in subsequent pregnancies. Findings from analysis of intervention studies reveal a lack of statistically significant impact on outcome variables. However, qualitative self-report data indicates improved psychological conditions among participants. In addition, intervention studies do not consistently include similar outcome variables, making it difficult to compare the effectiveness of various interventions. Healthcare professionals are in a unique position to assess for grief and related psychological issues, provide emotional support, and educate women about resources available to them in their time of loss; however, there is insufficient data to propose specific evidence based interventions.

### **Clonal Variation of *Pseudomonas aeruginosa* within the Cystic Fibrosis Lung**

*Laurel Stevens, Senior, Cellular and Molecular Biology  
Mary Gates Scholar*

*Mentor: Sam Moskowitz, Pediatrics*

*Pseudomonas aeruginosa* (PA) is an opportunistic pathogen that commonly infects the lungs of individuals with cystic fibrosis (CF). *Pseudomonas* lung infection in CF usually becomes chronic, leading to progressive lung destruction and early death. The goal of this project is to define the clonal diversity of PA within the CF lung and determine the extent to which clinically obtained sputum samples represent the actual bacterial diversity present within the lung. As a pilot study to assess clonal variation, my mentor collected samples of post-mortem airway secretions from different locations within the lungs of a CF patient and cultured the secretions to obtain PA isolates. In addition to the post-mortem PA isolates, I also studied bacterial samples obtained from the same patient during the five years preceding death. I assessed phenotypic characteristics of these isolates, including mucoidy, pigment production, colony size and shape, and motility. I also compared genotypes of the post-mortem isolates to each other and to pre-mortem isolates. The genotypes were compared using Random Amplified Polymorphic DNA typing (RAPD). This method uses polymerase chain reaction (PCR) to amplify random genomic products using short empirically validated primers, followed by agarose gel electrophoresis and comparison of the banding patterns. Comparison of the RAPD banding patterns showed no differ-

ences exceeding the conventional threshold for declaring a lack of clonal relationship (difference of more than three bands) between isolates from different areas of the lung or between pre-mortem and post-mortem isolates. These results suggest that sputum sampling may adequately represent the clonal variation of PA within CF airways, as indicated by the strong genotypic similarities of pre-mortem and post-mortem CF isolates.

### **Fluorescence Microscopy of DPPC:DPhPC:Dchol Lipid Monolayers on a Calibrated Langmuir Trough**

*Mark Stevens, Freshman, Physics*

*Mentor: Sarah L. Keller, Chemistry*

*Mentor: Ben L. Stottrup, Physics*

Lipids bilayers and proteins form cell membranes. Recently there has been considerable interest in the possibility that phase separation in lipid bilayers plays a role in the localization of proteins within cell membranes. In the lab, cell membranes can be modeled by lipid bilayers, and monolayers offer a way to study individual bilayer leaflets. While monolayers exhibit similar characteristics to bilayers, there are important differences. Specifically, the range of composition where liquid-liquid phase separation is formed in lipid bilayers is much smaller than in monolayers. Understanding these differences is important when applying the results of monolayer studies to bilayers. Results will be presented from fluorescence microscopy and the Langmuir film balance studies of the lipid monolayer system of DPPC:DPhPC:Dchol. DPPC:DPhPC:Dchol is chosen in anticipation of future bilayer work on the kinetics of liquid-liquid phase separated behavior in our lab. Experiments are done using a home-built Langmuir trough extensively calibrated to produce molecular areas and to characterize systematic errors.

### **Plasma Sources and Lifetimes within the Jovian Magnetosphere**

*Angela Stickle, Junior, Earth and Space Sciences*

*Mentor: Robert Winglee, Earth and Space Sciences*

The Jovian magnetosphere is fed by plasma from Io, the icy Galilean moons and the Jovian ionosphere. The plasmas from these different sources not only differ in mass composition and outflow rate, but also have access to different regions. The mixing of these plasmas plays a critical role in determining the overall size and structure of the Jovian magnetosphere. 3-D multi-fluid simulations that incorporate the heavy and light ion interactions are used to model the mixing of heavy ion torus plasma with light ion outflow from the Jovian magnetosphere. It is shown that at smaller radii than the Io torus the plasma is completely co-rotational and that the main loss mechanism is to the Jovian ionosphere. Light ions continue to have essentially no departure from being fully co-rotational out to about  $13 R_J$ , while the heavy torus ions show some slippage with lifetimes of the order of about 60 hrs. Between  $13 R_J$  and about

$20 R_J$  lifetimes of both light and heavy ions is of the order of about 100 hrs. These characteristics are most strongly dependent of the torus plasma density rather than the ionospheric outflow rate. Beyond this distance, deviations from co-rotation become increasing larger and lifetimes decreases. The properties of the ionospheric outflows play an increasingly important role in this region. The co-rotation boundary and position of the magnetosphere are shown to move significantly under the convection of torus and ionospheric plasma from the inner magnetosphere into the outer magnetosphere.

### **Narrative: Future, Past and Present**

*Alan Strathmann, Senior, Comparative History of Ideas, Digital Arts*

*Mary Gates Scholar*

*Advisor: Shawn Brixey, Digital Arts*

Having focused on the experience of trauma and narrative experience during my research for the Undergraduate Research Program's Summer Institute in the Arts and Humanities 2004 I am excited to be in the midst of work concerned with the experience of ongoing narratives and narratives occurring over corresponding timeframes. I am currently conducting research that is focused on the notions of presence and agency utilizing real-time video processing and projection installation artwork design. I have been constructing prototypes of what shall ultimately be human-scale sense-controlled video installations that will provide active participants with an experience tantamount to living cinema or an engagement of real-time temporal distortions through distinct challenging of our experience of presence and space. It is my hope that I am elected to participate in this year's Undergraduate Research Symposium via a poster session during the scheduled event. I will also have on hand a small-scale active prototype that will demonstrate the basic principles of my research findings to date. This example will consist of a small web-camera and a laptop both of which I will provide. I look forward to the Symposium and to all of the work and research that will be presented.

### **Identification of the Staphylococcal Macrolide Efflux *msrA* Gene in New Bacteria**

*Megan Striplin, Senior, Microbiology*

*Mentor: Marilyn C. Roberts, Pathobiology*

Bacterial resistance to antibiotics is an ongoing problem in public health and medicine with increasing numbers of strains resistant to common antibiotics such as penicillin, or erythromycin identified. Many of these resistance genes are associated with mobile elements, which allow transfer between related strains and between unrelated genera of bacteria. This results in the spread of the same antibiotic resistance gene in unrelated bacteria and is why bacterial resistance spreads so quickly through bacterial communities. Our laboratory is interested in spread of acquired

macrolide resistance genes. Macrolides are used to fight community-acquired infections such as bronchitis and atypical *Mycobacterium* disease. Experiments were designed to determine whether a macrolide efflux gene, coded by the *msrA* gene, and identified only in *Staphylococcus*, is now present in unrelated Gram-positive and/or Gram-negative bacteria. DNA-DNA hybridization was used to screen thousands of recent bacteria. Positive isolates including Gram-positive *Corynebacterium*, *Streptococcus*, and *Enterococcus* and Gram-negative *Pseudomonas* were identified and used in polymerase chain reaction (PCR) assays. The resulting PCR products were verified using DNA-DNA hybridization with <sup>32</sup>P-labeled probes and/or sequencing. The *Corynebacterium* sp. *msrA* gene was sequenced and shared 100% identity at the nucleotide and amino acid level with the *Staphylococcus msrA* gene previously sequenced and available in GenBank. This verifies our hypothesis and demonstrates for the first time that the *msrA* gene is now in unrelated Gram-positive bacteria. We are currently working to verify the *msrA* gene in the other isolates. If the *msrA* gene is confirmed in *Pseudomonas*, this gene can be added to a growing number of Gram-positive antibiotic resistance genes, which can be acquired, and by Gram-negative bacteria and it is likely the *msrA* gene will continue to spread to new bacteria over time.

### **Speech, Ink, and Slides: The Interaction of Content Channels**

*Jonathan Su, Junior, Computer Engineering*

*Mary Gates Scholar, Goldwater Scholar*

*Mentor: Richard Anderson, Computer Science and Engineering*

In this poster, we will discuss empirical exploration of digital ink and speech usage in lecture presentation. Our interest in understanding how ink and speech are used together is to inform the development of future tools for supporting classroom presentation, distance education, and viewing of archived lectures. We want to make it easier to interact with electronic materials and to extract information from them. Furthermore, we want to provide an empirical basis for addressing challenging problems such as automatically generating full text transcripts of lectures, matching speaker audio with slide content, and recognizing the meaning of the instructor's ink. Our results include an evaluation of handwritten word recognition in the lecture domain, an approach for associating attentional marks with content, an analysis of linkage between speech and ink, and an application of recognition techniques to infer speaker actions.

### **Computerized Symptom and Quality-of-Life Assessment for Patients at Overlake Hospital Medical Center - Radiation Oncology**

*Tammy Suen, Senior, Social Work*

*Mentor: Donna Berry, Biobehavioral Nursing and Health Systems*

Cancer symptoms and quality of life issues are of the highest priority to oncology clinicians and researchers. Clinicians are faced too often with shrinking resources, removing opportunities for lengthy interpersonal interactions. Patients arrive in the therapeutic setting with varying levels of symptoms and other types of responses to the cancer diagnosis and experiences. Using an electronic assessment questionnaire we can give radiation oncology patients an opportunity to share any concerns they are experiencing related to symptoms and quality of life. Based on questions that appear on a touch screen laptop computer, the answer are used to identify those patients who need additional resources such as written information, referral to social work and/or dietary or who need specific follow-up from their doctor or nurse in addressing particular concerns. The application, Electronic Self-Report Assessment- Cancer (ESRA-C) was designed by an interdisciplinary, investigative team at the University of Washington to improve communication between patients and healthcare team members. In our poster, we will address the pilot testing from May 2004 to present in 159 patients attending the Radiation Oncology clinic in the Overlake Hospital Medical Center, Bellevue. We will illustrate how ESRA-C is deployed in the clinic and the likelihood of psychosocial service referrals based on patient's response through the Symptom Distress Scale and the SF-8 quality of life assessment. We will illustrate and describe the cancer symptoms and quality of life information reported by the patients.

### **Characterization of bacterial flora found in the gastrointestinal track of larval rockfish (*Sebastes* sp.)**

*Oby Sumampouw, Senior, Biochemistry, Microbiology*

*Mary Gates Scholar*

*Mentor: Russell P Herwig, School of Aquatic and Fishery Sciences.*

Rockfish play an important role in Pacific Northwest marine ecosystems and are also an important consumable food. There is an interest in characterizing the microbial flora associated with rockfish and to understand the interaction of microorganisms with the fish. The microbial flora is thought to affect fish health and survivability and therefore may play an integral part in life cycle of these fish. The goal of the project was to isolate bacteria from the gastrointestinal track of larval rockfish, to analyze their phenotypic properties, and to determine their identities. Fish were obtained from the NOAA Fisheries laboratory in Mukilteo, WA. There were two groups of fish, one was fed with an artificial diet consisting of rotifers and the other group was not fed. Each group consisted of ten fish. The surfaces of the fish were sterilized and the fish were sacrificed to extract their gastrointestinal microflora. Thirty randomly picked bacterial isolates from each group were plated and screened for their ability to inhibit common rockfish pathogens, *Aeromonas salmonicida* and *Listonella anguillarum*. Afterwards, we determined the whole-cell fatty acid composition of the isolates using gas chromatog-

raphy. Representative isolates were then further characterized by determining their 16S rDNA sequences. Based on the colony morphologies on Marine 2216 agar plates, bacteria isolated from unfed fish were a more diverse population and were more numerous than bacteria associated with the fed group. All bacterial isolates however did not show any antagonistic capabilities toward the two tested pathogenic species. A larger sample size of fish might reflect a more realistic representation of fish normal flora.

### **The Evolution and Biogeography of Oaks**

*Xiaoya Sun, Junior, Biodiversity Group, UW-Sichuan Program*

*Mentor: Matt Hodson, Botony*

*Mentor: Anita Devineni, Stanford University*

*Mentor: Benjamin D Hall, Biology*

Oak trees are a valuable resource, both for their economic and esthetic contributions. The genus *Quercus*, belonging to the family *Fagaceae*, contains approximately 500 oak species. The four major subgroups within *Quercus* are: section *Lobatae* including red and black oaks, section *Protobalanus*, which contains the golden cup oaks, section *Quercus*, called white oaks and section *Cerris*, containing most of the strictly Eurasian oak species. Related oaks, such as the Asian genus *Cyclobalanopsis*, can be used as outgroups in phylogenetic studies. The goal of this project is to sequence a gene from many species within *Quercus* and from the data to infer a well-resolved phylogeny. We also wish to investigate the biogeographic implications of the phylogeny—that is, what it can tell us about the geographic origin and dispersal of various major groups. Efforts elsewhere to obtain a well-resolved oak phylogeny, based upon plastid and ribosomal ITS sequences, were not highly successful. Our project is based upon the sequencing the nuclear gene *RPB2*, which encodes the second largest subunit of RNA polymerase II. We are focused on the gene region from exon 2 to exon 11. With DNA extracted from oak leaves, the polymerase chain reaction (PCR) is used to amplify *RPB2*. Because some oak species may be hybrid, the two allelic *RPB2* sequences are separated by cloning, and then sequenced using an automated sequencer. With preliminary data from 15 oak species, sequence alignment and phylogenetic analysis suggests that *RPB2* is capable of generating a well-resolved *Quercus* phylogeny.

### **Establishment of Connections Between the Peroxisome and Other Aspects of Yeast Physiology**

*Lauren Surface, Junior, Neurobiology*

*Mary Gates Scholar*

*Mentor: Brian Kennedy, Biochemistry*

*Mentor: Daniel Lockshon, Biochemistry*

The only known function of the peroxisome in the yeast *Saccharomyces cerevisiae* is the degradation of fatty acids. However, a number of additional proteins, many of which whose function is poorly understood, are located there as

well. Our goal with this project is to identify additional proteins that are required for peroxisome function to establish interactions with other areas of the cell. This will enable us to better understand the role of the peroxisome in biological processes. To begin, a set of yeast strains, each with one of the approximately 4000 non-essential genes deleted, was tested for the ability to grow when oleic acid (a fatty acid) was supplied as the sole carbon source. Lack of growth has previously been shown to identify many of the known peroxisomal (*PEX*) genes. In addition to the known *PEX* genes, we found poor growth on oleate to be caused by ~80 additional genes. By genetically substituting Pex11-GFP, a fluorescently tagged peroxisome protein, for *PEX11* in each of the positives from the screen, the effect of each deletion on the integrity of the strain's peroxisome was assessed. Yeast two-hybrid screens using as baits the proteins deleted in our most promising hits will allow these proteins' interaction partners to be found. From these interaction findings, we can further explore the role and connections proteins involved in the peroxisome have in other areas of the cell.

### **Immersion [Emission]**

*Joan Swearingen, Senior, Art, Photography*

*Mary Gates Scholar*

*Mentor: Phillip Thurtle, Communication, Comparative History of Ideas*

*Mentor: Kari Tupper, Women's Studies, Comparative History of Ideas*

*Mentor: Claudia X. Valdes, Digital Arts*

*Mentor: Lisa Darms, Digital Arts*

*Immersion [Emission]* is a video installation as informed by my explorations into the process of using the tactile physical world as a guide for memory and narration after experiencing a traumatic event. Drawing on the writings of philosophers, historians, and several personal accounts across time and culture, as well as looking at several artists' responses to trauma, I examined the qualities of space and structure created through imagination that provide the relief in which to build upon after the crippling destruction of trauma. I used different attributes of form, such as color, texture, and depth to develop a visceral sculpture piece that evolved in the course of the sixteen-minute film. Projected onto a small screen of velum, the viewer enters an intimate space in which they bring their own memories creating a fusion between different accounts of time and experience, achieving a transformative understanding outside the capacity of verbal exchange.

### **Graphical Human Interface (GHI) in Clinical Cancer-Symptoms Reporting**

*Robert Tai, Senior, Informatics*

*Mentor: David McDonald, Information School*

The traditional procedure for cancer symptom assessment is a paper questionnaire completed by the patient. Through

a paper-based questionnaire, a patient can not readily describe the location and the intensity of the pain. This issue coupled with a high cost of data collection from the patient and the management of written questionnaires leads to a low utilization rate of this information. Graphical Human Interface (GHI) is a project addressing the problems of the paper-based process. GHI, using web-based technologies, constructs an interactive visual human model for the patient to localize and describe his symptoms. With GHI the patient can edit his inputs, and have a graphical representation made available to clinicians for assessment. We address the usability, efficiency and appropriateness of symptom management in the GHI system, through a series of research studies. Initial research includes a formative usability study and participatory interface design. Later research may include trials with actual patients in clinics, upon approval of Human Subjects Division. We expect that GHI will enhance physician-patient interaction, specific symptom prevention and management, and increase appropriate referrals to support services. GHI is a student-led research project that develops from a NIH-funded bioinformatics research study called "Electronic Self-Report Assessment-Cancer" (ESRA-C) lead by UW health sciences researchers, who also oversee the development of GHI study.

#### **Automatic Expectations within Attachment-Related Contexts**

*Melissa Takahashi, Senior, Psychology*

*Mentor: Vivian Zayas, Psychology*

*Mentor: Yuichi Shoda, Psychology*

Adult attachment theory proposes that individuals who are securely attached expect their partners to be supportive and comforting in times of need. In contrast, individuals who are insecurely attached expect their partners to be unavailable and even rejecting in times of need. The purpose of the present research was to answer the question: Are individuals with a secure attachment style more likely to expect positive outcomes after thinking about an attachment-related situation than individuals with an insecure attachment style? Four hundred and fifty-six undergraduate psychology students at the University of Washington completed self-report questionnaires to assess their level of security (vs. insecurity) within adult romantic relationships. Half of the participants were also randomly assigned to either a visualization condition in which they visualized a distressful life event or a no visualization condition. A computer task was developed to assess the expectations automatically activated within attachment-related contexts. Each trial consisted of an audio prime that described either an attachment-related situation (e.g., "If I turn to my partner, my partner will be...") or a nonattachment-related situation (e.g., "If my partner is invited to a party, my partner will be..."). Participants' task was to classify the valence of a target word (e.g., accepting, rejecting) that appeared in the middle of the computer screen as either "good" or "bad."

The time it took participants to correctly identify the valence of the target word was recorded for each trial. The present research showed that, on average, individuals were faster at identifying positive target words after an attachment-related prime than a nonattachment-related prime. Moreover, interpersonal expectations differed depending on whether or not participants had engaged in the visualization task. Finally, securely attached individuals were faster than insecurely attached individuals at identifying positive target words and slower at identifying negative target words following an attachment prime.

#### **Biofilm Triggered Antibiotic Release from pH-sensitive Hydrogels**

*Leonard Teo, Senior, Bioengineering*

*Misty L. Noble, Graduate Student, Bioengineering*

*Mentor: James D. Bryers, Bioengineering*

*Mentor: Buddy D. Ratner, Bioengineering*

Some five million medical devices and biomaterials are implanted in the United States each year. Significantly, 80% of hospital-acquired infections are associated with implants or indwelling medical devices, with a case-to-fatality ratio for these infections ranging between 5-60%. To prevent and treat these infections more effectively, a smart polymeric matrix that releases therapy at low pH is currently being developed for biofilm prevention. The polymeric matrix can swell in response to a decrease in pH brought about by the acidic environment of developing biofilms. In low pH, the reactive amine end groups of the matrix are protonated, which results in a net positive charge causing electrostatic repulsion and expansion of the network structure and the release of the drugs out of the network. The matrix is prepared by incorporating an antibiotic, ciprofloxacin, into the polymer matrix, which is a mixture of 2-hydroxyethyl methacrylate (HEMA), hydroxypropyl methacrylate (HPMA), and N, N-dimethylaminoethyl methacrylate (DMAEM) using tetraethylene glycol dimethacrylate (TEGDMA) as a cross-linking agent. Sets of polymer matrices with different monomer proportions are prepared and cut into 10-mm round disks. The swelling ratios of the disks and release rates of the drug are studied at various time periods in varying pH buffer solutions. Preliminary results reveal that the swelling ratio of the disks in pH 5.3 buffer is about twice the swelling ratio in pH 7.0. In addition, the cumulative ciprofloxacin released at pH 5.3 is higher than that in pH 7.0, 85% and 70%, respectively. We have demonstrated the pH-sensitivity of the polymer matrices by showing an increase in drug release and swelling ratio in acidic environment. Thus, this drug delivery system can be used in biofilm prevention as a coating for different medical devices and implantable biomaterials.

#### **Investigating Office Discipline Referrals through the BEACONS Project**

*Lily Tharp, Junior, Pre-Education*

*Zesbaugh Scholar*

*Mentor: Doug Cheney, Special Education*

*Mentor: Bridget Walker, Experimental Education*

The BEACONS Project, or the Behavioral, Emotional, Academic and Curriculum for the Ongoing Needs of Students, assists schools and communities in the state of Washington to address the challenging behavior of students with and without disabilities. Children with or at risk of developing emotional and behavioral disorders often face struggles in the area of academics. Schools may not understand how to support these children's needs. Since 1998 BEACONS has been working with schools in a collaborative effort to develop school-wide, targeted, and intensive interventions for students. The objective of the BEACONS project is to support schools with the implementation of Positive Behavior Supports (PBS) for both these at-risk children and their families. PBS are individualized or system's strategies that enhance the positive social and academic competence of students, while decreasing their problem behavior. BEACONS believes that it is imperative to provide educators with training to work with these difficult children. The project provides participating educators with ongoing and professional development programs helping teachers to gain knowledge and strategies about Positive Behavior Supports. Changes that result from these supports will be measured by conducting a review of Office Discipline Referrals within participating schools. Findings indicate that schools that have implemented these PBS strategies see a reduction in the amount of Office Discipline Referrals as well as other disruptive behaviors in the classroom.

### **Contribution of Polymerase $\beta$ to chemotherapy resistance in pediatric brain tumors**

*Ana Thomas, Senior, Neurobiology*

*Mary Gates Scholar*

*Mentor: Michael S. Bobola, Neurosurgery*

Polymerase  $\beta$  is the smallest human DNA polymerase responsible for short patch DNA repair. When cancer is exposed to various forms of therapy, Polymerase  $\beta$  acts to repair the DNA in both diseased and normal tissue, which would, in affect cause it to be a mechanism of resistance to therapy. We hypothesize that inhibition of DNA Polymerase  $\beta$  will sensitize tumor cells to current chemotherapeutic methods. In this study we are using anti-sense suppression of Polymerase  $\beta$  to monitor its effect on chemosensitivity. By monitoring pediatric-brain-tumor-derived-cell-lines that have Polymerase  $\beta$  activity inhibited, we can evaluate its mechanistic contribution to commonly-used chemotherapy drugs, such as carmustine, temozolomide and cisplatin. If the cancer cells are sensitized to chemotherapy after Polymerase  $\beta$  activity is suppressed, it would show a direct contribution of Polymerase  $\beta$  to chemotherapy resistance. If Polymerase  $\beta$  proves to be a significant resistance mechanism, then chemical inhibitors to Polymerase  $\beta$  activity will

be surveyed for an effect on cellular resistance; results with the inhibitors will be directly compared to anti-sense results. Additionally we will assess variation in Polymerase  $\beta$  activity in a set of medulloblastoma tumors to determine *in vivo* variation in this activity. Through our research we are hoping to make treatment more effective by identifying resistance mechanisms and applying this information to improve current therapies.

### **Investigating possible relationships within data collected in regards acquaintance sexual aggression**

*Tamra Ann Thomas, Senior, Psychology*

*Mentor: Paula Nurius, School of Social Work*

A study using female undergraduate participants was conducted to expand on previous findings regarding acquaintance sexual aggression. In two separate sessions, participants rated their emotional responses to descriptions of forty-five 2nd person scenarios involving themselves and a male acquaintance. The stimuli participants evaluated were based on real women's accounts of situations that lead to acquaintance sexual aggression. The stimuli did not include the act of sexual aggression. In addition to evaluating these scenarios, participants completed questionnaires related to their sexual experience and social goals. My proposed poster topic for the undergraduate research symposium is based on a larger, ongoing, joint study between the UW Departments of Psychology and Social Work. I am personally curious as to whether there is a relationship between participants' self-reported sexual experience and their emotional responses to situations that may lead to acquaintance sexual aggression. I intuit that women who have sexual experience but do not report having been victims of acquaintance sexual aggression or rape will rate "stressful" or "anxious" emotions as being experienced less when compared to women with little or no sexual experience or those who have been victimized. I must, however, find more literature that would support or refute my hypothesis. While the data for my poster has already been collected, I am still in the process of analyzing it. It is important to note that this experiment does not infer any causal relationships between sexual experience and women's perceptions about their interactions with male acquaintances. The results of this experiment and further research, however, would be beneficial in order to inform both men and women that perception of and emotional responses to situations can vary considerably among individuals.

### **Examining the Functional Role of the ThyX Gene in *Mycobacterium Tuberculosis* through Mutagenesis**

*Chris Thouvenel, Junior, Biology*

*Mary Gates Scholar*

*Mentor: Carol Hopkins Sibley, Genome Sciences*

The synthesis of thymidine is essential for the replication of any cell. A recent discovery has shown that there are two completely different enzymes that can carry out the

reaction necessary for thymidine synthesis. In *Mycobacterium tuberculosis*, the bacterium that causes most cases of tuberculosis, the enzyme (called ThyX) differs markedly from the enzyme used in humans (called ThyA) for the production of thymidine. If the ThyX enzyme could be repressed then the *M. tuberculosis* would be unable to replicate and would die in its human host without affecting the host's own thymidine synthesis. The aim of my research is to understand the functional role of the ThyX enzyme in this alternative pathway in *M. tuberculosis*. We use another bacterium, *E. coli* that lacks its own thymidylate synthesis pathway as a test system. These *E. coli* grow only when thymidine is supplied in growth medium. I have introduced point mutations in specific residues of the *ThyX* gene. I tested each mutant *ThyX* gene to determine whether it could function by allowing the *E. coli* to grow even in the absence of thymidine. This research has the potential to aid in creating a drug that would inhibit the alternative thymidylate synthesis pathway in *M. tuberculosis*, but not the ThyA enzyme in humans.

### **Comparison of Paired Urinary and Salivary Cortisol as a Biomarker of Stress**

*Garrett Tomblinson, Senior, Anthropology*

*Mary Gates Scholar*

*Mentor: Kathleen O'Connor, Anthropology*

*Background:* Cortisol is a steroid hormone produced by the adrenal gland. Cortisol production increases in response to physical and psychological stress. In practice, salivary cortisol is used as an indicator of acute stress and urinary cortisol is used as an indicator of chronic stress. The extent to which urinary and salivary cortisol concentrations reliably differentiate between chronic and acute stress remains ambiguous. Our goal is to compare urinary and salivary cortisol profiles with prospective and retrospective stress assessments to examine if they are reliably differentiating acute and chronic stress. *Methods:* First, we compared a standard cup method for saliva collection to a more efficient Salivette® method, to ensure the most efficient and accurate method for the second phase of the study. For the second phase, ten volunteers (males and females) between the ages of 18 and 50 collected urine and saliva samples three times daily (morning, afternoon, and evening) for seven days (Wednesday to Tuesday). At the time of each saliva collection, they prospectively ranked their stress level on a 5-point scale. Further, they retrospectively ranked their stress for the previous day on the same 5-point scale. *Results:* Interestingly, we found that the cup method for saliva collection produced cortisol concentrations significantly lower than the Salivette® method. The cause for this discrepancy was found to be the chewing gum used to promote saliva production for cup collection. Results for the paired urine and saliva collection (currently underway) will also be discussed.

### **Madrona K-8 School: Intervention and Improve-**

### **ments in Student Achievement**

*Allison Hong Tran, Senior, English*

*Mentor: Kathy Kimball, Educational Leadership and Policy Studies*

The Madrona K-8 School: Intervention and Improvements in Student Achievement is a project that looks into school interventions from an outside source to see whether the students at Madrona have improved on their test scores. This project looks specifically at the current eighth graders. This cohort was chosen due to the fact that this group started 4<sup>th</sup> grade the year the intervention, (Madrona Partnership: UW, Seattle Schools, and the Business Community), had been introduced. The students of this cohort have their test scores evaluated against previous test scores (taken by other cohorts at the school) to see if the intervention has helped increased test scores. The tests include: the WASL, DWA, and the ITBS. The four interventions are Reading Coach (for all grades), WASL tutoring (for grades four and seven), Safe and Civil Schools (for all grades), and the Behavior Learning Center (for all grades). The first two interventions are involved in teaching the students to improve on reading and knowing the WASL. The two last interventions serve to help students learn about how they can improve their own behavior in order to stay in class and learn. The object of the intervention is to improve student achievement as measured by these tests.

### **Patient-centered Health Record**

*Diem-Thy Tran, Senior, Informatics*

*Xun Zhang, Senior, Informatics*

*Mentor: David McDonald, Information School*

The goal of a Patient-centered Health Record (Pc-HR) system is to empower patients to organize their personal health information, become more informed about their health progress, and be able to easily provide their physicians with crucial health information. Pc-HR is an ongoing project by members of the UW Biomedical & Health Informatics Program. Our research focuses on assessing the users needs, re-designing, and studying the usability of the Pc-HR user interface (UI). For the initial user needs assessment, we conducted interviews and usability tests of an existing Pc-HR prototype. In order to develop a patient-centered interface for Pc-HR, we relied on user-centered design methods such as card-sorting and web design guidelines from the National Cancer Institute. Next we re-designed the current Pc-HR interface and conducted further usability tests to compare two new HTML mock-up prototypes. Based on our findings, we suggest a number of recommendations for the final re-design of the Pc-HR system. Our project demonstrates the importance of user-center design in creating a personal health information management system. It is important that a health record system is designed around patients to help them organize their personal health information in a much more efficient and intuitive way. The benefits of a patient-centered

health record system can also improve doctor and patient communication.

### **Endocycle: Exploring the Role of E2F1 Protein in *Drosophila* Polyploidy Cells**

*Vuong Tran, Senior, Biology*

*Mentor: Bruce Edgar, Genome Sciences*

In eukaryotic cell growth and proliferation, a cell would typically undergo G1, S, G2 and M phases. However, during *Drosophila* larval development, tissues such as fat body and salivary gland skip the G2 and M phases in order to replicate DNA without dividing. As a result, large polytene cells arise from a process known as endoreplication. E2F1 is a transcription factor that plays a vital role in regulating the endocycle. *In situ* hybridization experiments have shown that endogenous E2F1 mRNA levels do not oscillate, therefore, its regulation has to be regulated at the post-transcriptional level. Throughout G1, E2F1 protein is accumulated in an endoreplicating cell. Its role is to transcribe mRNA of genes such as *cyclin E* that are needed for S phase. Alternatively, E2F1 activity can be negatively regulated by binding to RBF protein, which represses E2F1 transcription sites. Presumably, this would also aid in E2F1 degradation, whose full mechanism is not yet known. As a result, we can see oscillation of E2F1 protein which builds up during G1 and then degrades at the start of S phase during each endoreplication cycle. Evidence of oscillation can be clearly seen though E2F1 antibody staining of wildtype fat body tissue. The importance of E2F1's role in the *Drosophila* endocycle can be seen when we over-express its transcription in fat body and salivary glands, which causes faster accumulation of the protein. Essentially, this would truncate G1 phase, allowing for more endoreplication cycles to occur. As a result, we see much larger nuclei in these tissues. Other experiment such as overexpression of *myc* gene also increases DNA content. However, it is very likely that *myc* overexpression induces overall growth, providing an upstream affect by increasing E2F1 accumulation.

### **The Use of the Manganese Ion for Measuring Calcium Uptake in Pituitary Tumor Cells: A MRI Contrast Agent to Demonstrate Functional Activity**

*Sara Van Nortwick, Sophomore, Bioengineering*

*Mary Gates Scholar*

*Mentor: Satoshi Minoshima, Radiology*

Human pituitary tumors can result in vision loss as a result of abnormal levels of hormone production and ultimately death if left untreated. Magnetic Resonance Imaging (MRI) is capable of detecting tumors anatomically but is not capable of providing functional information related to cellular metabolism and hormone secretion. The ability to determine synapse and hormone secretion activity would allow for a tailored treatment of pituitary tumors by demonstrating the areas of increased calcium activity and necrosed

tissues. Calcium is the primary means of signal transduction and is an important trigger of hormone secretion in neuroendocrine cells. Cancerous pituitary cells lead to a hormone imbalance, indicative of changes in levels of calcium uptake. Manganese mimics calcium's role in cell activity and can be visualized non-invasively in vivo using MRI since it shortens the T1 relaxation constant. In this study, we propose the use of manganese to measure differences in calcium influx in primary pituitary cells, the rat GH3 cancerous pituitary cell line, and the rat C6 glioma glial cell line. Manganese uptake will be quantified for both stimulated and unstimulated conditions for each cell type using atomic absorption spectrophotometry to demonstrate differences in calcium uptake and, therefore, synapse activity and hormone secretion levels. The potential of manganese as a contrast agent for MRI of brain tumors in vivo will be demonstrated according to differential uptake between normal and cancerous cell types.

### **Sample classification using gas chromatography – mass spectroscopy.**

*Matthew Van Wingerden, Junior, Chemistry*

*Mary Gates Scholar*

*Mentor: Robert Synovec, Chemistry*

Gas chromatography with mass spectral detection (GC-MS) is a very useful analytical tool in chemistry. Using this technique, complex mixtures can be separated and identified with great precision. The intent of this project was to probe the ability of recently developed data processing and filtering software to classify GC-MS separations of complex sample mixtures under rigorous conditions. In order to accomplish this four samples of gasoline were collected at different fueling stations around Seattle. These gasoline samples were vaporized and chromatographically separated using an Agilent gas chromatograph, and the data was collected using the Hewlett-Packard Chemstation program. Each of the four gasolines were run in replicate 50 times and the data set was imported into Matlab, a matrix-based computer program for processing large volumes of data. Novel software developed in the lab was used to correct for variations in the data that were not chemically significant, such as rising baselines, discrepancies in the injection volume, retention time shifting, and feature selection. After submitting the data set to these preprocessing steps and eliminating the chemically insignificant variations, the data was processed using Principle Component Analysis (PCA). PCA reduces the data set and separates the replicates into groups based on the most variable components, where the variations are due to chemical class differences, thus allowing the user to objectively classify unknown chromatograms. To determine how robust the novel classification technique is, the sample mixtures were analyzed using a range of total separation times. Shorter times yield less separated data, creating a greater challenge for the classification method. It was found that the novel classification

method successfully classified samples using both ten minute and ninety second runtimes, partial classification was accomplished at thirty seconds, and classification failed based on mass spectral data alone (zero separation time).

### **Modeling the Reactivity of Superoxide Reducing Non-Heme SOR Enzyme with a Fe<sup>II</sup>(Tren-S) Model Complex**

*Susan Veith, Senior; Chemistry*

*Mentor: Julie A. Kovacs, Chemistry*

The free radical superoxide (O<sup>-1</sup>) is dangerous to anaerobic and aerobic biological systems due to its selective reactivity within catalytic enzyme sites. Two enzymes are designed to combat buildup of superoxide by destroying it, superoxide reductase (SOR) and superoxide dismutase (SOD). When SOR and SOD do not reduce superoxide, this produces a build up that leads to radical chain reactions, neurotoxicity, DNA damage, and enzyme inactivation, which can stop cell growth and lead to mutagenesis and cell death. Superoxide build up has also been linked to Alzheimer's Disease and liver damage through extensive research. The Kovacs Bioinorganic Research group, under direction of Dr. Julie Kovacs, is attempting to create model catalytic enzyme sites of SOR in order to study the mechanism of superoxide reduction by this enzyme. Using U.V./Vis and Infrared Spectroscopy we can determine the reactivity and intermediate stages of an SOR model enzyme active site, (Fe<sup>II</sup>[Tren-S]), which will allow characterization of this active site in order to create a working model. Results so far have been varied as synthesis and characterization of these complexes and their intermediate Superoxide binding step must be done at temperatures of -78° C in order to prevent formation of a  $\mu$ -oxo dimer, (Fe<sup>III</sup>-O-Fe<sup>III</sup>). This is an oxidized combination of the Fe<sup>II</sup>[Tren-S] model complexes joined by an oxygen molecule and not directly useful to the topic at hand. Future work on this subject includes the synthesis of SOD model enzyme catalytic sites and synthesis of multiple SOR model enzyme catalytic sites to characterize all aspects of the enzyme and superoxides selective reactivity within those sites.

### **A Time Series Study of Deep Sea Hydrothermal Vent Chemistry**

*Elena Wagner, Junior; Biochemistry*

*Mentor: David A. Butterfield, Joint Institute for the Study of the Atmosphere and Oceans*

Deep-sea vents are fascinating underwater ecosystems that are home to a wide variety of life. Microorganisms are able to extract energy for metabolism from the disequilibrium that results when hot, anoxic hydrothermal fluids mix with cold seawater. In order to understand how hydrothermal ecosystems function, we need to know how the energy supply, which comes from the vent itself, fluctuates over

time. In order to do this, two time-series water and particle samplers were deployed with their intakes in diffuse flow vents near Hulk in the Main Endeavour Field (47°57'N, 129°06'W) and Clambed vent (~ 1km N of Hulk) from August 2003 through June 2004. There they collected weekly water samples and recorded vent temperature every 15 minutes. I analyzed these samples using ion chromatography, flame atomic absorption, flame atomic emission, and titrations to determine their mineral and elemental components. From this data, one can determine what the hydrothermal component of the vent water was and from there how it varied over the 10-month experiment. Based on the chemical composition of water samples collected, the diffuse vent at Hulk maintained a fairly steady hydrothermal component (94.5 to 96.5% seawater or 3.5 to 5.5% hydrothermal); Clambed hydrothermal component fluctuated to a greater degree (88 to 99% seawater or 1 to 12% hydrothermal fluid). This level of difference in habitat variability is probably significant for microbes living at the vent orifice.

### **Discovering the Favorable Conditions for Online Deliberation**

*Andrew Waits, Senior; Communication, Political Science*

*Mary Gates Scholar*

*Mentor: Kirsten Foot, Communication*

The implications of the Internet on public discourse are a major topic of interest and debate among communication and political scholars. Proponents of deliberative democracy view the Internet as a means of enhancing the public sphere through the notion of deliberation. This project contends that the Internet can promote democracy, but only if it is programmed to do so and only in terms of the paradigms and political theories that inform the program. Therefore, if deliberation is a desired outcome of computer-mediated communication, online environments must be programmed and designed according to what is required of deliberation. The purpose of this project is to discover the theoretical conditions favorable to producing deliberation online. To this end, this project begins by justifying the use of a specific definition and theoretical model of face-to-face deliberation that function as the conceptual base for the rest of the project. This project then investigates the offline conditions employed by modern experiments in face-to-face deliberation, which were found to promote a high quality of deliberation. These modern experiments include projects such as Citizen Juries, study circles, the National Issues Forums, and the 1996 and 2003 National Issues Convention. These offline conditions, combined with the communicative and participatory requirements defined as essential to this project's specific definition of deliberation, will then be applied to online settings to create a set of "best practices" for online forums wishing to promote political deliberation.

### **Geologic History and Significance of a Fossil Forest Preserved in Living Position Within the Columbia River Basalt Group**

*Peter Wald, Senior, Earth and Space Sciences*

*Tad Dillhoff, Evolving Earth Foundation*

*Mentor: Roger Buick, Earth and Space Sciences*

The Miocene Columbia River Basalt Group is known for the well-preserved petrified forests contained within its various flows. This project examines one such Petrified Forest located in the Yakima Fold Belt near Yakima, WA. The fossil trees at this site display upright preservation in living position, a rare characteristic for fossil forests. There are two main goals for this project. The first goal is to survey the relative abundances of tree types found at the site in order that conclusions may be drawn regarding Miocene paleo-temperatures and paleo-precipitation rates for this location. This aspect of the project is being undertaken by paleobotanist Tad Dillhoff. Tree genera are being identified by field observations where possible and thin-section analyses where necessary. The second goal of the project, being carried out by earth science student Peter Wald, is to build an understanding of the geologic history and structures affecting the fossil trees found at the study site. This includes using geologic mapping techniques to form a better picture of local geologic structures and develop an understanding of the surrounding flows and their interaction with the folding events known to have occurred in the Yakima Fold Belt. Bulk mineral analysis using x-ray fluorescence spectrometry of basalt samples will also be carried out in order to determine the identity of the particular Columbia River Basalt Group flow(s) involved. These two investigations, along with in-depth study of the applicable literature and first-hand field observations, should lead to the development of working hypotheses concerning the nature of processes leading to life-position preservation of the fossil trees as well as post-burial processes that continued to affect the fossil forest up to modern times. The research in progress should lead to a better understanding of the paleo-ecology and geologic history of both the local work-site and the surrounding region.

### **Step-Wise Pattern in Sarcomere-Length Change Data**

*Chenyang Wang, Senior, Bioengineering*

*Mentor: Gerald H. Pollack, Bioengineering*

The current model of muscle contraction, as proposed by A.F. Huxley in the 1950's, suggests that each sarcomere contracts smoothly and continuously. However, sarcomere contraction experiments from this laboratory showed that the sarcomere contracts in a step-wise fashion. Each sarcomere shortens in discrete steps. Interestingly, these steps have regular sizes, which are always in multiples of 2.7 nm. This evidence seems to suggest that 2.7 nm is the quantal step in muscle sarcomere shortening. The previous ana-

lytical method used to obtain this result was prone to user-bias, and therefore, a more precise method was needed. The new method consisted of a series of MATLAB algorithms, capable of automatically analyzing the sarcomere contraction data. With minimal user input, the algorithms digitally filter the data for noise, analyze the data for steps, and compute statistics on the distribution of steps. To ensure the algorithms' reliability, their effectiveness was evaluated extensively using artificial data. Each set of artificial data contains steps of predetermined size, with the addition of random Gaussian noise. After analyzing the artificial data, it was clear that the algorithms were able to identify the predetermined step sizes, even at a high Gaussian noise level of 3 nm peak-to-peak. Currently, the algorithms are being fine-tuned, and will be applied to the real experimental data. Since the currently accepted muscle contraction model cannot easily account for the existence of a quantal step size in sarcomere shortening, our result may hint an alternative model of muscle contraction.

### **Policy Consequences of Increasing Income Inequality**

*Ashley Watson, Senior, Political Science*

*Mary Gates Scholar*

*Mentor: Bryan Jones, Director of Center for American Politics and Public Policy*

Although income inequality is much discussed in research circles across the United States, the policy consequences of such trends have yet to be studied in much detail. This study investigates the links between income inequality and political polarization and the cumulative impact these variables have on policy processes and outcomes. Using the Policy Agendas Project's coding scheme based on 19 major policy areas and 225 subtopic areas, the study's principle investigator coded over 30,000 roll call votes based on the policy content of each vote. The finished dataset includes all roll call votes taken in both chambers of Congress from 1945 to 2000. In addition, utilizing DW-NOMINATE scores for each vote, I will assess polarization trends across different policy areas. NOMINATE scores uses a technique of spatial modeling to place legislators on a liberal-conservative axis and can be seen as an indicator of elite polarization. I suspect polarization to be higher in those areas most closely linked with income inequality, like social welfare policy. Preliminary evidence points to a general decline in congressional support for social welfare policies. Moreover, conflict over this policy area among legislators has increased in recent years suggesting increased polarization. This study also explores the causal connection between income inequality and political polarization, an association that recent research has shown to be surprisingly close.

### **Genomic Epidemiology of *Mycobacterium avium* Complex**

*Kris Weigel, Senior, Biology*

*Mary Gates Scholar*

*Mentor: Gerard Cangelosi, Pathobiology*

Species within *Mycobacterium avium* Complex (MAC) are important opportunistic pathogens of humans and animals. An increasing number of immuno-compromised individuals (e.g. AIDS patients, chemotherapy patients, the elderly, etc.) beget a corresponding increase in our need to understand the phylogenetics and epidemiology of MAC. I will be focusing my genetic studies on one sub-species within MAC, *Mycobacterium avium avium*. I have identified eight large sequence polymorphisms (LSPs) *in silico* by comparing the genomes of the reference *M. avium* strain 104 with a different reference strain *M. avium paratuberculosis* K-10. I designed primers for a multiplex polymerase chain reaction (PCR) to test whether the deletion region is variably present in different *avium* isolates. For four already existing and characterized deletions (one by me), I designed short DNA sequences (oligonucleotides or oligos) that would anneal to the complementary sequence within the region. These oligos (via attached terminal amino groups) will be hybridized linearly to an activated Biodyne C (Pall Corp.) membrane. PCR product, containing biotinylated primers, from a multiplexed reaction will be hybridized perpendicularly to the membrane. Using autoradiography, this will result in a binary array of presence/non-presence for each deletion for each strain. Once successful with the first four deletions, the other previously mentioned variably present deletions will be incorporated into this membrane assay. This novel method of analysis will be much more efficient and expandable than the deligotyping method on which it is based, wherein each deletion must be tested individually using gel electrophoresis. If new deletions interrogated retrospectively on existing isolates suggests that this approach can provide novel information on the epidemiology of MAC, future studies will use it prospectively in combination with clinical and epidemiological information to better understand the routes of MAC acquisition.

#### **Identifying glial cell populations susceptible to ischemic injury in adult mammalian white matter**

*Desiree Willis, Senior, Neurobiology, Technical Communication*

*Mentor: Bruce R. Ransom, Neurology*

Ischemic injury can affect both gray and white matter in the central nervous system. White matter (WM) is metabolically distinct from gray matter and suffers ischemic injury in a unique manner. WM contains no synapses or N-methyl D-aspartate glutamate receptors, and therefore does not experience ischemia-induced excitotoxicity as seen in gray matter. This study was designed to determine the relative susceptibility of different glial cell types to ischemic insult. We used immunohistochemical markers to quantitatively assess the glial cells in normal WM and to learn

how these populations were affected by ischemia. We used mouse optic nerves (MONs), a representative WM tract that consists entirely of myelinated axons. MONs were obtained from 4-6 week old male Swiss Webster mice. Control conditions included perfusion fixed MONs and MONs kept normoxic for up to 12 hours at 37 °C superfused with artificial cerebrospinal fluid (ACSF) saturated with oxygen. Experimental conditions involved MONs exposed to varying durations of oxygen-glucose deprivation (OGD) followed by reperfusion. OGD was induced by switching to glucose-free ACSF saturated with nitrogen. MONs were collected at designated time intervals, fixed, cryoprotected and sectioned for immunohistochemistry. Cell nuclei were identified by the nonspecific nuclear stain DAPI, oligodendrocytes with APC, astrocytes with GFAP, oligodendrocytes precursors with NG2, and microglia with F4/80. Cell death was assessed based on loss of cell-specific antigens and increase in pyknotic nuclei. Our results will provide important insights into the mechanisms of ischemic WM injury by identifying the susceptible populations of glial cells. Strategies for protecting glial cells exposed to ischemia can then be tested and may suggest new approaches to improve clinical outcomes in stroke patients.

#### **Near-field optical probes for nanoscale photonic devices**

*Ben Wilson, Senior, Electrical Engineering*

*Mary Gates Scholar*

*Mentor: Lih Y. Lin, Electrical Engineering*

Near-field optical probes that can deliver light efficiently to nano-scale photonic devices are critical in the research area of nano-photonics. In this project, we develop near-field optical probes using tapered optical fibers with metal coating. We investigate different experimental conditions to obtain the optimal optical probe shape. A theoretical model is developed and simulation is performed to design the optical probe shape for optimal optical coupling efficiency to the nano-photonics devices. The results are critical to the quantum dot integrated circuits (QDIC) project ongoing in the Photonics Research Group at the Electrical Engineering Department of the University of Washington. QDIC is a photonic analogy to electronic VLSI, with the advantages of much higher integration density capitalizing on nano-scale quantum dot components that require low operating power, and much higher speed using photons as information carriers. Quantum dots (QD) are semiconductor nano-crystals with size measured in a few nanometers and can provide optical gain when pumped optically or electrically. The QDIC consists of various nano-scale QD devices, such as waveguides, modulators, switches, optical transistors, all-optical logical gates, and high-sensitivity photodetectors. It serves as a nano-scale platform for future high-speed computing and information processing technologies. Since these QD devices are all in nanometer scale, efficient light coupling into the devices is very challenging, and the near-field optical probes developed in this

project are critical for successful testing and measurement of the QD devices. In this symposium, we will present the theoretical modeling, simulation result, design of the near-field optical probe, its fabrication, and the measurement of the QD devices using the developed optical probe.

### **Computational Geometry of Mayan Pyrite Mirrors**

*Eric Winges, Senior, Computer Science and Engineering*

*Mentor: Richard Ladner, Computer Science and Engineering*

Among the artifacts found in the ancient Mayan ruins were many pyrite mirrors. The mirrors are composed of several pieces that were intelligently fit together to form a complicated geometrical structure. While the structure appears to be a random planar embedding of vertices, edges, and faces, it is very similar to a graph structure called a Voronoi diagram. A Voronoi diagram is a mathematical concept that is used in many geometric algorithms, and the focus of the project is to analyze whether the Mayans knew about Voronoi diagrams, or used the idea in their thinking when they constructed the mirrors. Using several different methods, it can be approximated how close the mirrors are to being actual Voronoi diagrams, and how far the vertices would have to be moved to match the structure exactly. Finally, there are several possible procedures that the Mayans could have used to plan out the geometrical pattern on the mirrors, using the concept of the Voronoi diagram as a guideline.

### **Isolation of Homozygous *KRP* Knockout Mutants and Possible Gene Function**

*Jamie Wong, Senior, Biochemistry*

*Mentor: Keiko Torii, Biology*

In multi-cellular organisms, cell differentiation and proliferation is an intricately regulated process that is vital for proper organ development. The mammalian *p27kip1* gene is a cell-cycle inhibitor and therefore negatively regulates cell division. Mutations of the *p27kip1* gene in mice are implicated in cancer and hyperplasia (enlargement of organ size). We hypothesize that the seven homologs of *p27kip1* found in plants have a similar function. Null mutants in five of the seven *KRP* (KIP1-RELATED PROTEINS) genes in Arabidopsis have been isolated that are homologous to the mammalian cyclin kinase inhibitor *p27kip1* using TILLing lines and Salk T-DNA insertions. The other two knockout mutants will be created using RNAi. Using the null mutants identified, we have systematically crossed mutants creating double, triple, and even quadruple mutants. Thus far, no notable phenotype has been observed, hinting that some of all of the *KRP* genes are redundant in function.

### **The Role of Substantia Nigra Dopamine in Spatial Navigation**

*Emily Wood, Senior, Psychology*

*Mary Gates Scholar*

*Mentor: Sheri J.Y. Mizumori, Psychology*

*Mentor: Katy M. Gill, Psychology*

It is well-known that dopamine is an important neurotransmitter in the mesolimbic system in modulating motor and cognitive functions. Disruptions in these functions are characteristic of dopamine deficiencies in illnesses such as Parkinson's Disease. However, it is not well understood what role dopamine plays in learning and memory in normal individuals. The goal of this study was to characterize the firing properties of dopamine neurons recorded in the substantia nigra of Long Evans rats in a complex learning situation. Single-unit electrophysiological recordings were conducted simultaneous to animals completing a spatial working memory task on an eight-arm radial maze. The firing properties of these dopamine releasing neurons will be assessed for spatial or event related (i.e. consumption of reward) correlates. In relation to spatial navigation, two main afferent structures of dopamine synapses are the hippocampus and striatum and have been implicated in separate learning strategies. It is possible that dopamine neurons are encoding context- or reward-specific information to these structures that would affect the choice of learning strategy. In a task incorporating differential reward contingencies (high versus low quantity of reward) based on spatial location, alterations in the visual testing environment or the reward location may cause disruptions in the context sensitivity of dopamine neurons related to reward processing. In addition, movement correlates, such as neurons encoding directed movement and velocity, in the substantia nigra will be monitored for alterations in their firing patterns. In terms of behavioral changes, it is expected that animals will perseverate making choices based on previous high reward locations when the testing environment or the reward location is changed. Changing the spatial context should also cause an increase in working memory errors. Establishing some spatial selectivity in this cell population would support the cognitive impairments observed in Parkinson's Disease.

### **Further exploration in phylogeny of Prostantheroideae (Lamiaceae)**

*Yunke Wu, Junior, Biology*

*Mentor: Richard Olmstead, Biology*

The mint family, Lamiaceae, is well known for the aromatic properties of its leaves and stems. Prostantheroideae is a subfamily of Lamiaceae native to Australia. Based on results from a recent molecular phylogenetic study, Prostantheroideae has been divided into the two tribes, Chloantheae (9 genera, 99 species) and Westringeeae (7 genera, 141 species). Chloantheae is characterized by the presence of successive vascular cambia, while Westringeeae has a lobed ovary and racemose inflorescence. Sequences of the plastid gene *ndhF* were used previously to infer phylogenetic relationship in this subfamily. However, interge-

neric relationship within the two tribes was poorly resolved. In this study we will include additional sequence data from the chloroplast DNA region *trnL-F*, which includes the *trnL* intron and the intergenic spacer between *trnL* and *trnF*. The goal of this research is to use this additional dataset, combined with *ndhF* sequences, to reconstruct a robust phylogeny for Prostantheroideae. Total DNAs of 24 species that represent all the genera in this group were extracted from silica-gel-dried leaves or herbarium tissues. The *trnL-F* region was amplified by polymerase chain reaction (PCR), sequenced, and analyzed with PAUP\* to reconstruct the evolutionary relationship in the subfamily. The preliminary analyses strongly support the division of Prostantheroideae into two tribes. In addition, the combined datasets recover a well-resolved phylogeny, where analyses of the individual chloroplast DNA region alone failed.

### **Transgenic Mice Carrier**

*Cory Wyatt, Junior, Bioengineering*

*Mentor: Satoshi Minoshima, Radiology*

Transgenic mice, which are used widely in scientific research, often have compromised immune systems. These animals must reside in a very controlled environment, such as the specific pathogen-free facilities here at the UW. While many experiments can be done within these facilities, the mice must be removed for certain experiments such as PET or MRI scanning. However, once removed, the animals cannot be returned without quarantine, due to possible exposure to potential pathogens. My research involves designing and building a carrier that will transport these mice into and out of the facility for scanning while maintaining a secure-pathogen-free environment. This carrier will allow for anesthesia as well as injection of the animal with MRI contrast agents and PET radiotracers. The carrier will consist of a plastic, airtight box with glove ports connected to a small, cylindrical attachment. There will be two attachments, one for PET scanning and one for MRI scanning. Each attachment will have a small cradle to hold and restrain a mouse for injection and scanning, as well as hold the MRI receiving coil. Anesthesia will be pumped in at the end of the attachment, with excess air leaving through the other end of the box. The carrier will be only opened to pick up a mouse within the barrier facility or to be autoclaved. With all of the above features, this carrier will improve how researchers are able to perform valuable, longitudinal imaging research using transgenic mice. Researchers will be able to run repeated experiments on the same animal, without having to wait for quarantine (which can last for weeks) or lose the animal to disease. This will also lower the cost of research, since transgenic mice can cost upwards of \$600 each, making their loss substantial.

### **Population Relationship and Evolution of *Rhododendron macrophyllum***

*Zhenxiang Xi, Junior, Biology*

*Mentor: Benjamin Hall, Biology*

*Rhododendron macrophyllum* is one of the only three *Rhododendron* species that are native to the Pacific Northwest. It is distributed along the coast and the Cascade Range from northern California to southern British Columbia. The main goal of this research is to reveal the evolutionary relationships of *R. macrophyllum* populations based on the DNA sequence of intron 4 in *RBP2*, a nuclear gene. The *RBP2* gene encodes the second largest subunit of RNA polymerase II, the enzyme that synthesizes messenger RNA in eukaryotic cell nuclei. *RBP2* intron 4 is about 700 bp and evolves quickly, making it suitable for analyzing different populations within this species. Total DNA of about 90 individual plants from different populations of *R. macrophyllum* was extracted from fresh material, and then *RBP2* intron 4 was amplified by polymerase chain reaction (PCR) and sequenced by the automated sequencer. Gene cloning was used in cases of heterozygosity. Twenty individuals from 5 other *Rhododendron* species that are closely related to *R. macrophyllum* were also sequenced. The preliminary results indicate that four distinct clades of *R. macrophyllum* are found based on this gene. There is a non-uniform distribution of the four clades varying with altitude and coastal vs. interior location, and a high level of heterozygosity in all populations. This may either be due to the overdominance of this gene or to historic gene flow between different populations. Some homozygous populations may have resulted from founder effects during and after Quaternary glaciation. Sequence comparisons between a variant intron 4 haplotype and that in other species related to *R. macrophyllum* suggest a possible role for introgression and recombination in *R. macrophyllum* evolutionary history. This research provides molecular data that can relate the genetics of a natural population to geological and climactic history.

### **Video Processing Circuit for Vision Applications**

*Tian Xia, Junior, Electrical Engineering*

*Mary Gates Scholar*

*Mentor: Andy Crick, Electrical Engineering*

Computer video processing has applications ranging from object tracking to mobile robot navigation. A major obstacle in video processing is the massive amount of data that needs to be processed in real-time. It is difficult to transmit the data from the capturing device to the computer in real-time, and difficult to process the data on a general-purpose computer at the high frame rate required for the desired applications. We approached the problem by attempting to reduce the amount of data sent to the computer by performing simple yet computationally expensive processing in specialized hardware. We attempted to perform color filtering on incoming data by using the incoming data as an index into a translation table stored in the on-board memory. Through the translation process, we expected to significantly reduce the amount of data by removing noise and effects of shading. My work focused on designing, build-

ing and testing a digital video processing circuit that performs color filtering on the incoming data from a video camera and sending processed data to the computer. I designed and built the circuit using programmable logic devices (FPGAs) and other discrete electronic components on a printed circuit board. Currently, the device performs image request and retrieve commands from the computer while the processing development is on-going. We hope to use the design for further applications in mobile robotics.

### **3D Digital Flow Visualization of Convection Cells**

*Toru Yamasaki, Senior, Aeronautics and Astronautics*

*Mary Gates Scholar*

*Mentor: Dana Dabiri, Aeronautics and Astronautics*

My research aims to digitally capture fluid particles in 3D convective motion. This is somewhat analogous to taking a video clip of Miso particles circulating in a Miso Soup due to convection caused by temperature gradient within the soup. Taking a video clip is no harder than pressing a button on a camcorder, but the resulting clip would be 2D with no time history of position and velocity of each fluid particle. In order to capture the “3D” flow with “digital” data storage of particles’ position and velocity, we employ a lens-camera apparatus with a pin-holed mask, which has three pinholes at the vertices of an equilateral triangle with different color filter. This setup creates a separation of a particle image into an equilateral triangle when the particle is not on the focal plane. Measuring the magnitude of this separation at each time increment enables us to determine the position and velocity of the particle. The actual experiments are being undertaken with silver-coated fine particles within glycerin media to allow for better visibility and to decrease accumulation of particles on the surface due to surface tension. With the verification of these results with the theory of Rayleigh-Bernard convection cells, my research will provide a novel, inexpensive means of recording and visualizing a 3D fluid motion.

### **Synthesis of Functional Quantum Dots for Targeted Cell**

*Suhong Yu, Junior, Materials Science and Engineering*

*Mentor: Divakar Gupta, Bioengineering*

*Mentor: Chen Fang, Materials Science and Engineering*

*Mentor: Miqin Zhang, Materials Science and Engineering*

Quantum dots (QDs) or semiconductor nanoparticles are known for strongly size-dependent optical properties as a result of the quantum confinement. They have a wide range of applications in the biomedical field. In this study, the CdSe/CdS core/shell QDs are synthesized via a colloidal chemical method. In this process, organometallic precursor is synthesized with organic solvents and capping materials. The produced CdSe core has an average size of 3.5 nm and the first peak of UV absorption spectrum around

570 nm. The structures of the core/shell quantum dots are characterized by optical spectroscopy, TEM, XRD to verify their epitaxial growth. The photoluminescence quantum yield of the as-prepared CdSe/CdS core/shell nanocrystals are in the range of 20–40%. In addition, the surface of the core/shell QDs is modified with organic functional groups such as carboxylic, amine, etc, so that they can be further conjugated with a wide range of cell targeting agents. The success of the surface modification is confirmed by Fourier transform infrared spectroscopy (FTIR).

### **Feature-Based Classification for Mouse Eye Image Recognition**

*Jenny Yuen, Junior, Computer Science and Engineering*

*Mary Gates Scholar*

*Mentor: Linda G. Shapiro, Computer Science and Engineering*

Cataracts are a common illness and there are hypotheses associating them to other illnesses such as Alzheimer’s disease and diabetes. Because of the different effects of each type of cataract, the classification of cataracts is important in the medical field. In order to prove or disprove the previous hypotheses, current studies are performed in mice eyes with the intention of testing it in humans in future studies. Currently, a human expert performs the cataract classification. When the set of images to classify is small, this method does not appear problematic given an expert. However, when the number of categories is large as well as the number of images to classify, this becomes a tedious and inefficient task both in the aspect of time as well as accuracy. The solution we propose for this problem is to automate such classification. Given a set of images of known categories, we want to create a classifier that can tell, given another image whose category we do not know, the category to which it corresponds. Using information from the image such as color and texture, we can extract the eye-ring formation pattern and the appearance of certain regions of the eye. Using this information from each image, we can create a model for each category. However, an image contains not only the information we are interested in, but also noise due to illumination problems; the size and form of the eyes can vary depending on the particular mouse, and the characterization of each type is not obvious in some cases even to the experts. We have developed a classifier that uses the ring pattern of the eye plus the intensity distribution of a horizontal line through its center to determine the class of an image. Our initial results show that we have been able to characterize some of the categories very well, while others can still be confused. We are working to define other features to extend the classifier to these other classes. We expect to be able to create a program that performs an efficient classification for these mouse eye images.

### **Problematic Eating, Interpersonal Difficulties, and Emotion Regulation**

*Kristina Zeller, Senior, Psychology*  
*Deborah Brand, Senior, Psychology, Business Administration*  
*Sarah Barker, Senior, Psychology*  
*Mentor: Mary E. Larimer, Psychiatry and Behavioral Sciences*  
*Mentor: Ursula Whiteside, Psychology*

This research attempts to begin to elucidate the relationship between problematic eating, interpersonal difficulties, and emotion regulation. Our primary question is whether problematic eating is related to interpersonal difficulties. Research has previously established a link between these two behaviors. We would also like to know if this relationship is moderated by an individual's level of emotion coping abilities (i.e., emotion regulation skills). We will look at a sample of young adults, some of whom are engaging in problem eating behavior (i.e., binge eating, fasting, vomiting, or excessive exercise to prevent weight gain). We will attempt to identify whether an individual's degree of problematic eating is related to their degree of difficulties in interpersonal relationships. These correlations, if significant, may have implications for eating disorder treatment focus, as the role of social support can be critical for improvements and relapse prevention. Findings will help answer whether eating disorder treatment should include skills training in interpersonal effectiveness and emotion regulation.

### **Dining Out: A Homeless Perspective**

*Dana Zemel, Senior, Geography*  
*Mentor: Lucy Jarosz, Geography*

It is generally assumed that all services providing food to homeless people are good. However, it is rarely considered how homeless people actually feel about the services that are being provided for them. The goal of my research is to understand homeless people's different perceptions of the varied types of food provision programs in Seattle. My research will consider how different kinds of food programs are viewed by homeless people and which programs are seen as helpful and effective in constructing upward mobility, or simply providing the means for survival on the streets. I will use qualitative research methods like in-depth interviews with members of the homeless community to examine personal attitudes and opinions about experiences with food programs in Seattle. I will also conduct participant observations at different food provision sites like food banks, soup kitchens, and alternative programs to identify different environments that are created by different food programs.

### **The GPCR G2A is required for Efficient Chemotaxis of Immune Cells to Apoptotic Supernatants and Lysophosphatidylcholine**

*Kang Zhang, Senior, Microbiology*  
*Mary Gates Scholar*

*Mentor: Keith Elkon, Immunology*

Rapid phagocytosis of apoptotic cells is thought to protect against autoimmunity by removal of dying cells while they are still intact and by the generation of immunosuppressive cytokines. How phagocytes locate apoptotic cells is largely unknown. Recently, lysophosphatidylcholine (LPC) has been implicated in both the recruitment and the uptake phases of apoptotic cell clearance. Since G2A, a G protein-coupled receptor (GPCR) predominantly expressed in the immune system, was identified as the first receptor for LPC, we examined its role in the clearance of apoptotic cells. Here, we demonstrate that recognition and uptake of apoptotic cells are not altered in G2A deficient mice. However, expression of G2A is required for efficient chemotaxis of immune cells in response to LPC as well as to supernatants from apoptotic cells. Mice deficient in G2A had a striking reduction in chemotactic response to LPC both *in vitro* and *in vivo*, yet were fully responsive to other stimuli. These findings indicate that expression of G2A on macrophages and perhaps other phagocytic cells is required for chemotaxis to apoptotic cells. Failure to rapidly remove dying cells may contribute to the lupus-like phenotype observed in G2A deficient mice.

### **Effect of Light on Corn Chloroplast DNA Demise**

*Lei Zhao, Junior, Biology*  
*Mentor: Delene Oldenburg, Biology*  
*Mentor: Arnold Bendich, Biology*

Recently, many annual plants' chloroplast DNA was found to decrease significantly during the development process from proplastids in meristem tissue to mature chloroplasts in leaf tissue. Light, which is one of the key factors in controlling chloroplast development, probably plays an important role in regulating chloroplast DNA degradation. The main goal of this project is to confirm whether the loss of chloroplast DNA would be affected by different light conditions. In this experiment, several pots of corn seeds were started with the same media and water supply in both light and dark conditions. The dark grown plants were etiolated, while those in the light grew normally. On the 14th day, some of dark grown corn plants were transferred into light. On the 17th day, the transferred plants turned a normal green color in both leaf and stem. Chloroplasts were isolated from both dark grown and light grown corns on 14<sup>th</sup> and 17<sup>th</sup> day and from those transferred on the 17<sup>th</sup> day. To measure DNA content in chloroplasts, DAPI was used given the intensity of its blue-white fluorescent light will reflect the DNA content in a chloroplast. The DAPI-DNA contents could be easily judged by observation with a fluorescent microscope; however, for accuracy we used OpenLab image-capture software, which can quantitatively determine the light intensity and chloroplast area. As a result, I found that chloroplast DNA in dark grown corn remains at a very high level compared to those grown in light, but it decreases rapidly after being transferred into light. Consequently, my

findings confirm that light, as a key factor, controls the demise of corn chloroplast DNA.

### **Exploring the Molecular Basis of Hybrid Seed Failure in *Arabidopsis***

*Diana Zwerling, Senior, Biology*

*Mentor: Luca Comai, Biology*

Different plant species can be crossed to each other, but often the seeds from such crosses abort at an early stage of development. Seed abortion usually correlates with failure of the endosperm, the seed nutritive tissue. In our laboratory we use the closely related species *Arabidopsis thaliana* and *Arabidopsis arenosa* as a model to study how hybrid seed failure is mediated. This is a good system since *A. thaliana* is developmentally and genetically well characterized, and different genetic accessions of *A. thaliana* vary in their ability to produce viable seed when crossed to *A. arenosa*. My project is to investigate the role of the transcription factor *PHERES1* (*PHE1*) in the outcome of hybrid *Arabidopsis* crosses. *PHE1* is a maternally silent, paternally expressed promoter of endosperm growth. *PHE1* overexpression results in endosperm overproliferation and seed abortion, similar to the phenotype of the hybrid *Arabidopsis* cross. I showed that *PHE1* expression is elevated in developing hybrid seed. Surprisingly, the *PHE1* transcript is derived from the maternal *A. thaliana* allele. Therefore, silencing of the maternal *PHE1* allele is lost upon hybridization. My hypothesis is that regulation of the maternal *A. thaliana* *PHE1* allele is perturbed by hybridization, causing overexpression and subsequent seed abortion. I will test the effect of suppressing *PHE1* expression on the outcome of the hybrid *Arabidopsis* cross.

## STUDENTS TALK ABOUT THEIR RESEARCH

*“Thanks to research and the support of my mentors, I have developed valuable skills in analysis, research, and problem-solving while identifying a clearer idea of how to achieve my life goals.”*

*- Jennifer Lee, Junior, Neurobiology and International Studies*

*“Research trains and teaches you how to think outside the box. It teaches you how to convey models, come up with a hypothesis and alternative explanations, and how to troubleshoot yourself when running into problems. Research helps you really learn the material and apply your knowledge, instead of just memorizing facts from a textbook.”*

*- Jennifer Hsu, Senior, Biology*

*“Research has helped me connect more surely with my strengths and deal with my weaknesses more effectively; I have changed my majors to better reflect my strengths and passions with the help of my research experience. Research, unlike classroom education, allows me to apply my knowledge to things that feel more significant, and I become more goal-oriented as a result.”*

*- Athena Epilepsia, Sophomore, Pre-Arts and Sciences*

# **PRESENTATION SESSIONS**

## **PLEASE NOTE**

Abstracts are listed alphabetically by the presenter's last name, unless otherwise noted.

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## SESSION 1A

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**\*Note: Titles and Abstracts in order of presentation.**

### **AFRICANS IN THE WORLD: PERSPECTIVES, CHALLENGES, AND POSSIBILITIES**

*Session Moderator: Patrick Lynn Rivers, American Ethnic Studies*

*Session Assistant: Maiensy Sanchez, Senior, Anthropology*

**Mary Gates Hall Room 228**

#### **Refugees and Housing in the Greater Seattle Area**

*Kimberly Logan, Junior, Political Science, Geography  
Mary Gates Scholar*

*Mentor: Suzanne Withers, Geography*

Incoming refugees to the United States experience many difficulties unique to them and that also differ by various ethnic groups. While there are multiple concerns, one of the most immediate needs for refugees is obtaining and maintaining adequate housing for themselves and their family. It is this basic need that makes it one of the most valuable human commodities. Not having a place to live negatively impacts the rest of their attempts to qualify for and maintain jobs, continue with necessary schooling, and care for their families. This project primarily focused on the usage of social networks by incoming refugees to obtain housing. In order to best evaluate a large incoming culturally homogenous refugee population, we choose to evaluate the Somali Bantu. They will be of the largest groups, approximately 13,808 refugees, accepted for admittance into the US for FY 2004. The Bantu lack a pre-existing social support structure in the US and are therefore initially dependent on government assistance and will quickly find themselves self-sufficient in a short time period. Working with the International Rescue Committee (IRC), one of the largest refugee resettlement agencies in the world, we have gained access to 21 different Bantu families. This project has been looking at their intra-family dynamics, housing obstacles, and social development as well as the administrative, spatial, and cultural dimensions to acclimation. I am evaluating their housing situations after three, six, and nine-month periods as well as considering their progress in regards to the other social and cultural acclimation challenges. The expected outcome is that the Bantu refugees will gain large amounts of support within their own ethnic group but will experience their primary challenges as a result of cultural differences and aid agency distribution help will be limited by a lack of outside collaboration between individual agencies.

#### **Transnational and Cross-border Relations and the International Spread of Ethnic Conflict: State Failure and the 1996 Zairian Crisis in the Great Lakes Region**

#### **of Central Africa**

*Eric Mvukiyehe, Senior, Political Science*

*Mary Gates Scholar, McNair Scholar,*

*Presidential Scholar, Merage Scholar*

*Mentor: Jonathan Mercer, Political Science*

Ethnic conflict is not always confined to the state in which it originates. In many cases, it crosses national borders, drawing in outside actors or igniting new conflicts elsewhere. Why does ethnic conflict spread across international borders in some cases but not in others, and how does such spread occur? These are puzzles that I attempt to solve in this paper. Though these questions are not novel, the existing analyses and explanations remain in their preliminary stages. Most researchers take the possibility of ethnic conflict spreading across international borders for granted, without explaining the specific mechanisms and conditions under which it occurs. In this paper, I first, develop three explanations from the literature of international relations and other social science disciplines: the Refugee Flows and the Transnational Ethnic Ties explanations, both of which share a third, the Institutional Capacity. The Refugee Flows explanation argues that ethnic conflict spreads due to the migration of refugee populations. Refugees alter the social, economic and political arrangements in the host state (ethnic balance of power) when they include “refugee warriors” who threaten the security of both the home and the host states. The Transnational Ethnic Ties explanation claims that ethnic conflict spreads as a result of cross-border relationships that may be strong (affective) or weak (instrumental). According to this theory, ethnic conflict will not spread if transnational ties are weak, unless the conflict presents opportunistic objectives that appeal to co-ethnics. I, then, evaluate the merits of these explanations in reference to the 1996 Zairian crisis in which ethnic Tutsi Banyamulenge started a military insurgency against the government of Zaire (renamed Democratic Republic of Congo in 1997). My findings lend credence to both the Refugee Flows and the Weak (instrumental) Transnational Ethnic Ties explanations, but do not support the Strong (affective) Transnational Ethnic Ties explanation. In addition, my findings support the Institutional Capacity argument suggesting that ethnic conflict spreads only to states that are institutionally weak. This study therefore has relevant implications for both policy and research communities.

#### **Traces of Identity: Myth and Monument in Post-Apartheid South Africa**

*Steven Myers, Senior, Comparative History of Ideas*

*Mary Gates Scholar*

*Mentor: Doug Merrell, Comparative History of Ideas*

For more than a decade, the driving force behind the reshaping of South Africa has been the power of forgiveness. The ability of all sides to work for a better future without resorting to recrimination, retribution or vengeance has been

the essential ingredient in the reemergence of South Africa socially, economically and internationally. The primary catalyst for this transformation has been the Truth and Reconciliation Commission. This film project will examine the question of whether forgiveness and reconciliation have run their course as the engine of transformation in South Africa. Through the use of archival footage, first-person interviews and location filming, this project will attempt to address a number of questions that may hold the key to South Africa's future. Among them: Is the collective revelation of shared trauma, even on such a massive scale as the TRC, sufficient basis upon which to rebuild a nation? What of those who are unable to forgive or unwilling to be forgiven; how are they included in the new dispensation? What of the generation coming of age today, without any experience of apartheid and the struggle for freedom, who seem to be willing to accept the entrenched legacies of enforced racism as their "proper" condition? In addition, it will look at the pragmatic ways in which the "new South Africa" must now deliver on the promises implicit in the "miracle" of their bloodless revolution and overcome the lingering remnants of apartheid: de facto racial segregation, debilitating poverty, an enormous disparity between rich and poor (i.e., between white and black) in income, wealth and living conditions, and the spirit of apathy among South African youth. Finally, it will look at the decimation of an entire generation of South Africans by HIV and AIDS; a circumstance that threatens to undo all of the gains made in the past decade.

**The Racial Politics of Black Internationalism: Re-thinking Race in the Age of Empire**

*Simeon Man, Senior, History, American Ethnic Studies*  
*Mentor: Chandan Reddy, English*

My research project is a historical study of black internationalist politics during the World War I era, a period that spans roughly a decade between the war and the latter half of the 1920s. Considering a range of recent interpretations of black internationalism by various scholars, my study relocates the crucial beginning point in the study of black internationalism to what I have periodized as the age of empire. Specifically, I argue that this crucible of international wars, revolutions, and migrations enabled the generation of a new black radicalism, one in which black intellectuals within the U.S. began to theorize their lives beyond the nation-state and in relation to other "colored" worlds struggling against imperialism. Looking beyond U.S. borders, moreover, enabled a new understanding of race among U.S. blacks, one that departed from the dominant discourse of race at the time. Drawing upon a range of black periodicals such as *Crusader*, *Negro World*, and *Crisis*, as well as writings produced by black intellectuals such as W.E.B. Du Bois and Hubert Harrison, my research seeks to assert some broad claims regarding historians' approaches to both the study of black radicalism and U.S. history. First, my project hopes to show that the "internation-

al" had always remained important for black radical politics as a site of imagining new possibilities; and second, it suggests the need to approach U.S. history globally in order to both understand the ways in which peoples, ideas, and aspirations resist national boundaries and to critique notions of American exceptionalism.

**The School Fee and a Child's Rights in South Africa**

*Julia Walker, Senior, Law, Society, and Justice, Comparative History of Ideas*

*Mary Gates Scholar*

*Mentor: Bruce Kochis, Interdisciplinary Arts and Sciences, Human Rights Education and Research Network*

*Mentor: Angelina Godoy, Law, Society, and Justice*

In contemporary South Africa a child's right to education and dignity is endangered by the practice of paying a school fee. In South Africa, a country where fifty percent of the people are below the poverty line, all children must pay directly for public education. This paper elucidates some of the issues the author witnessed while working in a South African public school, surrounding the school fee and a child's human rights. The very existence of the school fee is a violation of the child's right to education, and leads to violations against a child's human right to dignity. The child's right to education, with or without the ability to pay a school fee, is repeatedly protected in domestic as well as international law. The school fee, which has a long history in South Africa, is supposed to be mitigated by an exemption system as now stipulated in the South African Schools Act, yet the exemption system fails miserably to protect those children who cannot pay their fees. The negative effects on schoolchildren of the school fee is not evenly distributed and disproportionately affects the most vulnerable of South Africa's families, such as child-headed homes and families suffering from HIV/AIDS. The school fee also maintains segregation and creates vast inequalities between public schools. Besides being denied entrance to school, there are also additional psychological effects of embarrassment and humiliation that children who are unable to afford the school fee must face. There are various suggestions and solutions to the problems that the school fee inherently presents, as discussed by scholars and South Africa's own "Plan of Action [for education] 2003." There are also suggestions of how South Africa can progressively eliminate the school fee entirely, so that access to public education is free and available to all, regardless of financial capabilities.

**Politics of Punishment: The Death Penalty Debate in South Africa**

*Alexis Wheeler, Senior, Political Science, History*

*Mary Gates Scholar, EIP Presidential Scholar*

*Mentor: Lynn Thomas, History*

In 1995, the South African Constitutional Court unani-

mously ruled to abolish capital punishment despite significant public support for the practice. During the past decade, the demand for reinstatement of the death penalty has not only been strong, but has steadily increased across all racial and economic strata of the population. However, despite the overall rise in support for capital punishment, different racial and economic groups within the population have expressed differing levels of support, with well-off whites consistently being the most supportive of the death penalty and poor blacks the least so. My research seeks to explain both the overall rise in public support for capital punishment, particularly among blacks, and the differing levels of support indicated by blacks and whites, rich and poor. In order to probe these questions, several crime victim surveys and a wide variety of literature on violent crime and the death penalty in South Africa are being analyzed. Content and frame analysis are also being used to look at representations of crime in three major South African newspapers during the years 1995, 1998, 2001, and 2004. During the final phase of the project, media coverage of three or four highly publicized crime stories will be compared and analyzed. This project is still in progress and has not yet yielded definitive results.

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## SESSION 1B

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### ALGAE, PLANTS AND THE FRUITS OF RESEARCH

*Session Moderator: Billie Swalla, Biology*

*Session Assistant: Christopher Weeg, Senior, Comparative Literature*

**Mary Gates Hall Room 238**

#### **Exploring the pH Gradient in *Acetabularia acetabulum***

*Nikki Dejbod, Senior, Neurobiology, Biochemistry*

*Mentor: Dina Mandoli, Biology*

*Acetabularia acetabulum* is a giant marine green alga that is a classic unicellular model for studying cellular polarity. *Acetabularia* contains a large central vacuole with a dynamic pH gradient ranging from a pH of 3.5 in the apex to 8.3 in rhizoid, signifying a polar organ. We would like to identify the protein(s) responsible for the establishment and maintenance of this pH gradient. It has been suggested the physical distribution of either vacuolar H<sup>+</sup>ATPase (V-H<sup>+</sup>ATPase) or pyrophosphatase (PPase), both transmembrane proton pumps, may play a role in the localization of the gradient (Brauer *et al.*, 1997, *Plant Physiology*, 113: 809-816). If the pH gradient depends on proton pump density within the vacuolar membrane, then we expect more of these proteins in the apex than the rhizoid region. Furthermore, if there is subcellular localization of these proteins, then high levels of transcription and translation of mRNAs encoding those proteins may be present in those regions. To begin to test our hypothesis, oligonucleotide

primers for use in polymerase chain reaction (PCR) were created to amplify cDNA sequences of V-H<sup>+</sup>ATPase and PPase. The products were isolated, cloned, and the identities verified by sequence analysis. These products will be used to probe a Northern blot designed to characterize regional transcript levels of these two proton pumps: RNAs will be prepared from various regions of the alga (apex, upper and lower stalk, and rhizoid). Since *Acetabularia* presumably devotes significant resources to establish this ramified polar central vacuole, we believe that insights from this study will greatly contribute to understanding the necessity of this polarity, along with defining underlying mechanisms of pH regulation in *Acetabularia* and other relevant species.

#### **Failure of Nuclear Migration Induced by Low Chronic Doses of Arsenic**

*Vidhi Tyagi, Junior, Physiology*

*Mary Gates Scholar*

*Mentor: Dina Mandoli, Biology*

Arsenic is a toxic metalloid found in many natural substances throughout various environments. Both plants and animals, including humans, readily take up arsenic. Understanding arsenic biology is crucial to developing treatments for its severe health effects: exposure to chronic low doses of arsenic induces cancer and various vascular diseases in millions worldwide. *Acetabularia acetabulum*, a single-celled green alga, was selected as our model organism because it has distinct responses to arsenic at both high and low doses. High does cause death within an hour (N. Dejbod and DF Mandoli, submitted). Exposure to low chronic doses of arsenic results in alteration of the position of reproduction in *Acetabularia* possibly by inducing a failure of nuclear migration along the actin cytoskeleton. Induction of this phenotype depends on both cell age and duration of exposure. We are now determining if the appearance of the phenotype is also dependent on arsenical and concentration of arsenical. To determine the mechanism by which arsenic disrupts normal cell functions we will try to mimic arsenic phenotypes with actin inhibitors. These studies are the first steps in determining the genetic pathway by which arsenic induces a failure of nuclear migration.

#### **Putative case of Lateral Gene Transfer in *Acetabularia acetabulum***

*Bharti Sharma, Junior, Biology*

*Mary Gates Scholar*

*Mentor: Dina Mandoli, Biology*

The endosymbiotic theory explains the evolution of eukaryotic organelles that carry their own genome and replicate themselves independently from the host. However, many cases are known where organellar genes have transferred to the host's nuclear genome, a process called Lateral Gene Transfer. The goal of this project is to determine whether

a particular gene, *tufA*, which encodes a chloroplast specific protein, was transferred from the chloroplast to the nucleus in the giant, unicellular, green alga, *Acetabularia acetabulum*. *A. acetabulum* uses a non-canonical nuclear genetic code; we will use this as a tool to determine whether *tufA* resides in the nucleus. This “altered” nuclear genetic code’s signature is the substitution of an amino acid, glutamine for TAG and TAA that normally are stop codons. When sequenced, a nuclear signature (TAG coding for glutamine) was found close to the 3’ end of this gene. However, this alone is not definitive evidence for *tufA*’s location in the nucleus because its close proximity to the 3’ end suggested that it could be part of the 3’ untranslated region. To better understand codon usage in this gene, we must examine the full-length sequence. Currently, I’m employing a molecular technique known as 5’ Rapid Amplification of cDNA Ends (5’RACE) to sequence the unknown 5’ end of the gene. We will analyze this sequence for signatures of the nuclear genetic code i.e. glutamine substitutions for TAA and TAG. The *tufA* encoded protein is essential for the survival of chloroplasts. Thus, if *tufA* was laterally transferred from the chloroplast to the nucleus, then further analysis of the 5’ end could reveal target sequences responsible for shipping the *tufA* encoded protein to the chloroplast. 5’ end target sequences are common in nuclear genes coding for chloroplast specific proteins.

#### **Yeast communities on fruits from the Olympic Peninsula, W.A.**

*Tyler Bourret, Senior, Zoology*

*Mentor: Joe Ammirati, Biology*

*Mentor: Toby Bradshaw, Biology*

Yeast ecology is a sparsely studied field, and this project aimed to begin research on a relatively unknown population. Yeast isolates were obtained from fruits collected at three sites on the north, west and east facing edges of the Olympic Peninsula, Washington state. Fruits of *Symphoricarpos albus*, *Vaccinium ovatum*, *V. parvifolium*, and *Rosa gymnocarpa* were collected in November, 2004. In order to determine yeast community structure, three berries were collected from three individual plants for each species of shrub. Fruits were placed in 10 ml of water, vortexed for approximately 20 seconds, and 1 ml aliquots were plated on malt-extract yeast-extract agar. Approximately 200 isolates of yeast were obtained from 77 berries. Species identification and phylogenetic analysis of yeast isolates is being performed using the internal transcribed spacer (ITS) regions of the yeasts’ ribosomal DNA. This project will provide basic information on the yeast community of the Olympic Peninsula, and may also lend insight into the factors influencing community composition, such as site location and host-specificity.

#### **Fitness tradeoffs of fruit secondary metabolite production: the costs of capsaicin**

*Leslie McGinnis, Senior, Biology*

*Mary Gates Scholar*

*Mentor: Joshua Tewksbury, Biology*

Plant secondary metabolites, chemicals with no primary physiological function, have been studied primarily as mediators in plant-herbivore and plant-pollinator interactions. Little is known, however, about the ecological and evolutionary significance of secondary metabolites in fruit. Chili peppers (*Capsicum* spp.) provide an ideal system in which to investigate the significance of these chemicals. *Capsicum chacoense*, a chili from the Chaco region of Bolivia, is polymorphic for pungency with some plants that are hot and others that are not hot at all. This system allows us to investigate the costs and benefits of capsaicin production. We examined physical and physiological production costs of capsaicin by growing pungent and non-pungent plants from four populations in a controlled greenhouse experiment. We sought to determine if there is a cost to capsaicin production, where that cost is manifested in the plant, and if those costs vary between populations. Previous work examining fitness tradeoffs of plant defensive compounds has often failed to test production costs over abiotic resource gradients, such as water availability. We randomly assigned plants as stressed or well watered and gave them a small amount of water every three days or a copious supply each day. We measured floral abortion rates, total fruit production, fruit morphometrics (length, width, and weight), average seed number per fruit, average seed weight, capsaicin content, and plant biomass.

#### **Epigenetic Regulation of Seed Development in *Arabidopsis***

*Sarah Dobrozi, Senior, Biology*

*Mentor: Brian Dilkes, Biology*

During sexual reproduction, there is a distinct asymmetry in the maternal and paternal contribution to the offspring. One way in which this is manifest is the differential expression of genes from the maternal and paternal chromosomes. Gene expression is regulated in many ways, one of which is the placement of methyl groups on cytosine nucleotides and histone proteins. These methyl groups target particular genes for silencing and are used to mark regions of the genome for repression. Three repressive marks are known, DNA methylation at CG dinucleotides, DNA methylation at CNG trinucleotides, and methylation of the histone H3 protein at lysine 9 (H3K9). CG methylation has been well characterized in the plant species *Arabidopsis*, and is known to have an effect on the process of seed development. Methylation patterns on the maternal chromosome differ from those on the paternal chromosome, leading to parent-specific expression or repression of certain genes required for normal seed development. My research focuses on the other two repressive marks, CNG and H3K9 methylation. I am investigating the effects of these methylation marks on seed development by using mutant plants that lack methylation to determine if these marks have the

same effect as CG methylation. I have performed a series of crosses using mutants defective in CNG and H3K9 methylation and have collected, scored, and analyzed the resultant seeds to determine the effects of the mutants on both seed development and on seed abortion rate. My results show that the three epigenetic pathways do not operate in the same way. Seed size is affected by CNG and H3K9 methylation in the maternal parent, and seed abortion rate is affected by CNG and H3K9 methylation in maternal excess crosses. This provides a more complete understanding of the process by which epigenetic regulation of gene expression controls seed development.

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## SESSION 1C

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### BIOENGINEERING APPROACHES TO DRUG DELIVERY AND BIOMOLECULAR MOTOR ACTIVATION

*Session Moderator: Henry Hess, Bioengineering*  
*Session Assistant: Jade Anderson, Student Services*  
*Assistant, Bioengineering*  
**Mary Gates Hall Room 234**

#### “Smart” PDSA Polymers for Enhanced Delivery of Therapeutic siRNA

*Jennifer James, Senior, Bioengineering*  
*Mary Gates Scholar*  
*Mentor: Allan Hoffman, Bioengineering*  
*Mentor: Patrick Stayton, Bioengineering*

Advances in biotherapeutics have produced a variety of macromolecules for treatment of different diseases. Cellular uptake of these macromolecules occurs through endocytosis resulting in their endosomal entrapment and ultimately lysosomal degradation. The objective of this research is to increase the cytoplasmic delivery of therapeutic siRNA using “smart” PDSA polymeric carriers. “Smart” polymeric carriers are characterized by their unique ability to sense the changes in environmental pH where they switch from a stealth-like hydrophilic conformation at physiologic pH to a hydrophobic one in response to endosomal pH gradients. The poly (PAA-co-BA-co-PDSA) terpolymer was chosen as a smart polymeric carrier. The poly(PAA-co-BA-co-PDSA)-Polylysine conjugate successfully complexed therapeutic siRNA. The B cell line, FL18 cells, were treated with free and polymer complexed siRNA. siRNA therapy was used to knock down BCL-2 protein expression. BCL-2 is an apoptosis blocker for FL18 cells. RNA was isolated and RT-PCR was run to determine relative protein expression. Free siRNA did not affect protein production. siRNA at a concentration of 100nM was shown to decrease protein expression by nearly half that of the positive control. In addition, the poly (PAA-co-BA-co-PDSA) polymeric carrier exhibited low cytotoxicity examined using the LDH

leakage assay.

#### Independent Control of Hydrophobicity and Crosslink Density in Hyaluronic Acid Hydrogels for Drug Delivery

*Kenneth Liu, Senior, Bioengineering, Applied and Computational Mathematical Sciences*  
*Howard Hughes Scholar*

*Mentor: Jason Hwang, Bioengineering*  
*Mentor: Allan Hoffman, Bioengineering*  
*Mentor: Patrick Stayton, Bioengineering*

Hyaluronic acid (HA) is a linear, naturally-occurring polysaccharide made up of repeating disaccharide units of  $\beta$ -1,4-glucuronic acid linked to  $\beta$ -1,3-N-acetyl glucosamine. Its carboxyl groups have been esterified with benzyl alcohol and the product has been used commercially under the name HYAFF™ for various wound healing, tissue engineering, and biomaterials applications. The increase in hydrophobicity by gradually converting the carboxyl group of glucuronic acid to the benzyl ester gradually converts the extremely hydrophilic HA into an insoluble polymer at physiological conditions. Many investigators have used insoluble HYAFF™ scaffolds for tissue engineering and drug delivery applications because the unmodified HA dissolves too rapidly. Our group is interested in crosslinking a benzyl-modified HA to form bioresorbable hydrogels. Modifying the hydroxyl groups of the HA backbone to form methacryloyl ester groups provides reactive vinyl groups through which crosslinking can be accomplished. Preliminary results demonstrate our ability to independently control the hydrophilic-hydrophobic character of HA by separately varying the extent of benzyl modification and crosslinking. We hypothesize that the increased hydrophobicity and crosslink density with benzyl and methacryloyl modifications will reduce water uptake in the interior of the hydrogel. The effect of our modifications on swelling of the hydrogel should permit control of the hydrolytic and/or enzymatic degradation rates of the hydrogel. Current work includes crosslinking the methacryloyl modified benzyl ester of HA to form hydrogels, and characterizing the mechanical and degradative properties of these hydrogels. Our ultimate goal is to have independent control over hydrophobicity and crosslink density in order to tune the physical properties and degradation rate of the hydrogel for applications in controlled release and tissue engineering.

#### The development of pH-sensitive, poly (styrene-alt-maleic anhydride) copolymers for intracellular delivery

*Christopher Pirie, Junior, Bioengineering*  
*Mary Gates Scholar*  
*Mentor: Allan Hoffman, Bioengineering*

Many promising therapeutics are limited by the challenges

of intracellular delivery, including protein vaccines and genetic therapies, as these biomolecules must reach the cytoplasm in order to be effective. Biomolecules enter the cell by endocytosis, but remain trapped in the endocytotic pathway where they encounter acidic conditions and degradative lysosomal enzymes. These conditions can damage or destroy a potential therapeutic. In the past, smart polymers have been developed which enhance intracellular delivery. These polymers are biologically inactive at physiological pH, but become membrane disruptive in the acidic environment of the endosome. We have developed a new class of pH sensitive smart polymers based on alternating copolymers of styrene and maleic anhydride. These polymers are derivatives of the poly (styrene-alt-maleic anhydride) (pSMA) backbone based on modification by propyl, butyl, and pentylamine. Hemolysis assays were used to measure the membrane disruption of the polymers. This disruption was controlled by changing the total modification and type of modifier. We find that increasing the hydrophobicity of the polymer through increased modification and the use of a longer modifier chain resulted in greater hemolysis. Because of this polymer's easy of modification by nucleophilic attack of the anhydride group, it is an ideal candidate for drug conjugation and delivery.

#### **Control of Molecular Shuttles by Localized Fuel Delivery**

*Robert Tucker, Senior, Chemical Engineering*

*Mary Gates Scholar*

*Mentor: Henry Hess, Bioengineering*

*Mentor: Viola Vogel, Bioengineering*

Nanotechnology is the science of building devices at the molecular and atomic level. It is an interdisciplinary field joining biology, physics, and engineering. In nanotechnology (1 nm =  $10^{-9}$  meters) new engineering principles, such as self-assembly, are utilized. Currently, our ability to move objects with high precision is very limited at this scale. We are developing a nanoscale transport system, called a "Molecular Shuttle" which is capable of moving single molecules and nanoscale objects. The user of this Molecular Shuttle must be able to control three basic elements characteristic of any transport system including: the velocity of the shuttle, selectively loading and unloading cargo, and defining the path along which the shuttle moves. Our shuttles are assembled from biological and synthetic parts. The most important biological parts are motor proteins, which hydrolyze ATP to create the mechanical forces moving the shuttles. My project since January 2004 has been the investigation of a means to control the speed and movement of the molecular shuttles. As with many biological systems, the shuttles use ATP as a chemical power source. In my research, the ATP is "caged" and cannot be utilized by the shuttles until I release it from the cage by breaking a chemical bond with UV light. The primary benefit of using caged-ATP is that I can control which molecu-

lar shuttles move by directly controlling their fuel supply via precise UV illumination of an area. The poster presented discusses the design of the molecular shuttle, the method of speed control, and the results of the research including future improvements.

#### **The role of the cardiac myosin binding protein-C C0C2 and C1C2 subfragments on heavy meromyosin and actomyosin ATPase activity.**

*Matt Uhlman, Senior, Bioengineering*

*Mary Gates Scholar*

*Mentor: Samantha Harris, Bioengineering*

Myocardial contractions occur as a result of repetitive interactions between contractile proteins of the sarcomere. Actin and myosin are the major contractile proteins but a number of sarcomeric proteins exist and recent research has shown that mutations in these proteins are correlated with diseased heart conditions. One such protein is Myosin binding Protein C (MyBP-C) or C-protein, a 150 kDa, 10 or 11-segment modular protein found in cardiac (11 segments) and skeletal (10 segments) muscle. The function of the protein is not well understood, but an absence of the protein has been shown to cause hypertrophic cardiomyopathy in mice<sup>1</sup> and studies of familial hypertrophic cardiomyopathy (FHC), a heart disease characterized by left ventricular hypertrophy and which affects 1 in 500 people worldwide, have shown a 42% correlation with c-protein mutations<sup>2</sup>. Currently limited treatment options are available and none reduce the risk of sudden death syndrome that affects up to 10 percent of those with FHC and is the most common cause of sudden death in young athletes. Disease conditions may occur as a result of truncations of the protein<sup>3</sup>. These truncations may in turn alter ATPase activity. The N-terminal portion of C-protein is my area of study and is an area where MyBP-C binds to myosin<sup>4</sup> and may bind to actin<sup>5,6</sup>. The C0 subfragment is unique to the cardiac isoform of C-protein and may modify the peptides functionality in some way. The subfragments have been isolated and I am currently running ATPase assays to determine the effect of the C0C2 and C1C2 subfragments on actomyosin and HMM ATPase activity. Preliminary results have shown the C1C2 subfragment inhibits actomyosin ATPase activity. Next, is to determine if the C0 subfragment modifies this ATPase activity in any way. Finally, experiments to determine the effects of phosphorylation of the peptide will be conducted.

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## SESSION 1D

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### CELLULAR AND ORGANISMIC BIOLOGY

*Session Moderator: Mark Cooper, Biology*

*Session Assistant: Katya Yefimova, Freshman, Comparative Literature*

**Mary Gates Hall Room 288**

#### **Camera trapping for ocelots (*Leopardus pardalis*) in Rio Hondo, Bolivia**

*Joe Figel, Senior, General Studies*

*Mentor: Samuel K. Wasser, Biology*

Estimating population size of endangered species is one of the most critical responsibilities of conservation biologists. It is impossible to determine the effectiveness of management plans without having information on how the target animal responds to events such as habitat conversion or prey base recovery. Camera trapping is a non-invasive research technique that has the potential to obtain data on population size, distribution, abundance and the presence or absence of a species in a given area. The cameras are equipped with an infrared sensor that detects the body heat of the animal once it passes through the invisible beam. This in turn, triggers the flash of the camera. Every ocelot has a unique coat pattern, enabling the identification of each individual that has been photo 'captured.' This project, carried out in conduction with the Wildlife Conservation Society (WCS) represents the first field study using camera traps in a tropical rain forest habitat. It is our hope that the data collected from this project can be applied to other studies on wide-ranging, individually marked threatened species such as jaguar (*Panthera onca*) and tiger (*Panthera tigris*).

#### **Evolutionary Analysis of Human Olfactory Receptor Genes**

*Jessie Hsu, Senior, Biochemistry, Applied and Computational Mathematics*

*Mentor: Barbara Trask, Genome Sciences*

Olfactory receptor (OR) genes have evolved into the largest gene family in the human genome through repeated

duplication and diversification events. The human OR repertoire is a dynamically changing set of genes that currently consists of more than 1000 OR genes, the majority of which are pseudogenes. We are able to describe the selective pressures that underlie the extensive allelic diversity found in human OR genes by statistically analyzing sequence variation in ORs across several different ancestral and modern populations. We first selected five mouse ORs that bind to known ligands and identified their orthologous human receptors. Additionally, we chose two human paralogs and one pseudogene to be included in the study for comparison. For each of these human ORs, we amplified the OR genes from the genomic DNA of 53 individuals (106 chromosomes) and sequenced the protein-coding exon. We then used computational methods to identify single nucleotide polymorphisms (SNPs). We found that 34/47 SNPs identified from the seven intact genes are non-synonymous, i.e., they change the amino acid sequence of the OR. This SNP ratio gives an overall dN:dS value of approximately 0.9, indicative of relaxed purifying selection. However, the values for individual genes vary widely between purifying and positive selection. Several statistical tests that detect selection based on allelic diversity, including Tajima's D, Fu and Li's D and F, and Fay and Wu's H test, further suggest that some of the OR genes have undergone selective sweeps, which can be consistent with positive selection. The results from our study will allow us to informatively select allelic variants for functional testing to determine if evolutionary pressures are causing ORs to change in their ability to recognize and distinguish between various odorants.

#### **Regulation of mechanical power transmission in moth flight**

*Amy Paul, Senior, Biology*

*Mary Gates Scholar*

*Mentor: Michael Tu, Biology*

Understanding the interactions between neural and mechanical systems is key to understanding the control of animal movement. We are interested in the regulation of power generation by muscles during locomotion. Using the hawkmoth *Manduca sexta* as a model, we are investigating how mechanical power generated by the principle flight muscles is modulated by smaller, steering muscles. Hawkmoths engage in a stereotypical pre-flight warm-up behavior. Warm-up appears as low-amplitude wing fluttering, caused by almost simultaneous contraction of the wing elevator and depressor muscles. Just before taking flight, the moths shift from low to high amplitude wing strokes, and the pattern of elevator and depressor muscle activity shifts from nearly synchronous to alternating. Studies on flies have shown that at least one steering muscle can act as a "clutch" to regulate the transmission of mechanical power from the principle flight muscles to the wings. The onset of steering muscle activity corresponds to a dramatic increase in wing stroke amplitude. In moths, the anatomical arrangement of

the steering muscles also suggests that they can regulate the transmission of mechanical power to the wings. We are investigating how the subalar steering muscles regulate mechanical power transmission in moths. Using an array of extracellular electrodes, we monitor the firing pattern of the thoracic muscles during the transition from warm-up to flight. We are recording from the wing elevators, the wing depressors, and the subalar steering muscles. We are using a video camera to record wing motions and we subsequently match wing movement to the muscle firing patterns. Simultaneous recordings of wing motion and motor pattern will allow us to assess the extent to which the wing motion depends directly on the firing pattern of the elevator and depressor muscles, and the extent to which wing motion can be regulated by steering muscle activity.

### **Habitat Use and Ranging Behavior of *Callimico goeldii***

*Sarah Sterr, Senior, Anthropology, Philosophy*

*Mentor: Leila Porter, Anthropology*

One group of *Callimico goeldii* was studied from September 2002 – August 2003 in northwestern Bolivia. Data were collected using focal animal sampling at five-minute intervals, with observations balanced among group members. The *C. goeldii* diet consisted primarily of fungi (38% of feeding records), fruit (31%), arthropods (14%), and exudates (14%). Fungi and exudates were consumed more in the dry season than the wet season while fruits were consumed more in the wet season than the dry season. Secondary forests were the habitat used most frequently throughout the year (50% of observation records), but the group also used primary forest with dense understory (30%) and bamboo (17%) habitats. The group's home range was 85 hectares (ha). On average *C. goeldii* used 38.6 ha per month (range 27-55 ha) and day range averaged 1.1 km (range .8-1.4 km). Monthly average day ranges increased as frugivory declined, however monthly home range sizes showed no correlation with diet. Encounters with non-group members (one adult male) occurred only twice during the year. The *C. goeldii* group's home range is larger than those of many other callitrichines, whereas its day range is not. This contrast between large home range and small day range results from the group's occasional and seasonal use of a large area, but frequent and continual use of a small core area of approximately 40 ha. We propose that this ranging pattern of *C. goeldii* relates to two factors: 1) its seasonal shift in diet that requires it to forage in a variety of habitats; and 2) its lack of territorial behavior which eliminates the need to patrol boundaries as part of its daily movement.

### **Utilizing *galk* Homologous Recombineering to identify the role of CTCF, a ubiquitously expressed protein, for escape gene status of *Jarid1c* on the Inactive X Chromosome**

*Heather Vendettuoli, Senior, Biology, Public Health*

*Mary Gates Scholar*

*Mentor: Christine Disteché, Pathology*

In sexually dimorphic mammals, females are characteristically defined as having two X chromosomes, while males have one X and one Y chromosome. To ensure adequate gene dosage between the sexes, during early embryogenesis one of the female's entire X chromosomes is randomly inactivated. This results in transcriptional silencing of the entire inactive X, and inhibits the expression of those genes present. However, some genes located on the inactive X escape silencing. One of these escape genes is *Jarid1c*. The ability to escape from X inactivation poses the question: "How do genes that escape manage to remain expressed while embedded within silenced heterochromatin?" Our laboratory has shown that there are chromatin boundary elements between escape domains and inactivated domains allowing for the genes to escape the inactivation. The chromatin boundary element that was found between *Jarid1c* and its inactivated neighbor binds CTCF. If CTCF acts as a boundary element between the expressed and unexpressed genes on the X chromosome, one would predict that mutation of the CTCF binding sites would result in silencing *Jarid1c*. The goal of my research project is to examine the role of CTCF *in vivo*. Using BACs containing *Jarid1c*, I will then proceed to mutate the CTCF binding regions by *galk* homologous recombineering methods. This process will be repeated three times, as there are three CTCF binding sites. Successful mutations will be analyzed via Polymerase Chain Reaction and sequencing. After insertion into mouse early stem cells, the resultant transgenic mouse will be bred and analyzed to determine the role of CTCF for escape status of *Jarid1c*. Ultimately, I will determine whether mutations of the CTCF binding sites will result in a loss of *Jarid1c* gene expression from the inactive X. This may have implications for future research in epigenetics and their role in various diseases and cancers.

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## **SESSION 1E**

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### **CONFLICT IN CONTEMPORARY INTERNATIONAL RELATIONS**

*Session Moderator: Joel Migdal, International Studies*

*Session Assistant: Clay Schwenn, Academic Counselor,*

*Undergraduate Education*

**Mary Gates Hall Room 271**

### **Japanese Military Normalization and the US-Japan Alliance in the 21<sup>st</sup> Century**

*Lauren Bernsten, Senior, International Studies*

*Jacob Brown, Junior, International Studies*

*Guido Campana, Senior, International Studies*

*Maggie Cho, Senior, International Studies*

*Devin Cole, Senior, International Studies*

*Pat Hauge, Senior, International Studies*

*Nicole Lux, Senior International Studies*

*Heather Macdonald, Senior, International Studies*  
*Kiyomi Mathews, Junior, International Studies*  
*Brian McCool, Senior, International Studies*  
*Travis Oberlander, Senior, International Studies*  
*Fernanda Parra, Senior, International Studies*  
*Raymond Proper, Senior, International Studies*  
*Megan Reining, Senior, International Studies*  
*Stephanie Smith, Senior, International Studies*  
*Jessica Vogel, Senior, International Studies*  
*Mentor: Robert Pekkanen, International Studies*

Since its establishment at the signing of the 1951 Security Treaty Between the United States and Japan, the US-Japan alliance has provided the cornerstone of US strategic involvement in the Asia-Pacific region. In the post-war years, Japan's contribution to the alliance was to provide bases for forward US military presence into the region, in exchange for an American security guarantee and protection under the US nuclear umbrella. Japan, however, was legally prevented from assisting its US ally in war, due to its Article 9 constitutional prohibition on collective self-defense. This prohibition persisted despite the protests of some members of Japan's ruling Liberal Democratic Party (LDP). While this asymmetrical security relationship proved functional during the Cold War, the collapse of the USSR in 1991 undermined the working paradigm of the US-Japan alliance. Japan's failure to contribute militarily to the United States and United Nations coalition forces in the 1991 Gulf War revealed fundamental tensions in the alliance, and catalyzed a process in Japanese domestic politics. Responding to further developments in Japan's geo-strategic landscape throughout the 1990s (including the rising threats of China and North Korea), this process has combined with a demographic process of generational change to produce conditions in Japan under which the revision of Japan's 'Pacifist Constitution' must be considered as a nearing possibility. Such a revision would have great implications for increased US-Japanese security cooperation and would be a major boon for the implementation of US security goals in the post-September 11<sup>th</sup> world. This report will present the case that Japan is nearing the revision of its long-held 'Pacifist Constitution' and offer policy recommendations that the United States should pursue in order to 1) expedite and guide the revision process, 2) strengthen the US-Japan alliance, post-revision, and 3) ease regional tensions in Asia-Pacific.

### **Ghosts that bear arms: Nostalgia and Russian military involvement in the former Soviet states**

*Candace Faber, Senior, Political Science, Russian, Eastern European, and Central Asian Studies*  
*Mentor: Stephen Hanson, Russian, Political Science*

A surface examination of Russian military intervention in domestic conflicts in the two former Soviet states of Georgia and Tajikistan yields perplexing results: why does the new home of the former great power support seemingly

conflicting agendas in states that are otherwise relatively similar? In this thesis, I argue that nostalgia for the Soviet order is the driving force behind the conflict-based agreements, both tacit and explicit, between Russia and parties from formerly Soviet nations. The Soviet Union has fallen, and few political actors seek to restore it, but the ghosts of a system that permeated political, military, economic, educational, cultural, and ideological structures do not yet rest in peace. As the persistent conflicts in Georgia and Tajikistan demonstrate, attempts to change those structures will continue to meet resistance until reconciliation with the past brings about a more consistent, more logical, and hopefully, more peaceful political order. I begin with a brief overview of the cases and then review the three major theories on Russian post-Soviet military intervention, critiquing each in turn. I then review each case in-depth, searching not only the reasoning for intervention on Russia's part, but paying careful attention to the attitudes expressed by parties to the conflicts in both Georgia and Tajikistan. The research is still in progress, but I expect to find that "nostalgia," narrowly defined as a sense that the status quo of the late Soviet period is preferable to post-Soviet existence within the structure of newly independent states' governments, best explains the puzzling behavior of all parties. These results will have significance for any study of conflict resolution in multiethnic states whose order has shifted as a result of structural trauma, illuminating the potential fault lines for future conflicts in changing states.

### **Pakistan and the *Lashkar-e-Taiba*: Complications of a Proxy War**

*Heather Harms, Senior, International Studies*  
*Mentor: Cabeiri Robinson, International Studies*

A proxy war is a military conflict that is instigated by a major power that does not become overtly involved in the fighting. The Kashmir conflict is often viewed as a proxy war, with Pakistan supporting militant groups that fight in Kashmir. While Pakistan was initially surprised by the indigenous insurgency when it began in Kashmir in 1989, there is no denying that it has since been active in shaping the insurgency. It has also encouraged militant groups to become involved. It is insufficient to view this conflict as a proxy war, however. The *Lashkar-e-Taiba* (Army of the Pure), one of the Pakistan-based militant groups active in Kashmir, considers its actions in Kashmir to be part of *jihād* (armed struggle) and, therefore, a requirement for faithful Muslims. The *Lashkar's* objectives are more expansive than the objectives of the state of Pakistan. Pakistan wants Kashmir to become part of its state; the *Lashkar* wants to reclaim all lands that were previously under Muslim control. It wants to establish the dominance of Islam throughout the world. The distinction between the objectives of the *Lashkar* and Pakistan is significant. The state is constrained by this group, which enjoys substantial support from Pakistanis, because the *Lashkar* does not consider negotiations with India as legitimate. If, in the future, Pa-

kistan desires to resolve the conflict with India, the proxy forces will become a liability, an armed, trained organization with the ability to oppose the state.

### **Cuba's Revolutionary Reform**

*Jennifer Howk, Junior, Political Science*

*Mary Gates Scholar*

*Mentor: Steve Hanson, Political Science*

Cuba's post-Soviet survival strategy has defied nearly everyone's expectations. Since the Fourth Party Congress in 1991, the leadership has legalized foreign currency, reopened the island to foreign investment, and permitted limited entrepreneurial activity. This economic liberalization has ensured Cuba's basic survival, but the ideological price is high: Castro's reforms are shaping a Cuba that embraces the very evils against which his revolution has always purported to struggle. Yet the regime claims this "new" Cuban flavor of market socialism is the revolution's greatest project yet. How can such a fundamental contradiction be politically sustainable? This paper attempts to answer that through an institutional comparison with Mikhail Gorbachev's attacks on socio-economic "stagnation" and his pursuit of "pure Leninism" through economic and political reform. In this paper, I argue that Castro's pursuit of a "new" Cuba is an effort to implement perestroika-style reforms consistently with the ethos of perpetual crisis and struggle that has always legitimized his regime. Castro's reforms are an effort to rescue his legacy—and Cuba *Libre* itself—from the kind of energetic criticism of Brezhnevian stagnation that led the USSR into pseudo-democratic collapse. The new synthesis of Gorbachevian democratic-rhetoric and socially protective market reform is best understood as a continued expression of the revolutionary struggle that has secured public support for five decades. This paper first considers Gorbachev's institutional subversion of the Leninist revolutionary project to economic development and increased individualism. It then examines the internal and external institutional differences that allow Castro to pursue reform while consistently renewing and reinvigorating the nationalist struggle to which he owes his continued legitimacy and success. Finally, it explores what can be gained from such a comparison, and whether it offers any predictive value for the Cuban revolution's continued survival—and what that might imply for genuine democratic prospects on the island.

### **A View from the Outs**

*Alison Johnston, Senior, Economics, Swedish, European Studies*

*Mary Gates Scholar*

*Mentor: Christine Ingebritsen, Scandinavian Studies*

*Mentor: Michelle Turnovsky, Economics*

This paper will explain why Denmark is more suitable, macroeconomically, to join the European Monetary Union than Sweden. Becoming a member of the EMU entails a

complete loss of monetary policy and restrictions on fiscal policy, through the Stability and Growth Pact (SGP). This paper will analyze potential Danish and Swedish memberships based on three variables – business cycle cohesion, exchange rate regime, and cyclical deficit performance – that will indicate how both countries would perform given these monetary and fiscal policy restraints. The examination of the first two variables of my analysis – business cycle cohesion and exchange rate regime – revolves around an extensive literature review. Due to its different reactions to asymmetric shocks from Europe, more volatile aggregate demand and its flexible exchange rate system, Sweden would encounter a greater loss than Denmark in surrendering its autonomous monetary policy for a common European monetary policy. Denmark, on the other hand, demonstrates a much more aligned business cycle with Continental Europe, is more directly influenced by German symmetric shocks and has a fixed exchange rate; therefore, the loss of its monetary autonomy is not such a severe consequence, since Denmark has virtually lost it already. The final variable of my analysis – government deficit variability – will revolve around regression work that I have developed. I expanded an econometric model by economists Jordi Gali and Roberto Perotti ("Fiscal Policy and Monetary Integration in Europe", *Economic Policy*, Issue 37, October 2003) that measures the effects of the output gap on Sweden's and Denmark's budget deficits. My regression analysis has shown that, while considering both "reactive" and "forward-looking" policies, the Swedish output gap's beta coefficient is higher than Denmark's, indicating a greater volatility in Sweden's cyclical deficit, given a change in the output gap. Therefore, due to its higher cyclical deficit volatility, Sweden would have a more difficult time adjusting to the SGP than Denmark.

### **Are Sovereign Nation-States Compatible With Modern Science and Technology?**

*Julia Schwarz, Freshman, Pre-Major Arts and Sciences*

*Mentor: Vladimir Chaloupka, Physics*

It is increasingly apparent that the relationship between science and society has reached a new stage, qualitatively different from the relationship that existed at any earlier time. This change could be called a paradigm shift, or in physics terms a phase transition. For the first time, the capability of causing extreme harm, intentionally or accidentally, is – or will soon be – in the hands of small groups or even individuals. In this project, I looked at whether throughout history, science and technology have played an essential role in working towards a global society. In order to accomplish my goal, I evaluated a wide range of sources that document or examine the relationship between technology, warfare, large-scale incidents and accidents, and globalization. This quarter, which marks the beginning of the "Year of Physics" (the 100<sup>th</sup> anniversary of Albert Einstein's year of immense contribution to physics), I paid particular attention to Einstein's reaction to the develop-

ment of nuclear weapons, and looked at how we can apply the lessons we have learned to the 21<sup>st</sup> century. The complete project consisting of annotated bibliography of all documents I evaluated is available at [www.phys.washington.edu/users/vladi/julia\\_schwarz.html](http://www.phys.washington.edu/users/vladi/julia_schwarz.html). From my research thus far, I conclude that society's historical trend towards globalization has been significantly aided (if not caused) by the increasingly rapid advance of technology, and that a new way of thinking about global federalism is imperative if we expect to survive the unintended consequences of our own scientific knowledge.

### **Odd Man Out: Iran in the 'Axis of Evil'**

*William Pickert, Senior, Political Science, Seattle University*

*Mentor: Constance Anthony, Political Science, Seattle University*

In his State of the Union address on January 29<sup>th</sup>, 2002, President Bush used the term "axis of evil" to describe states that sponsor terrorism and threaten America or its allies with weapons of mass destruction, naming North Korea, Iran and Iraq, respectively. In May 2002, Undersecretary of State John Bolton formally included Cuba, Libya, and Syria. Although four of these countries are located in the Middle East, the inclusion of North Korea and Cuba, both Communist nations, begs the question of what these states have in common. The most significant similarity is that these states refuse explicitly to affirm the foreign policy goals of the hegemonic United States, in their respective regions. My paper will focus specifically on Iran, examining the hostile relationship between it and the United States, especially since the Iranian Revolution of 1979, and also in consideration of U.S. involvement in toppling a democratically elected government to install a monarch, the Shah. I will examine Iranian foreign policy goals, especially with respect to the sponsoring of terrorism and their nuclear ambitions. This paper will also consider whether U.S. foreign policy goals in the Middle East, namely democratic governance, control of nuclear proliferation and regional stability, would be better served by incorporating Iran more fully into the global economy, by dropping economic sanctions and supporting their accession to the WTO, and taking a less hostile stance to a country that has the best chance to become the model of Middle Eastern democracy. This is based on several factors: high literacy, a young population, a history of democratic government (without Western influence), common interests with the U.S., and the necessity of U.S. support for economic advancement. The hegemony of the U.S. with respect to Iran should shift from coercive to benign, giving Iran the consideration it deserves as a potentially stabilizing and democratizing force in the Middle East.

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## **SESSION 1F**

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### **ENVIRONMENTAL RESEARCH: SCIENTIFIC AND HUMAN DIMENSIONS**

*Session Moderator: David Secord, Program on the Environment*

*Session Assistant: Barbara Owens, Academic Counselor, Biology*

**Mary Gates Hall Room 389**

#### **The Effect of Heavy Metal Pollution in Aquatic Environments on Metallothionein Production in *Mytilus sp***

*Lee Ann Acker, Senior, Environmental Science*

*Jeremiah McMahan, Senior, Environmental Science*

*Mentor: James E. Gawel, Environmental Science*

Industrial development in Puget Sound has resulted in heavy metal contamination of local waters. Ecosystem contamination from cadmium, copper, and lead has damaged marine organisms on the cellular level and possibly affected the ecological balance. Metallothionein (MT) is a low molecular weight protein that binds heavy metals in marine organisms. This makes MT a valued *in situ* bioindicator of heavy metal pollution in aquatic environments. In this study, we examine the temporal and spatial changes in MT production in *Mytilus sp.* populations growing on floating docks in South and Central Puget Sound. We use the spectrophotometric method of Viarengo *et al.* (1997) to evaluate MT production in these mussels. MT is also measured in transplanted common-stock *Mytilus sp.* at the same sample sites to address possible heavy metal resistance through adaptation. We compare MT concentrations to metal levels in the water column and mussel tissues, as well as other general water quality parameters.

#### **Olympia oysters: Where have they gone, and can they return?**

*Jacqueline White, Senior, Biology, Environmental Studies*

*Mentor: Jennifer Ruesink, Biology*

Washington's only native oyster (Olympia oyster, *Ostreola conchaphila*) supported a vibrant fishery during the early history of the state, but by the late 1800s required protection in a network of State Oyster Reserves. Despite these efforts, the oyster has remained rare, and aquaculture has shifted to an introduced species (Pacific oyster, *Crassostrea gigas*). To address this continued scarcity, my project focused on documenting causes of decline, management practices, and population abundance. I reconstructed Olympia oyster history by reviewing documents from oyster ecologists, managers, and harvesters, which demonstrated the commercial overexploitation of oysters, and added harm from water pollution, invasive competitors and predators, and habitat loss. Reserves initially provided seed oysters

to maintain commercial production, but as the decline ensued, priorities shifted to clams and Pacific oysters. Recently, though, interest has grown in Olympia oyster restoration, and current practices involve transplanting small oysters to suitable sites. However, little information is available on how to alter habitat to encourage natural recovery. For this reason, the second aspect of my project involved comparison of recruitment on bare tideflat and five distinct substrates. The experiment was set up at the North Bay reserve, Puget Sound, in May 2004. Spat abundances were recorded in October, at which point recruits were small. This suggested settlement in late summer, in contrast to historical reports of spring settlement. Recruitment improved at low elevations and on shell, with the greatest abundance on Olympia oyster shell, followed by live Olympia oysters, whole Pacific shell, crushed Pacific shell, gravel, and bare tideflat. Olympia shell provided a better recruitment substrate than gravel, but shell treatments could not be distinguished statistically. Altogether these findings are broadly applicable to Olympia oyster management and restoration efforts, and also highlight the unique history of Washington's native oyster.

### **Lake Thermal Responses to Climate Change Mediated by Landscape Position**

*Jennifer Griffiths, Senior, Biology, Dance*

*Mentor: Daniel Schindler, Aquatic and Fisheries Sciences*

Understanding the responses of aquatic ecosystems to climate change is a critical goal of current ecological research. Do all ecosystems in a geographic region respond coherently, do they respond uniquely, or do their responses depend upon landscape organization? Thermal characteristics of aquatic ecosystems are a fundamental component of the mechanisms controlling nutrient cycling and biotic growth in lakes and these characteristics have been shown to be sensitive to climate change. I sought to determine whether landscape organization contributed to the responses of five interconnected lakes in the Wood River System, Southwest Alaska. Temperature data have been collected daily since 1998 allowing a variety of response variables to be compared among lakes and years. Thermal response variables important to lake characteristics include the timing of spring thaw and fall turnover, average monthly temperature, maximum temperature, length of summer (growing season), and degree days (thermal capacity). All five lakes show a warming trend over the length of the time series but the data do not indicate a relationship between lake landscape position and thermal responses. Thus, lakes in the Wood River system exhibit coherent thermal responses to climate change.

### **Protecting Global Commons with Sub-national Policies: Explaining Climate Change Policies Across the United States**

*Andrea Carter, Junior, Community and Environmental Planning*

*Mary Gates Scholar*

*Mentor: Nives Dolsak, Policy Studies, UW Bothell*

IR scholars typically focus on nation-state as the unit of analysis although subnational politics may have important bearing on international outcomes. The politics of global climate change is an eloquent example of this. The United States has been a laggard in developing policy responses to global climate change. Unlike the federal government, several U.S. states have adopted some sort of global climate change policies. Some U.S. states would be considered major world emitters if their emissions were compared to that of other countries. Greenhouse gas emissions from Texas, for example, would rank as the seventh highest in the world, exceeding those from United Kingdom, Canada, and France. Apart from the interesting implications for IR theory, this suggests that IR scholars should study subnational efforts on climate change along with those of national governments. This paper analyzes factors affecting U.S. states' commitment to mitigating global climate change although the U.S. federal government has not enacted any such policies. The states' commitment levels are operationalized as an ordinal variable ranging from enactment of policies for objectives not related to climate change but bear upon emission of green gases (lowest commitment), to enactment of policies mandating specific emissions reduction targets for existing emitters (highest commitment). Five theoretical models of governments' decisionmaking are empirically examined for all 50 states. Different policymaking models privilege different causal variables. Our objective is to assess the extent to which these models predict the stringency of the policy that states' adopt. The first model, examines an influence of aggregate levels of costs and benefits of policy change. The second model examines the role of public opinion regarding local and regional environmental problems. The third model examines the influence of states' capacity to mitigate global climate change, as suggested by the managerial theory of compliance. The fourth and the fifth models examine the role of non-state actors on policymaking, i.e., the impact of environmental NGOs and business responsiveness, respectively. Empirical findings are compared with those for commitment of national governments from a previous analysis of global climate protection at the national level.

### **Environmental Health in Nicaragua**

*Paige Beckley, Senior, Environmental Health, Spanish*

*Mentor: Matthew Keifer, Environmental Health*

As Central America and other developing regions of the world become more industrialized, environmental health becomes more important. My research focuses on Nicaragua, a country that, while continuing to develop its economy, is beginning to direct its attention to other quality of life issues. This project is a joint effort with the medical faculty at the Autonomous University of Nicaragua in Leon. My research consists of key informant interviews of twelve lead-

ing environmental health specialists in the country, representing government agencies, NGOs, and the private sector. Identification of the people interviewed was provided by the Autonomous University and by referral from interview participants. The guided interviews sought to identify and prioritize the most serious environmental health problems in Nicaragua, identify their effects, and explore possible solutions. The information collected was analyzed via simple content analysis and priorities were organized by frequency of reporting. The informants indicated that the most pressing environmental health issues are lack of potable water and poor sanitation, which lead to such illnesses as diarrhea, parasitosis, and contagious diseases. Informants reported the cause of these problems is two fold: lack of resources and inadequate education and that the most feasible solution to better sanitation is population education about health, proper sanitation, and environment. Education must start with the most vulnerable populations: populations without access to potable water, in extreme poverty, and in rural communities. The potable water network must also be extended. The goal of the interviews was also to form ties between organizations to assist future projects, explore possibilities for group research and develop projects for international students. The findings from my research are already incorporated into the curriculum of an environmental and occupational health course for fifth year medical students at the Autonomous University of Nicaragua.

### **The Convergent Evolution of Solid Waste Management in Urban India: Solutions from History and Abroad**

*Mona Radheshwar, Senior, Biology, South Asian Language and Literature*

*Mentor: K.P. Singh, Asian Language and Literature*

Trends in exponential population growth have led to major obstacles in solid waste management for large cities across the globe. Many third world countries lack the infrastructures necessary to efficiently handle the garbage produced, resulting in severe consequences to public health and environmental stability. My research has been to investigate the recycling/garbage dynamics of one of India's most cosmopolitan cities, Mumbai (formally Bombay) and to examine solutions and technologies from abroad that may prove to be more efficient in dealing with the city's waste stream. While world class in the realms of industry and art, Mumbai is still using technologies and ideologies for waste disposal that were outlawed and replaced in the United States more than one hundred years ago. The Municipal Corporation of Greater Mumbai (MCGM) formally manages the city's municipal solid waste, while the recycling sector relies heavily on materials separated from the waste-stream by unorganized low-caste laborers, called rag pickers, who work atop the city's open dumps. Countries across the globe have realized that if separated and treated correctly, garbage can be converted into thousands of marketable products from raw materials and compost to electricity. My research has lead me to believe that in Mumbai's case, stimu-

lation of the garbage/recycling economic sector by the establishment of separation facilities, commercial composting and the organization and incorporation of rag pickers into the formal sector is a necessary civic investment for this growing metropolis of 12 million. The next question is: who will take the initiative to implement new waste management strategies? Will it be the municipal government, the non- governmental organizations or the private business?

### **Economic and Environmental Implications of the Transition from Subsistence Farming to Cash Cropping in Rural China**

*Kayanna Warren, Senior, International Studies, Biology*

*Mary Gates Scholar, Udall Scholar*

*Mentor: Stevan Harrell, Anthropology*

My research is a multifaceted part of the ongoing compilation of research being done by Professor Stevan Harrell in Yangjuan and Pianshui villages in Sichuan Province, China. My research details the local political economy of the transition from subsistence farming to cash cropping a new hybrid corn. I am researching where it comes from, where it goes, and if there really is an economic benefit for the farmers undertaking this transformation. I also determine what the corn is used for once it reaches the factories and what this might mean about the changing markets in China. In my descriptive detailing of the local political economics of this change, I also detail some of the practices associated with this corn and discover if there is an environmental impact from use of this corn, and if so, what kind. Secondly, my research will determine why farmers began cash cropping – whether this transition to cash cropping is brought on because of farmers' own impetus or because of government urging and if this is a typical example of the reasons a village begins cash cropping. I also tie my assessment into the broader pattern of transitioning Chinese markets and China's emerging goals regarding development, touching on subjects related to China's WTO accession and subsequent growing share in world trade. The research required interviews of 32 households in Yangjuan and Pianshui as well as interviews with middlemen, transporters, and government officials in the nearby towns of Baiwu and Yanyuan. I also interviewed seed producers in Chengdu and factories in Xichang. All interviews were conducted in Chinese. In the villages, I had the help of some residents who speak both Mandarin and Yi to help me do interviews.

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## **SESSION 1G**

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### **GENETICS AND IMMUNITY**

*Session Moderator: Tuofu Zhu, Laboratory Medicine*

*Session Assistant: Ananth Shenoy, Senior, Biochemistry*

**Mary Gates Hall Room 231**

## **The Effect of a Placebo for Memory Enhancement on Unconscious Metabolic Processes**

*Catherine Carey, Senior, Neurobiology*

*Mentor: Alex Suarez, Psychology*

It has been estimated that many medical treatments in history owe their success to the placebo effect, since many treatments, including some current treatments, have no specific active ingredient. Placebo is not an issue of gullibility; people of all types and personalities respond to it. Indeed, the people who respond poorly to a placebo for a given illness also tend to respond poorly to the active drug which the placebo represents. The end goal is to find out more about the body's ability to self-heal. The ability of placebos to ameliorate pain, depression, Parkinson's disease, and other conditions, for which the patient can feel a change, is well established. However, research on the effect on consciously undetectable processes such as immune levels and cortisol levels is still in its infancy. This study hopes to contribute to that knowledge. Its purpose is to test a placebo for levels of cortisol in the saliva of students undergoing a stressful midterm. Samples of saliva will be taken a week before the midterm to determine baseline levels, and then taken again in the moments just before the midterm, to compare the change in cortisol levels between a stressful and non-stressful setting. The purpose is to see if a placebo labeled as a mnemonic enhancer will lower the stress level of the students, as measured by enzyme immunoassay of their cortisol levels. The saliva will be collected under controls for the effect on cortisol of circadian differences, jet lag, and shift work, as well as consumption of birth control and other steroids, citrus fruits, and nicotine.

## **Sequence Analysis of HIV-1 Strains in CD14+ Monocytes and CD4+ Lymphocytes in Patients with ART**

*Leah Michelle Hampson, Sophomore, Microbiology*

*Mentor: Tuofu Zhu, Laboratory Medicine*

Monocytes, a type of white blood cells found in peripheral blood, are an important yet underrated and indirect source of Human Immunodeficiency Virus (HIV-1). Previous studies have shown that HIV-1 could be found in the monocytes, and HIV-1 is not reproduced in blood monocytes unless they have differentiated into monocyte-derived-macrophages. Recent results from Zhu laboratory and others indicate that HIV-1 can replicate in CD14+ monocytes in vivo during highly active anti-retroviral therapy (HARTT), suggesting possible role for CD14+ blood monocytes as reservoir of HIV-1. However, the influence of antiretroviral therapy (ART) on this occurrence of viral compartmentalization has also not yet been examined until this time. In order to understand how the different regimes might have different influence on HIV-1 evolution here, we characterized HIV-1 sequences in CD14+ monocytes and CD4+ T lymphocytes in patients with ART. Patients PBMC samples were separated into CD4+ T cells and CD14+ monocytes by positive and negative selection. HIV-1 genes, Gag (P17)

and envelope (C2V5) are PCR amplified, cloned and sequenced from multiple time points. Sequences were compared between the CD4+ lymphocyte and CD14+ monocytes at different time points. This project is extremely important because current therapies, such as HAART do not eradicate HIV-1 in patients. By examining early time points, before therapy, and later time points during therapy, insight is gained as to where the virus is being harbored and how effective these therapies are. What is learned in this study could eventually lead to more efficient therapies that eradicate rather than simply reducing the virus.

## **Pregnancy, Preterm Labor, and Immunity: How the Placenta Recognizes Infection**

*Joëlle Lucas, Senior, Business, French*

*Mary Gates Scholar*

*Mentor: Kristina Adams, Obstetrics and Gynecology*

Preterm birth occurs in 10% of pregnancies and can lead to severe consequences for the infant including cerebral palsy, chronic lung disease, and death. Intrauterine infection is associated with extremely premature births and inflammatory responses to bacterial products are thought to drive labor in these cases. Understanding the earliest placental immune response to infection may lead to an effective therapy for preterm labor. Our objective was to determine the role of Toll-Like Receptor 4 (TLR4) in the immune response within amniotic epithelium, the placental tissue in direct contact with amniotic fluid, after exposure to lipopolysaccharide (LPS), a gram-negative bacterial product. An immune response to LPS occurs when LPS binds to TLR4, causing the production of tumor necrosis factor-alpha (TNF- $\alpha$ ), an immunologic protein elevated in infection-associated preterm labor. To test our hypothesis, we exposed biopsies of amniotic epithelium to LPS in a 4-hour time course. At each time point, tissues were fixed in paraformaldehyde, treated with a detergent for permeabilization, and immunolabeled with fluorescent antibodies specific for TLR4 and TNF- $\alpha$ . Three-dimensional images of the amniotic epithelium were constructed by confocal microscopy to determine relative quantities and cellular location of TLR4 and TNF- $\alpha$ . Immediately after LPS exposure, TLR4 expression was concentrated to the amniotic epithelial surface, the site in direct contact with amniotic fluid. Two hours after LPS exposure, there was a 21-fold increase in cytoplasmic TLR4 expression. Surface TLR4 expression increased six-fold by 4 hours. To determine if upregulation of TLR4 also resulted in an inflammatory response, we studied changes in TNF- $\alpha$  expression. Cytoplasmic TNF- $\alpha$  increased two-fold by 4 hours. Increases in TLR4 and TNF- $\alpha$  proteins suggest that amniotic epithelial TLR4 is functional and capable of initiating a placental inflammatory response. Blockade of TLR4 at this crucial placental interface may prevent an inflammatory response leading to preterm labor.

## **Detection of Minor Strain in Dual HIV-1 Infection**

*Blythe McLoughlin, Junior, Microbiology*  
*Mentor: Tuofu Zhu, Laboratory Medicine*

Studies of individuals who appear to resist HIV-1 infection, despite repeated exposures, may provide insight into the mechanisms by which HIV-1 can be prevented and controlled. Genetic analysis of breakthrough HIV infection in these later sero-converters (LSC) and their relationship with infected long-term sexual partners will provide information on virus transmission. This project focuses on an interesting patient from a Seattle cohort of these LSC individuals. Patient LSC40 remained uninfected throughout seven years of high-risk exposure to HIV-1 with multiple partners. In addition, LSC40 showed HIV-1 immune responses (cytotoxic T lymphocytes) years before his infection, a rare characteristic previously linked to protective immunity. Earlier work in Zhu lab has shown that there were two distant strains present in LSC40. However, some genes of the minor strain were not detected by routine technique. Consequently, we performed the polymerase chain reaction (PCR) to amplify LSC40's HIV-1 genes and utilized a new technique, the heteroduplex mobility assay (HMA) to differentiate the major and minor strains. Using this method, we detected, cloned, and sequenced the minor strain in the whole genome of LSC40. Phylogenetic analysis of each gene revealed significant genetic distance between LSC40's major and minor strain. The most interesting finding is both the major and minor HIV-1 strains of LSC40 are significantly different from the sequences of his two long-term partners. This research leads to ongoing studies to see if CTL responses protected LSC40 from HIV genetically similar to those he was being constantly exposed to by his long-term partners, but left him susceptible to a breakthrough virus that was genetically different. Further examination will be needed to determine whether LSC40 was super-infected or co-infected.

### **Gap Junctional Communication Involved in Rat cerebral Pial Arteriole Dilation**

*Thomas Noh, Senior, Physiology, Psychology*  
*Mentor: Al Ngai, Neurological Surgery*

Cerebral blood flow is closely matched to the energy requirements of the brain. When the brain is activated by sensory stimuli, there is extra demand for nutrients such as oxygen and glucose. Blood vessels in the brain relax in order to increase in their diameter (dilate), thereby allowing more blood flow to meet the increased energy demand. The underlying mechanisms coupling brain blood flow to neuronal activity, however, remain elusive. Our laboratory has documented that brain surface arterioles dilate in response to sensory stimulation. The unanswered question then, is how the dilation signals travel from the inside of the brain, where neuronal activity originates, to the surface vessels. My research focuses on the involvement of gap junctional communication in the conduction of these dilating signals along blood vessels. Using rats as an animal

model, a cranial window was implanted and later used for observation via videometry. We also measure surface evoked potentials as an indicator of neuronal activity. After obtaining control measurements, gap junction protein inhibitors were perfused through the window for ten minutes. Additional measurements were taken after perfusion. The post-perfusion data showed a decrease in the dilation response while maintaining a normal somatosensory evoked potential, which measures the flux of electrical signals in the brain during sensory stimulation, indicating that the somatic stimulus was received and processed by the brain. The attenuation of the dilation response suggests that gap junctional communication is involved in the conduction of dilation signals along the arterioles of the rat brain.

### **Content Validity of the SimPraxis™ Pelvic Lymph Node Dissection Interactive Cognitive Trainer**

*Linh Tran, Senior, Bioengineering, Mathematics*  
*Mary Gates Scholar*  
*Mentor: Robert Sweet, Urology*

For years, the surgical atlas was the gold standard preparatory medium by which a surgeon or student could prepare for an operation. More recently videotapes have provided more detail, but both provide "passive" learning. We evaluated the content validity of a novel computer based "interactive" cognitive simulator to train the skills necessary to perform pelvic lymph node dissection. Ten prostate cancer experts who performed over 100 PLNDs each over the past 2 years from multiple academic institutions were asked to interact with the SimPraxis™ (Seattle, WA) PLND simulator in both practice and testing mode. Afterward, they rated various aspects of the simulator's content with yes/no questions and on a 5 point Likert-scale. Before interacting with the simulator, 90% of the subjects felt that a validated simulator would be useful for training pelvic lymph node dissection. Results of post-interaction rating were as follows: the simulator's effectiveness in "enhancing anatomical knowledge" received a mean score of 4.1 with SD of .74. Its ability of "aiding in understanding of the procedure" received the mean score of 4.5 with SD of .71. Its aid in "training the indication concepts and steps necessary to perform the procedure" received experts' mean ranking of 4 with SD of .5. The experts' choice of an assistant trained on simulator received an average score of 3.8 with SD of 1.03. In addition, 100% of the subjects felt it would be useful as a training tool and more useful than standard video training in teaching PLND. 80% would like to see it implemented into the curriculum of residency programs and 60% thought it would be useful for accreditation. We have established content validity for the SimPraxis™ simulator to train the skills necessary to perform pelvic lymph node dissection. Construct and predictive validity studies are underway.

### **HIV-1 Selection During Sexual Transmission - A Unique Case Study**

Amanda Woodward, *Sophomore, Biology*  
Mentor: Tuofu Zhu, *Laboratory Medicine*

Human Immunodeficiency Virus Type 1 (HIV-1) is most commonly transmitted via unprotected sexual contact in the United States. However, some individuals remain uninfected after repeated exposure to the virus through sexual contact with multiple infected partners. These individuals are designated exposed seronegatives (ES) and are a useful model for studying HIV-1 transmission factors. We have identified a unique relationship chain in which an ES individual became infected with HIV-1 near the end of a long-term (*non-exclusive*) sexual relationship with an infected partner. Surprisingly the virus infecting ES63 was determined to be a genetically different strain of HIV-1 from his long-term partner, P63. Our goal in this case study was to determine why the virus infecting ES63 did not originate from his long-term infected partner, but rather from another unidentified sexual partner. One main factor was whether P63's strain of HIV-1 was actually viable and able to be transmitted. In order to scientifically conclude this, my project was to verify P63's "source" partner (PP63) and sequence this partner's entire HIV-1 genome. Since we determined P63's virus is genetically distinct from ES63's, we hypothesized that PP63 must also harbor genetically distinct virus from ES63. The whole genome of HIV-1 from PP63 was amplified by polymerase chain reaction (PCR) using a nested PCR method, cloned and sequenced. A phylogenetic tree analysis was performed using the sequences to create a physical representation of the genetic differences among HIV-1 strains in the three individuals. From this data, we were able to conclude that the HIV-1 strain detected in PP63 was transmitted to P63, viable, and as predicted different from ES63. These results will allow us to focus on other possible factors, such as host immune responses and genetic mutations that might account for ES63's resistance to a particular HIV-1 strain.

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## SESSION 1H

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### LIVING SYSTEMS

*Session Moderator: Ginger Armbrust, Oceanography*  
*Session Assistant: Lilia Peng, Freshman, Academy for Young Scholars*

**Mary Gates Hall Room 295**

#### **Luminescence Dating of Tanzanian Sediments: An Archeological Approach to Dating the Past**

*Christina Jean Fusch, Senior, Anthropology, Near Eastern Studies*  
*Mentor: James Feathers, Anthropology*

In this undergraduate research project, the goal was to take an archaeological perspective to dating specific sediments collected from the Loiyangalani River Valley in the Serengeti National Park of Tanzania, Africa. These sedi-

ment samples, which were transported to the University of Washington for dating by archaeologists in collaboration with the University Research Expeditions Program (UREP), were collected and are being dated to achieve three primary objectives. The first is analysis of the Serengeti ecosystem during the Upper Pleistocene (c. 125,000-10,000 years ago) to gain deeper understanding of the ecosystem's dynamics, particularly climate variation where little has been researched or is known. The second objective is to achieve results applicable to the competing models/hypotheses, punctuational and gradual, toward the origins of so-called "modern" human behavior in sites that date to the Middle Stone Age (150,000-40,000 years ago). The hope is that the resulting data will favor one particular model concerning this crucial time in the development of *Homo sapiens*. The final objective is conservation and recovery of remains from erodable alluvial sediment portions of the valley that are being disturbed by vehicular traffic and modern environment. In research, the Optically Stimulated Luminescence (OSL) and Infrared Stimulated Luminescence (IRSL) dating techniques were used to date the collected sediments. By using OSL and IRSL dating, an estimate of the age of these samples can be formed by exposing portions of the sediments to light and measuring their luminescence signal. The progress thus far is that these samples have already undergone initial preparation and tests and have produced final results, dating the samples to around the Middle Stone Age, which will affect the objectives noted above. This project was completed over both Summer and Autumn Quarters 2004 using equipment and lab space from the University of Washington's Thermoluminescence Dating Lab.

#### **Tracing changes in salmon abundance across centuries: identification of archeological remains utilizing molecular technologies**

*Marco Hatch, Senior, School of Aquatic and Fishery Sciences*

*Mary Gates Scholar*

*Mentor: Kerry Naish, School of Aquatic and Fishery Sciences*

Cultural deposits, notably middens comprising food remains such as shellfish and animal bones, represent organisms that were harvested over many thousand of years. For changing harvesting practices to be properly interpreted, faunal remains must be identified to the lowest possible taxonomic level. Pacific salmon (*Oncorhynchus spp.*) probably comprised a significant portion of this harvest, but have only been classified to the genus level in previous studies, and thus inter-specific variation in food availability has been masked. Vertebrae are most often all that remain of Pacific salmon in middens but these vertebrae are morphologically identical and thus prevent species level identification based on physical characteristics. The purpose of this study was to apply molecular technologies to Pacific salmon remains from the Watmough Bay, Lopez Island archeological site

for species identification with the eventual aim of characterizing changing harvest practices in the area. Archaic salmon remains have been identified using the COIII, Cyt B, and 16s regions of the mitochondrial DNA. This technique is possible because each cell typically contains at least 2 orders of magnitude of mitochondrial DNA per one copy of genomic DNA, thus increasing the likelihood of obtaining intact sequences. The quantification of salmon species abundance as displayed in cultural deposits provides a unique vector to understanding the history of population shifts. One possible use for this new data is comparisons of relative abundance between contemporary and archeological data, providing a means of examining the consequences of fresh water habitat destruction on stream rearing salmonids.

### **Dynamics of the Puget Sound Virioplankton**

*Benjamin Johnson, Senior, Biological Oceanography*  
*Mentor: Gabrielle Rocap, School of Oceanography*

Viruses are the most abundant biological particle in the ocean, averaging  $10^7$  virus-like particles per milliliter. This viral component of the plankton interacts with every trophic level, from primary producers to top predators. Studies of marine virus-host interactions indicate that these particles play a major role in numerous ocean processes, such as maintenance of host population's clonal diversity, nutrient recycling, carbon sequestration and even climate control. Related studies have recently led to the discovery that the virioplankton is a mixture of DNA and RNA viruses. Several recent studies indicate highly diverse populations of RNA viruses are found across the oceans, implying that these viruses constitute an important, but undetermined proportion of the virioplankton. Most research to date, however, has focused on the effects of DNA virus-host interplay, while RNA virus abundances and effects remain largely unknown. In order to refine our knowledge of the virioplankton's roles, the differences between DNA and RNA viruses must be determined. The research presented here is meant to begin elucidating the individual proportions and roles of DNA and RNA viruses within the Puget Sound. Using samples taken aboard the R/V Thomas G. Thompson at a site in Lynch Cove, Washington, I will use epifluorescence microscopy to enumerate the entire virioplankton and bacterioplankton assemblage using the fluorescent nucleic acid stain SYBR Gold, and will develop a method for counting single-stranded RNA virus-like particles using the single-stranded RNA-specific fluorescent nucleic acid stain SYTO RNAselect. With these tools I will develop a time-series describing the dynamics of DNA and single-stranded RNA viruses, bacterioplankton, and phytoplankton abundances. The results from this study are, to my knowledge, among the first efforts to delineate the individual roles of DNA and RNA viruses in the marine environment, and will assist future efforts to develop a complete model of virioplankton roles.

### **Genetic Diversity of *Synechococcus* in the Northwest Straits**

*Karen Peterson, Senior, Microbiology*  
*Mary Gates Scholar*  
*Mentor: Gabrielle Rocap, Oceanography*

A significant proportion of the world's picophytoplankton is photosynthetic cyanobacteria. The abundant genus *Synechococcus* contributes substantially to oceanic primary production and inhabits coastal as well as oligotrophic waters. Most data regarding their genetic diversity comes from oligotrophic regions, leaving coastal waters largely underrepresented. An identification of the environmental and biological forces acting on these valuable organisms requires more information on the patterns of genetic diversity within coastal systems. I collected environmental water samples from two sites within the Northwest Straits coastal system and studied 16S-23S rRNA Internal Transcribed Spacer (ITS) sequences for information about genetic diversity of *Synechococcus* at those sites. ITS regions were PCR-amplified from the environmental samples using cyanobacterial specific primers, and PCR products were cloned and sequenced. I chose the non-coding ITS region because it is likely to accumulate mutations more rapidly than coding genes. This allows resolution of phylogenetic relationships at the ecotype level, a property exploited by several previous studies on cyanobacterial distribution and diversity. Previous studies sorted *Synechococcus* ITS sequences from various oligotrophic and coastal systems around the world into more than 10 groups based on genetic relatedness. Phylogenetic analysis reveals that my clonal sequences sort into three of these groups, with 37 clones in group I, 10 in group IV, and 4 in group XIII. The strong mixing of the water column eliminates obvious physical niches at the collection sites, yet there is nevertheless a very specific pattern of distribution of *Synechococcus* ecotypes. This implies different ecotypes are exploiting different niches. In order to identify the environmental and biological forces creating these niches, more data about the ecosystem and about the genetic and physiological diversity of *Synechococcus* ecotypes needs to be collected.

### **Bacterial activity and diversity off the coast of Vancouver Island, British Columbia, estimated using 5-bromo-2'-deoxyuridine (BRD-U)**

*Tiffany Straza, Senior, Oceanography*  
*Mary Gates Scholar*  
*Mentor: Richard G. Keil, Oceanography*

One challenge in marine microbiology is to determine the types of active bacteria present in a given environment. In this study, the actively growing subset of the total bacterial community was defined as those organisms that were assimilating the thymidine analog 5-Bromo-2'-deoxyuridine (BrdU). Using terminal restriction fragment length polymorphism (t-RFLP), we assess overall bacterial diversity,

and the diversity of the actively growing sub-community. During August 2004, samples were collected in the eastern North Pacific near the coast of Vancouver Island, Canada. Our previous results (2001-2003) for the semi-enclosed coastal fjords of Clayoquot Sound, Vancouver Island, have shown that the structure of the growing estuarine bacterial community is correlated with total thymidine incorporation, salinity, and phytoplankton abundance and type. Simultaneous monitoring of the fjords and the nearby ocean waters allows characterization of the growing heterotrophic bacterial community across the range of environments from river to open ocean conditions, and allows estimation of the similarities between these related environments.

### **Cryopreservation of the haplophase of the giant unicell, *Acetabularia acetabulum***

*Kevin Wherry, Junior, Biochemistry*  
*Mentor: Dina F. Mandoli, Biology*

Cryopreservation of the haplophase of *Acetabularia acetabulum* is an important step in making this unicellular alga a more powerful unicellular model. Continuous culture and maintenance of more than a handful of mutant lines is not practical for any model system. A method of long-term storage at high density would enable control of both the pace and volume of culture work while eliminating the loss of valuable cell lineages. We have generated GFP-labeled populations by transforming *A. acetabulum* with *Agrobacterium tumefaciens* (D. Capps, A. McMahon & DF Mandoli unpublished). Some of these transformants display mutant phenotypes in the T1 generation. Because the genes associated with these defects may have been disrupted and therefore “tagged” with a foreign gene (GFP), each of these phenotypes has the potential to reveal key information regarding gene function. *A. acetabulum* can be stored as diploid zygotes at 15°C for 2-4 years (Berger, S. & Kaefer, M.J. 1992. *Dasycladales: An Illustrated Monograph of Fascinating Algal Order*. Elsevier Press, London. 247 pp.). Cryopreservation of haploid gametangia in liquid nitrogen would be more efficient, reducing the labor and space required. Furthermore, cryopreservation of the haplophase would facilitate experimental crosses because, unlike diploid zygotes that must reach maturity before they can be crossed, haploid gametangia can be crossed immediately. Three cryoprotectants in seawater (glycerol, DMSO, MeOH) gave viable gametangia upon thawing. Gamete release and mating occurred in the days following thawing of *A. acetabulum*. Quantification and refinement of cryopreservation will yield an important tool enabling large-scale mutant searches in *A. acetabulum*.

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## **SESSION 1I**

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### **MECHANISMS OF DISEASE, INFECTION, AND HEALING**

*Session Moderator: Rachel Klevit, Biochemistry*  
*Session Assistant: Tobias Joel, Sophomore, Pre-Social Sciences*

**Mary Gates Hall Room 287**

### **Effects of Environmental Enrichment on Progenitor Cell Fate in the Dentate Gyrus Following Traumatic Brain Injury in Rats**

*Lindsey Gaulke, Senior, Biology*  
*Mentor: Ramona Hicks, Rehabilitation Medicine*

Millions of people sustain a traumatic brain injury (TBI) each year, and many experience long-term cognitive and behavioral deficits. Neurons in the hippocampus – a region of the brain important for learning and memory – are especially vulnerable to damage. According to the old dogma, lost neurons were not replaced after TBI; however, recent studies have shown that progenitor cells do exist in the adult mammalian brain, producing new neurons and astrocytes throughout life. In rodents, neurogenesis has been identified in the dentate gyrus (DG) region of the hippocampus. Studies have shown an increase in DG progenitor proliferation after TBI, suggesting self-repair of the brain after injury. Neurogenesis also increases in uninjured animals living in an enriched environment. In the present study, we used a lateral fluid percussion model of TBI to examine the effects of environmental enrichment on progenitor cell fate in injured rats. The animals received either a fluid percussion or sham injury, and were then housed in standard or enriched environments. We injected the rats with the mitotic marker bromodeoxyuridine (BrdU) 48 hours after injury and euthanized them after four weeks. Following brain removal, we cut sections through the injured area and stained them with markers for neurons, astrocytes, and BrdU. We then recorded the number and fate of new cells in two sub-regions of the DG, the hilus and the granule cell layer. Environmental enrichment significantly increased cell proliferation in both the hilus and granule cell layer in injured animals. These animals also had more new neurons in both regions, and more astrocytes in the granule cell layer than sham animals or those with injury but no enrichment. The effects of enrichment on survival and fate of the progenitors after TBI supports the hypothesis that they may contribute to functional recovery after injury.

### **The Role of Polycomb and Trithorax Genes in Multipotency**

*Christina Leonhard, Junior, Biology*  
*Anne Sustar, Lab Technician, Biology*  
*Mentor: Gerold Schubiger, Biology, Genome Sciences*

What special properties of stem cells and other pluripotent cells allow them to sustain the ability to differentiate to a range of fates? The answer may be found in *Drosophila*. *Drosophila* imaginal discs of the larvae, the precursors for

adult structures, have the ability to undergo transdetermination, which is when cells in discs that are determined for one state, such as leg, switch to the determined state of another disc, such as wing. The Schubiger lab participated in a microarray study that identified mRNAs different in transdetermining versus non-transdetermining cells. This study found that several members of the Polycomb group (PcG) and trithorax group (trxG) genes were shown to be up or down regulated. We tested the functional role of these genes by inducing transdetermination and checked for changes in transdetermination frequency in loss of function mutants. We identified three mutant genes that caused significant deviation from the expected frequency of transdetermination. Of these three genes, both Polycomb and Enhancer of Zeste had enhanced mRNA representation while Suppressor of Zeste(2) reduced mRNA representation. Polycomb and Enhancer of Zeste mutants significantly increased the frequency of transdetermination in leg discs, while Suppressor of Zeste(2) mutants eliminated the transdetermination event. Next, we will test whether gain-of-function of these genes affects the frequency or area of transdetermination. Furthermore, to verify the expression profile of these genes from the microarray, in situ must be done on transdetermined discs. Investigating these genes will help define what about these cells allow them to gain multipotency.

### ***In Vitro* Interference of Survivin Phosphorylation in Therapy-induced Senescence**

*Belinda Luk, Senior, Biology*

*Mentor: Daniel Y. Wu, Medicine, Oncology*

Survivin is member of the human inhibitor of apoptosis (IAP) family shown to inhibit programmed cell death (apoptosis). Known to be over-expressed in 80% of cancer cells, survivin has been postulated to enable cancer cell survival following therapy. Survivin is phosphorylated in mitosis by the cyclin-dependent mitotic kinase Cdc2 (also known as Cdk1). This regulatory event has been shown to be pivotal for the stability of the survivin protein and may be a direct effector event of Cdc2 deregulation that occurs in escape of cancer cells from therapy-induced accelerated cellular senescence. We have postulated that specific interference of the survivin phosphorylation can prevent senescence escape and thereby enhance cancer therapy. As a proof of principle, we sought to generate specific peptide inhibitors and test their effect on *in vitro* phosphorylation of survivin by Cdc2 kinase. We therefore established an *in vitro* kinase assay by generating recombinant survivin in a glutathione-S-transferase (GST) fusion protein expression system. I show here that a dimerized cyclin B1-Cdc2 kinase can efficiently phosphorylate survivin only after the GST fusion partner is removed. Peptides designed based on known phosphorylation site on survivin are tested in this kinase system and shown to specifically interfere with survivin phosphorylation. In the near future, I plan to ex-

amine the *in vivo* effect of these peptides on therapy-induced ACS by fusing their sequences to a delivery sequence derived from HIV Tat protein.

### **Structural and Functional Analysis of the Sensor Kinase PhoQ by NMR**

*Anna Schneider, Junior, Biochemistry, Mathematics*

*Mary Gates Scholar*

*Mentor: Rachel Klevit, Biochemistry*

Two-component systems are a class of very common regulatory systems used by many Gram-negative bacteria to control essential cell functions related to pathogenesis. Each two-component system is composed of a sensor kinase protein that, when activated by a signal, phosphorylates a specific partner protein that regulates gene expression. One such sensor kinase is PhoQ, an integral membrane protein in *Salmonellae*. PhoQ contains a transmembrane domain, an extracytosolic sensor domain, a second transmembrane domain, and a cytosolic histidine kinase domain. We are seeking to determine the biochemical mechanism by which the sensor domain of PhoQ senses the signal molecules  $Mg^{2+}$  and C18G (an antimicrobial peptide), and the changes in the protein's three-dimensional conformation that result from the sensing event. Our primary technique is two-dimensional nuclear magnetic resonance spectroscopy (2D-NMR), which detects the chemical environment of each amino acid residue within the protein and allows one to track dynamic changes in protein conformation in solution. Specifically, we have isolated a mutation (H157R) in the *phoQ* gene that reduces the bacteria's ability to respond to either  $Mg^{2+}$  or C18G. Wildtype and mutant versions of the PhoQ sensor domain labeled with nitrogen-15 were expressed and purified, and their 2D-NMR spectra were collected either in the presence or absence of  $Mg^{2+}$ . As expected, the mutant spectrum does not change upon addition of  $Mg^{2+}$ , but the mutant spectrum is significantly different from either the  $Mg^{2+}$ -free or the  $Mg^{2+}$ -bound wildtype spectrum. Next, three-dimensional NMR spectra were collected of the wildtype sensor domain labeled with both nitrogen-15 and carbon-13. These data were used to assign each peak in the NMR spectra to a specific amino acid in the protein allowing us to interpret each spectrum at a deeper level.

### **Sphingosine-1-phosphate mediated smooth muscle cell migration**

*Dustin Shilling, Senior, Biochemistry, Neurobiology*

*Mary Gates Scholar*

*Mentor: Guenter Daum, Vascular Surgery, Biochemistry*

Today thirty percent of vascular surgery patients suffer from restenosis, a complication in which smooth muscle cells (SMCs) generate an intima and cause a narrowing of the lumen and restriction of blood flow. It is unclear why some patients develop restenotic lesions and others do not, but a genetic predisposition is probably responsible. To address

this phenomenon, our laboratory investigates two mouse strains, one of which develops occluding lesions after carotid ligation injury (FVB), and one that does not (C57Bl/6). My research focuses on identifying biochemical mechanisms responsible for migration of SMCs derived from these two strains, as migration of SMCs from the media towards the lumen of the injured vessel is a critical process in intima formation. I screened aortic SMCs for differences in migratory response to various chemoattractants, including platelet-derived growth factor (PDGF) and sphingosine-1-phosphate (S-1-P), using a Boyden chamber analysis. From these experiments, I found that S-1-P acts as a strong chemoattractant of FVB-SMCs, but not for C57Bl/6-SMCs, and that S-1-P amplifies the PDGF migratory response in FVB-SMCs and causes an inhibition in the PDGF induced migration of C57Bl/6-SMCs. In investigating why S-1-P has different effects in the two cell types, I found that FVB-SMCs activate protein kinase B (PKB) in response to S-1-P stimulation, whereas C57Bl/6 mice do not. PKB is well documented in regulating changes in the cytoskeleton and providing the capacity for cell movement. We suspect that FVB cells express an S-1-P receptor that is absent in the C57Bl/6 SMCs and upon activation leads to PKB activity and cell migration. These results point to S-1-P as a potentially critical factor in vascular lesion development, and suggest that the response to S-1-P may be part of the genetic variability in humans. Ultimately, S-1-P may emerge as a novel target for pharmacological interventions to prevent restenosis.

#### **Characterizing Novel Interactions between Lamin A/C and UBC9**

*Linnea Welton, Senior, Neurobiology and Swedish*

*Mary Gates Scholar*

*Mentor: Brian Kennedy, Biochemistry*

Laminopathies are a group of debilitating diseases that arise from mutations in *LMNA*, the gene encoding A-type nuclear lamins. A-type lamins are proteins important to the architectural integrity of the nucleus. They are also thought to influence chromatin organization and gene expression. To better understand the roles of A-type lamins, it is imperative to identify functionally relevant interacting proteins. We performed a yeast two-hybrid screen, using full-length lamin A as the bait protein, to identify novel A-type lamin-interacting proteins. A first round of the screen identified UBC9, a SUMO conjugating enzyme. SUMO is a small ubiquitin-related modifier protein that is covalently linked to lysine residues in a variety of target proteins. The post-translation modification of proteins by SUMO can modulate their function in cellular process, such as gene expression. Currently we are verifying the candidate lamin A-UBC9 interaction using a variety of approaches. Through *in vitro* binding assays, we are mapping the relevant domains of lamin A important for UBC9 binding. We are also performing immunofluorescence assay to determine whether these two proteins colocalize in subnuclear

domains. Ultimately, we will test whether disease-associated mutants of lamin A are compromised in UBC9 binding as a first step to determine whether this interaction is significant in the prevention of laminopathies.

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## **SESSION 1J**

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### **NEW MATERIALS, STRUCTURES, AND SYNTHETIC STRATEGIES**

*Session Moderator: Alvin Kwiram, Chemistry*

*Session Assistant: Robert Snoeberger, Senior, Chemistry, Mathematics*

**Mary Gates Hall Room 284**

#### **Towards the Synthesis of a Magnetic Conducting Polymer**

*Trisha Andrew, Senior, Chemistry*

*Mary Gates Scholar*

*Mentor: Natia Frank, Chemistry, University of Victoria*

A fairly recent development in materials science technology is the concept of using organic molecular materials as alternatives or complements to the inorganic, solid-state components found in conventional structures, such as switches, conductors, and semiconductors. In addition to their potential technological interest, one particular class of multifunctional materials – molecular-based magnetic semiconductors – has the added attraction of occupying a relatively uncharted niche in science. While the interplay between conductivity and magnetism in inorganic systems is beginning to be understood, an explicit knowledge of the synchronicity between conductivity and magnetic exchange interactions in organic systems is yet to be attained. The long-term goal of this project is to garner an understanding of spin-correlated conductivity in organic systems by (a) exploring the structure-activity relationships that govern the influence of conductivity on magnetic exchange and vice versa and (b) constructing an appropriate model system that combines conducting and magnetic functionalities in a single component. In that vein, an organic oligomer (quinquethiophene) bound systematically and covalently to stable organic radicals (benzoimidazole-1-yl-3-oxyl-1-oxide) was proposed as a potential model system for investigating spin-correlated conductivity in organic systems. In order to lay the initial steps to assembling the proposed model system, the synthesis and characterization of certain key “monomers” was attempted and the results discussed herein. 6-Bromo-3-oxy-2-phenyl-5-thiophen-2-yl-benzoimidazol-1-ol (ThioBrBNN) and 5-bromo-3-oxy-2-phenyl-benzoimidazol-1-ol Radical (BrBNN) were synthesized with 17% and 34% yield, respectively, and characterized by EPR and UV-vis spectroscopy. The EPR spectra of ThioBrBNN and BrBNN are dominated by the hyperfine coupling of the unpaired electron with two equivalent nitrogen nuclei, one bromine

nucleus, and aromatic protons. In addition, however, the EPR and UV-vis spectra of ThioBrBNN display noticeable perturbations caused by the presence of a thiophene moiety, thus confirming the presence of electronic coupling between the radical and oligomeric components of the proposed model system.

### **Kinetics and Mechanisms of Oxidation of Lead (II) Solid Phases by Chlorine in Drinking Water**

*Haizhou Liu, Junior, Civil and Environmental Engineering  
Jaeshin Kim, Graduate, Civil and Environmental Engineering*

*Mentor: Gregory Korshin, Civil and Environmental Engineering*

Dramatic increase of water-borne lead in Washington DC drinking water caused by subtle changes of its chemistry has shown the importance of unexplored reactions between species of Pb(II) and chlorine/chloramine. It is now believed that lead contamination in drinking water distribution systems with lead pipes occurs via the corrosion of Pb (0) and dissolution of lead (II) solid phases, for instance hydrocerussite  $Pb(CO)_2(OH)_2$ . In contrast with that, lead (IV) oxides, especially  $PbO_2$ , have very low solubility and are deemed to be beneficial for lead control. Since the oxidation of lead (II) solid phases by chlorine is crucial for the formation of Pb (IV) species, the goal of our project was to determine the rates of oxidation of the representative lead (II) phases by free chlorine, explore influences of major water chemistry parameters and understand their relationship with lead solubility. Particles of hydrocerussite and lead oxide (500 mg/L) were placed in water containing chlorine (15 to 50mg/L) at different pHs, total carbonate and chloride concentrations. Scanning electron microscope (SEM) and X-ray diffraction (XRD) gave information on the morphology and surface structure of formed solid phases. It was observed that the Pb(II)-chlorine reactions had characteristics of a self-catalytic oxidation reaction sensitive to the concentration of chloride. There was a lag period (4 to 8 hours) for chlorine consumption before it steadily decreased as a result of lead (II) oxidation. The lag period was shortened to < 4 hours when the system was either exposed to the atmosphere or in the presence of total carbonate concentration < 0.001 mol/L. The reaction did not occur for the oxidant concentrations below a threshold level (ca. 15 mg/L as Cl<sub>2</sub>) or when the total carbonate was as high as 0.01 mol/L. The results of this study will provide a better understanding necessary for predicting lead release in drinking water distribution system and preventing lead contamination.

### **Effects of Guided Phase Separation on the Efficiency of Polymer Photovoltaic Devices**

*Peter Salvesson, Senior, Biochemistry*

*Mary Gates Scholar*

*Mentor: David Ginger, Chemistry*

The growing energy needs of the planet necessitate the development of efficient and cost effective sources of renewable energy. Solar energy has the potential to fill this need. However, current silicon based solar cells have a prohibitively high cost/ampere ratio. Solar cells made from blends of conjugated polymers could potentially be much more cost effective. Unfortunately, the efficiency of current polymer solar cells is orders of magnitude less than their silicon counterparts. The phase-separated morphology of polymer blends is known to impact solar cell performance. The goal of this project is to study the phase separation of polymer blends on indium tin oxide (ITO) substrates and to understand how changes to the film morphology affect the efficiency of the entire solar cell. We have used both Dip-Pen Nanolithography and microcontact printing to change the chemical properties of ITO substrates with phosphonic acid monolayers. Thus, we alter the phase separation of polymer blends coated onto these electrodes. We present a comparison of photovoltaic device efficiency versus surface patterning and the resulting polymer morphology. Additionally, we discuss the possibility of using surface modification as a viable strategy for improving solar cell efficiency.

### **Synthesis of Iridium Complexes for the Study of Carbon-Hydrogen Bond Activation**

*Jared Silvia, Senior, Chemistry*

*Mary Gates Scholar, Goldwater Scholar, Churchill Scholar*

*Mentor: D. Michael Heinekey, Chemistry*

Carbon-hydrogen bond activation is a highly sought after goal in the field of organometallics. The ability to selectively break the carbon-hydrogen bond in an organic molecule would allow for the functionalization of saturated hydrocarbons for use in a wide variety of processes including polymer manufacturing. The purpose of this research is to address the problem of C-H bond activation through the use of a metal catalyst. The complex of tris(3,5-dimethylpyrazolyl)borate iridium(III) trimethylphosphine dihydride ( $Tp^*Ir(PMe_3)_2H_2$ ) has been studied as a possible starting material for such a catalyst. Work has focused on modifying the supporting ligand structure to yield a metal center with the desired reactivity. Various pathways have been attempted to reach the desired molecule starting from the same initial complex. Further work has focused on developing a novel, three-coordinate tris-carbene ligand. This ligand, which would bind in a facial manner, has not been studied with iridium complexes. The main interest is in the properties of the dihydrogen complexes involving the tris-carbene ligand. Such a complex would be an intriguing comparison with the well-studied  $Tp^*$  analog which has been the primary focus of research. All manipulations are performed in an air-free environment. Characterization of the various complexes is achieved primarily through proton and phosphorous nuclear magnetic resonance (NMR), and mass spectrometry.

## **Controlling Nucleation and Growth with Dip-Pen Nanolithography**

*Ryan Thompson, Junior, Chemistry, Program on the Environment*

*Mentor: David S. Ginger, Chemistry*

Dip-Pen Nanolithography is a relatively new technique that allows one to tailor surface chemistry on the nanometer scale. We are using this technique to study how nanoscale surface templates can serve as sites for the nucleation and growth of larger two- and three-dimensional structures. To accomplish this, we begin by writing nanoscale dots of alkythiol molecules with either hydrophobic or hydrophilic terminal functional groups using an Atomic Force Microscope (AFM) tip. We can create surface features as small as 50 nanometers in diameter. We use this technique to study template-directed nucleation in two separate systems: phase-separating polymer blends, and catalytically active inorganic binding peptides. In the polymer experiments, we spin coat a polymer blend solution at high speeds onto the substrate. We then study the resulting polymer films using optical and AFM to examine the impact of the patterns of the phase separation of the polymer film. For the peptide experiments, we attach peptides to the patterned features using electrostatic interactions. We have shown that the procedure allows us to guide phase separation in polymer thin films and direct the absorption of small peptides to fixed sites on surfaces.

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## **SESSION 1K**

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### **RETHINKING CAPITALISM AS SOCIAL ENGINEERING: THE DYNAMICS OF CAPITALISM IN CULTURAL AND HISTORICAL DIFFERENCE**

*Session Moderator: Clarke Speed, Anthropology*  
*Session Assistant: Anna York, Program Coordinator,*  
*Jackson School of International Studies*

**Mary Gates Hall Room 242**

#### **The Spirit of Capitalism: A Look at Cultural Narratives of Contemporary China and 19<sup>th</sup> Century America**

*Heather Evans, Senior, Anthropology, Comparative History of Ideas*

*Mentor: Bryan Tilt, Anthropology*

The goal of this project is to identify recurring themes in cultural narratives that develop as societies experience intense economic capitalization. Cultural narratives, the stories we tell ourselves about who we are, encompass a wide range of material including patriotic tales, religious scripts, and parables. Within each culture's collection of stories or narratives, there are recurring themes or "scriptlines" that are picked up and repeated, reinforcing the weight with which those scriptlines are valued by society. This project

examines cultural scriptlines common to both the early American Protestant work ethic stories and to the narratives currently being constructed in China since economic reforms adopted by Deng Xiaoping in the late 1970s. Through a review of historical research on and popular literature of early 19<sup>th</sup> century America, this paper explores the 'rags-to-riches' and 'rugged individualism' scriptlines developed in America during budding industrialization. Comparatively, the paper also examines the emerging capitalist identity of the growing, mobile labor force or 'floating population' in China through a review of ethnographic information collected by anthropologists during the last twenty years as China moves toward full economic liberalization. This project highlights the function of cultural narratives in rationalizing social changes wrought by economic transitions, drawing a parallel between the Protestant work ethic and the emerging discourse surrounding *suzhi* or "cultural quality" in contemporary China. The paper argues that cultural scriptlines underpinning a successful capitalist system include: the virtue of industriousness, the righteousness of enduring hardship, self-determination, and tokenism. These scriptlines, common to both contemporary Chinese and 19<sup>th</sup> century American narratives, are essential to justifying the personal risk and rewards, and the class hierarchy resultant of a capitalist system.

#### **The Train Wreck: Economic Liberalization and Human Rights Colliding in the Global South**

*Cameron Herrington, Senior, International Studies*

*Mary Gates Scholar*

*Mentor: Angelina S. Godoy, Law, Societies and Justice, International Studies*

Focusing on Guatemala, this project examines two sets of international legal pressures upon the state, how they conflict with each other, and how this collision of interests is playing out in the global South. Economic liberalization pressures require the state to limit its participation in the economy, including the provision of social services and the regulation of the market. However, human rights mandates increasingly call upon the state to ensure that economic and social rights, including access to clean water and health care, are granted to their citizens, many of whom cannot afford them in a liberalized market environment. These two opposing mandates, both stemming from the global North, are like two trains rushing headlong at each other. This research investigates what happens at the point of collision. The result of this project will be an article that draws upon field research completed in Guatemala in July 2004, as well as extensive research on the Central American Free Trade Agreement (CAFTA). The primary case study will be that of a group of Guatemalan HIV/AIDS patients who have brought a case before the Inter-American Commission of Human Rights claiming that their government is violating their human rights by not providing them with antiretroviral medication. At the same time, Guatemala is on the verge of entering into CAFTA, which contains intellectual property

provisions that further limit access to generic drugs. If the patients are successful in forcing the government to provide them with medication, the state will be legally obliged to do so, yet less able to do so as a result of CAFTA. Research in these areas is largely completed. The remaining task is to situate the obligations placed upon the Guatemalan state by these two sets of international law – trade agreements and human rights instruments – in the context of a theoretical discussion of sovereignty, human rights and hegemony.

### **Bolivian Rain: Redefining Human Rights within the Neo-liberal Order**

*Hannah Janeway, Comparative History of Ideas, International Studies*

*Mentor: Angelina Godoy, International Studies*

In the past decade increasing water scarcity has led to both increased dialogue and conflict concerning the role water should play in our globalized world. On the forefront of this debate has been Cochabamba, Bolivia. In early 2000, Cochabamba's water supply was privatized leading to riots that spread across the country. These riots signified Bolivians renunciation of the classification of water by major international institutions as a human need, not a human right. This paper examines social and economic arguments about the classification of water as a human right. It looks at if water's privatization violates this fundamental right. The topic is approached through an examination of both scholarly written works and personal accounts and through first hand experiences and interviews. The paper addresses the social, political, and economic factors leading to the water wars in Cochabamba. It stresses that access to water is a human right and suggests that the violation of this right resulted from Bolivia's impoverished position in the neo-liberal economic order. Dependence on foreign aid, due to lack of domestic capital, liberal economic conditions of lending institutions and domestic corruption pigeonholed the Bolivian government into a flawed privatization process. I argue that there is an urgent need for the World Bank to re-evaluate some of its policies. In conclusion, the paper also recognizes the complexity of the issues and formulates solutions for the future.

### **Brand Name Holding Companies**

*Daniel Jung, Senior, International Studies*

*Mentor: Gary Hamilton, Sociology, International Studies*

This research provides empirical data to the emergence and diversification of brand name holding companies since 1960. A brand name holding company is a firm that does not manufacture or retail the products they merchandise. Using the Fortune 500 and case studies as a starting point, it examines the proliferation of brand name holding companies across four consumer product categories: apparel and footwear, health and beauty products, consumer electronics, and food and beverages. By observing how firms

have created and acquired brands over the past forty years, it becomes clear that brands have become more than just a tool to distinguish products or signify quality. Rather, they are a method for firms to establish organizational control over an increasingly complex consumer market. Comparisons of brand name ownership across product categories reveal external factors that influence the manner in which firms stake out market space and cater to demands. More specifically, these findings attempt to connect the increasing prominence of brand name holding companies to the rise of contract manufacturing and the emergence of big-box retailers such as Wal-Mart and Target. The incorporation of these three aspects of production into a broad perspective on the new American firm provides a clear picture of how the proliferation of brand name holding companies has affected manufacturing, retailing, and vice versa.

### **Mutual Integration: The Interaction Between the U.S Catholic Church and Latino Communities**

*Erin Murphy, Senior, American Ethnic Studies*

*Mentor: Erasmo Gamboa, American Ethnic Studies*

The large influx of Latino immigration to the United States simultaneously means a considerable increase in the U.S. Catholic population. The Meso-American Indian heritage of Latinos creates a culture very different from the previous Anglo-European immigrants. The U.S. Catholic Church, as an institution, has been challenged to devise new ways of ministry in order to effectively care for these people who are defined by this distinct culture. This project examines how the Catholic Church has, or has not, adequately integrated the growing population of Latinos and their divergent culture. The first part of my research investigates this question within a historical context from 1848 to the present day. I will explore prominent issues pertaining to the interaction between the Catholic Church and Latino communities. These issues include Americanization and the pressures of assimilation and identity, discrimination, language obstacles, Protestant involvement, and transnationalism, which is the constant flow of people and/or material items between national borders. I also aim to interview Catholic Church leaders and laypeople and include their assessment of the contemporary situation. The second part of my research focuses on Mexican-Americans and the Catholic Church's reception of their cultural symbols and icons, which are central to religious rituals. The incorporation of images and rituals mirrors the larger incorporation of the people and their culture and the transformation of the Catholic Church. I anticipate the study to reveal the Catholic Church's progress in successful integration of Latinos and their culture; however, much more still needs to be accomplished. Latinos are a living testimony of previous reluctance to integrate. The tension between two incredible opposites, indigenous and European, gave birth to the mestizaje as the contradictory cultures conformed to each other. Their ability to alter and incorporate is a model for the U.S. Catholic Church today and society in general.

## **Implications of Intellectual Property Law on Human Rights Theory**

*Brian Rowe, Senior, Informatics, Political Science*  
*Mentor: Melody Y. Ivory-Ndiaye, Information School*

Intellectual Property Rights (patents, trade secrets and copyrights) have gained much attention over the past few years with the explosion of information dissemination and recent expansion of patents to cover processes and trade secrets to include software source code. The focus of this study is to explore the interaction of Intellectual Property with Human Rights. The exploration is conducted through a literature review of the history of Intellectual Property Rights and interviews with professionals in the Human Rights and Intellectual Property fields. I will interview professionals in the Intellectual Property and Human rights fields with the intent of better understanding the link between these two areas of rights. This study will help to create a dialog over questions including but not limited to: Do trade secrets interact with freedom of expression? Do patents influence individual's health and well-being? How do trade secrets interact with freedom of expression? Results of these interviews and the literature review may provide ideas on how to balance competing interest or use right structures to support mutual interests. More information can be found at the study website [www.freedomforip.org](http://www.freedomforip.org).

## **National Development Policies in Light of Chinese Global Manufacturing**

*Trisha Rule, Senior, International Studies*  
*Monique Atherton, Senior, International Studies*  
*Srinivas Duggirala, Senior, International Studies*  
*Jason Hinsley, Senior, International Studies*  
*Jesse Jahnke, Senior, International Studies*  
*Yayoi Koyama, Senior, Political Science*  
*Tracy Lin, Senior, International Studies*  
*Hillary Madsen, Senior, International Studies*  
*Kammy Man, Senior, International Studies*  
*Camille Reynaud, Senior, International Studies*  
*Megan Salmon, Senior, Business Administration, International Studies*  
*Lina Tang, Senior, International Studies*  
*Amy Tung, Senior, International Studies*  
*Joanna Wong, Senior, International Studies*  
*Richard Yu, Senior, Business Administration, International Studies*  
*Mentor: Gary Hamilton, Sociology*

China has started market reforms in 1978, and has grown at an annual rate of over 9 percent for the last 20 years. Currently, it is the 6<sup>th</sup> largest economy and the 4<sup>th</sup> largest trading nation in the world. The imbalance between China and the United States makes China the single largest source of American trade deficit. Our research examines China's extraordinary growth and its close linkages with the US economy, as well as changes in the US economy that are directly related to the dynamic economic changes in Asia.

Based on our examination, we have developed recommendations for developing trade policies with China and with other nations regarding China. In our research, we have compiled and analyzed China's integration into the global economy by investigating China's current export economy and patterns of growth. The project has also closely examined the manufacturing sector of the economy, which serves as an obvious demonstration as the engine of China's economic growth. In this next phase of our research, financial institutions are examined such as the emerging Chinese securities, bond markets, and regulatory reform. Additionally, we have also incorporated issues concerning sustainability and stability in regards to China's legal regime, environment, and human rights arena. The examination of China's historical background, manufacturing, and financial sectors is crucial in assessing its economic growth and formation of recommendations for trade policies, as well as the sustainability for the rest of the world.

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## **SESSION 1L**

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**\*Note: Titles and Abstracts in order of presentation.**

## **SHAPING LEARNING EXPERIENCES IN UNIVERSITY EDUCATION**

*Session Moderator: Brad Portin, Educational Leadership and Policy Studies*

*Session Assistant: Maria-Jose Bravo, Senior, Biology*

**Mary Gates Hall Room 251**

### **On-line Exhibit: Chinese Students in UW**

*Shi Chen, Junior, Anthropology*

*Lin Li, Junior, Anthropology*

*Mentor: Stevan Harrell, Anthropology*

The project is performed by two exchange students from China in the UW-Sichuan program that will finally be put on the Burke Museum's website. Chinese students have been at the UW for one hundred years, from initially the very few people to now about several hundred students from mainland, Hong Kong, Macao and Taiwan. How was their life in UW and US society like and changed through these periods? How does this reflect Chinese people's experience and identity in U.S.? And how does this reflect Chinese and U.S. society as well as the relationship between both through the past one hundred years? We will try to explore and present these issues by a vivid exhibit on line, which will be composed of documentary and oral history, concrete data, and a lot of photos and interview movie clips. We collect these materials from various resources, including official documents from UW and U.S. government, newspapers, literature, interviews, and photos both from individuals and Wing Luke Asian Museum. Then we will contextualize those and make it visible and lively on a website, using website-designing and movie-processing

technology.

### **The Effects of Sleep Quality and Sleep Quantity upon the Life Satisfaction of College Students**

*Elizabeth Haller, Junior, Psychology, Seattle University*  
*Christopher Rinehart, Senior, Psychology, Seattle University*

*Mentor: Kathleen Cook, Psychology, Seattle University*

College dormitory students who received an average of 6.5 to 8.5 hours of sleep per night were hypothesized to have higher feelings of life satisfaction than those who received a different average amount of sleep per night. Life satisfaction was measured by the variables mood, happiness, depression, self-esteem, stress, and physical health. The students who had low sleep quantity were hypothesized to have the same sleep quality as the students who had high sleep quantity. The students who had low sleep quality were hypothesized to have a lower life satisfaction than those who had high sleep quality. Sleep quality was measured by the variables energy, the degree to which the subject woke up feeling well-rested, the subject's level of fatigue, and the degree to which the subject had trouble sleeping at night. Data showed that the relationship between sleep quantity and sleep quality was not statistically significant. In addition, the relationships between sleep quantity and life satisfaction and between sleep quality and life satisfaction were not statistically significant. Recommendations for future research include the use of a sample with a larger age range representation because college students do not represent the entire population.

### **The History and Culture of Engineering Education at the University of Washington**

*Charles Rogers, Senior, Comparative History of Ideas, Community, and Environmental Planning*  
*Mary Gates Scholar*

*Mentor: Clarke Speed, Anthropology*

Considering engineers' powerful occupations to design and maintain the technologic means through which people mediate reality, an examination of Engineering education—the ordering of the engineer him- or herself, allows for a unique aperture into the culture of science and possibly whiteness itself. No comprehensive, written history or teaching philosophy—from the perspective of an independent observer—of the University of Washington's College of Engineering exists. Using interviews and primary source historical documents obtained mostly from the University of Washington Library's Archives, this project probes the development and growth of the College of Engineering as a site where knowledge is produced, and consciousnesses shaped, to meet the technological demands of not only Washington state, but also a growing national superpower and the global applications of a culture of science.

### **Small Group Research**

*Sally Rosamond, Senior, Interdisciplinary Arts and Sciences, UW Bothell*

*Mary Gates Scholar*

*Mentor: Diane Gillespie, Interdisciplinary Arts and Sciences, UW Bothell*

Instructors use student groups frequently in undergraduate classrooms to create learning situations that include working as a part of a team and sharing knowledge and skills. Behavioral and sociological theories of human learning support this pedagogy; however, students have expressed anecdotally that interpersonal conflicts and unfair work distribution create negative group experiences. In this on-going study, we are investigating undergraduate classroom groups in the Interdisciplinary Arts and Sciences program at the University of Washington, Bothell campus. We are using the qualitative research methods of in-depth interviews and focus groups to collect data from students and faculty. Analyzing interview transcriptions, we have generated themes that we are further validating through additional interviews and focus groups. The two themes that have emerged are: 1) students apply labels to group members, often quickly evaluating the group member's potential to contribute; and 2) frameworks from pre-existing work and organizational contexts guide students' decisions about how to interact in their groups. In the first paper from this research, we are identifying how these labels and frameworks are influencing the social dynamics of groups and are enhancing or inhibiting scholarly collaboration.

### **The Effects of Mental Construal on Academic Goal Achievement**

*Jonathan Sabo, Senior, Psychology*

*Mary Gates Scholar*

*Mentor: Jason Plaks, Psychology*

The purpose of my research is to explore how the way people mentally construe their educational goals affects their effort, strategies, and performance in a difficult college course. Do people put in more and get better results when they focus on abstract, 'why' related details of their goal (keeping their eye on the prize)? Alternatively is effort and success facilitated by an emphasis on concrete, 'how' related details (taking things one step at a time)? To explore these questions, I conducted a longitudinal study in an introductory Neuroscience course. Students filled out questionnaires assessing their chronic level of construal, self-esteem, goal orientation, and self-efficacy. The student's study habits, strategies, and performance on each exam throughout the quarter were assessed. I will discuss the results of this study along with implications for how students should be encouraged to think about their education.

### **Split-Ergativity in Tibeto-Burman**

*Douglas Whitehead, Senior, Linguistics*

*Mentor: Frederick Newmeyer, Linguistics*

Languages with ergative-absolutive morphology case-marking and/or verb-agreement, occupy a sizeable minority of the world's languages. Whereas the crucial distinction for nominative-accusative languages is between subject and object, for ergative languages treat transitive subjects differently from intransitive subjects and transitive objects. However, most ergative languages are not ergative in the strict sense—rather, they employ “split-ergativity”—some environments triggering nominative-accusative morphology, others triggering ergative-absolutive morphology. Ergative splits are common throughout the Tibeto-Burman languages (which includes languages like Tibetan and Burmese), conditioned in some cases by verb aspect, in other cases by verb semantics, and in others by the semantics of the subject noun-phrase. Moreover, multiple conditioning factors may play a role in the ergative split. Split-ergativity Sherpa, for instance, is caused by a combination of verb aspect and NP-semantics. In this paper I will describe and compare the ergative splits in several Tibeto-Burman languages (Tibetan, Kham, Thulung, Gurung and Vayu). I will consider whether or not split-ergativity in these languages can be accounted within the various frameworks of generative linguistics. In a broader sense, I will consider the relevance of generative grammar in explaining cross-linguistic typological variation in general.

#### **Dialect Study of the Pacific Northwest**

*Alice Lemieux, Senior, Linguistics*

*Mentor: Alicia Beckford-Wassink, Linguistics*

The Dialect Study of the Pacific Northwest is a multi-year sociolinguistic study being undertaken at the University of Washington. This region has been under-represented in previous North American dialect studies (e.g. Dictionary of American Regional English), leaving the speech varieties of the Pacific Northwest difficult to characterize. This has lead many people, laypersons and academics alike, to describe this region as lacking a distinctive dialect. However, settlement history of the region and native speaker intuitions suggest unique dialect features. This study aims to collect the necessary data for linguists to more accurately and scientifically describe the speech in our region. Through this descriptive process the researchers hope to be able to comment on the currently unsupported claims regarding Pacific Northwest American English. The study will progress in several phases: background research, data collection, and analysis. My research for the study entails determining what background research and methodology will be required to conduct the study. I have completed a background study looking at the settlement history of Washington State and the linguistic legacies of the various settlers; with the guidance derived from this research I am developing a pilot study that I will implement in Vancouver Washington to test the methodology for the larger dialect study. My methods will draw on accepted sociolinguistic practice in similar urban studies. This pilot study will collect speech data from 20 informants, including conversa-

tional, reading, and word list data. Informants' demographic information will also be gathered. The acoustic properties of this data will then be measured, analyzed, and summarized in the hope of shedding light on Vancouver speech and correlations between demographic and linguistic features. The results of the pilot study will also be used to test the efficacy of the methodology in order to best conduct the study for the entire Pacific Northwest.

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## **SESSION 2A**

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**\*Note: Titles and Abstracts in order of presentation.**

### **APPLIED MATHEMATICS AND PHYSICS ENGINEERING**

*Session Moderator: Eric Klavins, Electrical Engineering*

*Session Assistant: Tobias Joel, Sophomore, Pre-Social Sciences*

**Mary Gates Hall Room 284**

#### **Computer Model of a Self-Assembly Robotics Testbed**

*Sam Burden, Freshman, Mathematics*

*Mary Gates Scholar*

*Mentor: Eric Klavins, Electrical Engineering*

Self-Organization is a phenomenon that manifests in a variety of contexts: molten rock occasionally forms patterned crystalline structures over long periods of time; cell structures assemble by seemingly automatic processes from nebulous materials; chemical reactions alter compounds in predictable ways. The Self-Organizing Systems group is working to develop mathematical models of these types of automatic processes and provide empirical data to support the models. The lab is investigating self-assembly at three scales: at the nano-scale, where molecular machines can be created by programming single strands of DNA to form specific structures; at the MEMS-scale, where the doping and agitation of silicon cubes could lead to three-dimensional fabrication techniques; and at the macro-scale, where the design and manufacture of a robotics testbed is enabling us to explore specific models of self-assembly in a highly controllable environment. Our testbed is an example of a distributed system, where a large number of relatively simple devices interact locally to produce an interesting global behavior. Triangular robotic ‘tiles’ float passively on a forced-air table, mixed randomly by oscillating fans. When tiles collide, they latch and execute local assembly rules that direct them to either remain latched or break apart. By designing the local rules correctly, a variety of structures can be created. We found the design of the tiles to be a difficult task; I have been working on a computer model of the physical testbed to aid in the design process and to provide a forum to test ideas that are out of the scope of the project, such as assemblies involving thousands of parts.

This model can be validated experimentally and can be used to answer interesting questions about the system.

### **Selective Polymer Deposition on Silicon Microparts For Self-Assembly**

*Harvey Ho, Senior, Electrical Engineering*

*Mentor: Babak A. Parviz, Electrical Engineering*

*Mentor: Christopher Morris, Electrical Engineering*

Self-assembly occurs in nature and most notably in biology. Biological self-assembly can create very complex systems using only basic building blocks. Using nature as a model, our main goal is to use self-assembly as an engineering tool in order to fabricate Micro-Electromechanical Systems (MEMS). Given the scale that we are working with, other methods of fabrication, such as pick-and-place, cannot be used. The microsystems are comprised of microparts, which are our building blocks. Each micropart can be as small as 70-100 $\mu\text{m}$  (the width of a human hair), and can have circuit paths patterned on its surface. Self-assembly requires various microparts to come together and bond in order to form a meaningful structure. The bonding occurs when a glue-like liquid polymer adhesive cures between two adjacent parts. Since there are regions on the micropart where we have circuit elements, we do not want polymer to randomly coat the micropart. Therefore, the major point of this research has been to selectively deposit polymer on specific regions of the microparts. Selective deposition of the polymer was achieved through the insolubility of the polymer in a high water content environment. Utilizing the polar properties of different molecular monolayers, we were able to render regions of a micropart either hydrophilic or hydrophobic. The micropart was initially immersed in an ethanol-polymer solution and water was later introduced into the system. Both liquid polymer and water were soluble in ethyl alcohol, thus when water was added to the solution the polymer precipitated out of the ethanol and sought out the hydrophobic surface. Using this process, we have been able to selectively deposit polymer on hydrophobic gold pads ranging in size from 100 $\mu\text{m}$  to 300  $\mu\text{m}$ . We have determined that when water is added at higher rates, the polymer forms more uniformly across multiple pads.

### **A Java Implementation of Hill's Method for the Computation of Cpectra of Linear Operators**

*Firat Kiyak, Sophomore, Pre-Engineering*

*Mary Gates Scholar*

*Mentor: Bernard Deconinck, Applied and Computational Mathematics*

Differential equations are used in all disciplines of science to model phenomena whose behavior varies continuously with some variable. Assuming a good modeling equation has been found, the next step is to construct solutions of this equation. Having accomplished this, the last step is to investigate the stability of these solutions, so as to deter-

mine what the impact of the solutions we found will be on the original scientific phenomenon. At the most basic level, one examines the linear stability of a given solution: the stability of the solution with respect to infinitesimally small perturbations. Typically this reduces the stability problem to a spectral problem:

$$L y = \bar{\epsilon} y$$

where  $L$  is a differential operator. In this context, the stability problem is the problem of determining all  $\bar{\epsilon}$  values for which a  $y(x)$  exists that is everywhere finite. We have investigated a new numerical method, which is based on Hill's method to analyze the stability of linear operators by computing their spectra. I have implemented this numerical method as a Java-Maple application that can be used to analyze the spectra of linear operators. With this application a user will be able to put in their stability or spectral problem and after that the solution of the problem will be computed and the spectrum plotted. From this output the user will be able to deduce stability or instability, as well as examine the nature of the instability, if one exists. This application will aid in many research projects where linear stability problems are analyzed.

### **Stability and Dynamics of Transverse Field Structures in the Optical Parametric Oscillator Near Resonance Detuning**

*Braxton Osting, Senior, Applied and Computational Mathematics, Physics, Mathematics*

*Mary Gates Scholar*

*Mentor: J. Nathan Kutz, Applied and Computational Mathematics*

Optical parametric oscillators (OPOs) are constructed with quadratic nonlinear materials and are commonly used as tunable sources for coherent radiation and the generation of high power pulses. Parametric mixing between signal and pump fields with cavity diffraction leads to the formation of localized electromagnetic field structures referred to as cavity solitons. Such structures, if stabilized, can be used as fundamental components for all-optical devices and applications. Thus, understanding the underlying dynamical aspects of these nontrivial electromagnetic structures is paramount to technological considerations. We consider the formation and stability of electromagnetic structures in an OPO system near the resonance detuning limit. An order parameter equation is derived for an OPO near resonance detuning limit in two and three dimensions. It is found that the parametric mixing between signal and pump fields with cavity diffraction leads to a quintic, fourth-order evolution equation of the Swift-Hohenberg type which supports the formation of cavity solitons, plane waves, and periodic structures. The formation, interaction, and stability of each of the nontrivial spatial structures is considered via extensive numerical simulations.

### **Theory of Q-Switching in Actively Mode-locked Lasers**

*Joshua Proctor, Senior, Aeronautics and Astronautics En-*

*gineering,*

*Mary Gates Scholar*

*Mentor: Nathan Kutz, Applied and Computational Mathematics*

An analytic theory is proposed which characterizes Q-switching in an active mode-locked cavity as the nonlinear interaction of two unstable modes: one symmetric, another anti-symmetric. The phase difference between these modes generates a nonlinear beating interaction which gives rise to quasi-periodic behavior in the laser cavity. This quasi-periodic behavior is responsible for the Q-switching phenomena and is controlled by the interaction and overlap between neighboring pulses. Using a linear stability analysis, a simple qualitative description of the Q-switching phenomena is given which is verified with numerical simulations of the governing active mode-locked equations. This model characterizes the Q-switching as a function of the physical parameters of the laser cavity and elucidates the mechanisms for controlling its behavior.

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## SESSION 2B

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### EARTH SCIENCES AND ANCIENT LIFE

*Session Moderator: Erin Miller, Physics*

*Session Assistant: Barbara Owens, Academic Counselor, Biology*

**Mary Gates Hall Room 271**

#### **“The Drumbeat of Tiny Raindrops”: Climate Feedbacks on the Evolution of Mountain Ranges**

*Jennifer Fletcher, Senior, Physics*

*Mary Gates Scholar*

*Mentor: Gerard Roe, Earth and Space Sciences*

Mountainous ranges on Earth are shaped by the combined processes of tectonics, erosion, and climate. Plate convergence causes uplift of mountain ranges, which are eroded over time by the action of rivers and glaciers, which in turn are controlled by climate. A useful framework for looking at this problem is that of a critical wedge orogen, an idealization of mountain evolution whereby the mean profile maintains a constant slope. Previous research shows that a robust scaling relationship exists between the width of the mountain range, the precipitation, and the flux of rock into the system. However, this work treated the precipitation as independent of mountain scale. The fact that precipitation is affected by mountain topography is exemplified by the rain shadow characteristic of so many mountain ranges. I am coupling orographic precipitation feedback models, in which the precipitation is a function of the size of the orogen, with the critical wedge scaling relationship. Simplifying model assumptions make it possible to derive analytical expressions for the gain of the system with feedback. These expressions make the relationship between the sensitivity of the system and the mountain width, flux of rock from

plate convergence, and precipitation tractable. The goal is to better understand the sensitivity of a critical wedge to the orographic precipitation feedbacks. One interesting possibility is that of a strong positive feedback, in which precipitation significantly decreases with mountain scale. As the mountain size increases, the decrease in precipitation reduces erosion and causes the mountain to grow more in response to tectonic flux, the result being a “runaway mountain.” Preliminary results show that while this dramatic behavior may be restricted to a narrow range of conditions; the strength of the feedback is nonetheless a dominant control on the size of the mountain range. Results are used to better understand the physics underlying the interplay between climate, tectonics, and erosion in mountain ranges.

#### **Unusual Landforms on Mars**

*Christopher Glein, Senior, Chemistry*

*NASA Space Grant Scholar*

*Mentor: Stephen Wood, Atmospheric Sciences*

*Mentor: David Catling, Atmospheric Sciences*

The planet Mars presents a fascinating and diverse landscape filled with many interesting geologic features. This project examines light-toned layered formations (LLFs) in the Martian tropics. Understanding the nature, origin, and evolution of these outcrops will likely provide significant insight into the evolution of Mars. This is because these formations appear to be associated with outflow channels and other evidence of ancient water. We focus on LLFs in Juventae Chasma and examine them using a combination of data from Mars Global Surveyor’s Mars Orbiter Camera (MOC), Mars Orbiter Laser Altimeter (MOLA), and Thermal Emission Spectrometer (TES), as well as Mars Odyssey’s Thermal Emission Imaging System (THEMIS). We have compiled an extensive catalog of high-resolution images, topographic profiles, and thermal inertia maps. This dataset has enabled us to determine the geologic setting, geomorphic attributes, and thermal properties of LLFs. Based on our investigation of Juventae Chasma, we conclude that LLFs are probably composed of consolidated salt deposits mixed with dust and sand. This supports both the lacustrine and aerosol deposition origin hypotheses. Currently, we are fine-tuning our methodology of deriving thermal inertia by accounting for complex atmospheric effects, such as clouds. In the future, we plan to investigate LLFs in other chasms and craters on Mars.

#### **Vegetation Survey of the Pumice Plains 25 Years After the Eruption of Mount St. Helens**

*Iara Lacher, Senior, Biology*

*Mentor: Roger del Moral, Biology*

We described vegetation on the Pumice Plains, directly north of Mount St Helens, 25 years after the devastating lateral eruption. Our purpose was to assess succession and to compare it to vegetation described in 1992. Species cover was

obtained from 271 200-m<sup>2</sup> plots, each sampled with 12 1-m<sup>2</sup> quadrats. Environmental data included location (GPS), elevation, surface features, impact type, slope, aspect, and distance to refugia. Canonical Correspondence Analysis (CCA) was applied to determine the best statistical explanation of vegetation patterns based on these factors. The vegetation remains heterogeneous, with limited, but significant correlations to the environment. Spatial factors (east-west and north-south coordinates, distance to refugia, elevation) were the principal correlates while percent pumice and rocks were important. The 1992 study revealed similar limited correlations with spatial features. Thus, after 25 years, the vegetation remains influenced by dispersal effects and chance. Since 1992, the number of species and the cover has increased dramatically in all sites. In particular, erosion that has formed more distinct drainage channels has allowed vegetation in broad drainage systems to develop substantially, from 2.6% to 38.3%. Floristic variation on the Pumice Plains remains substantial, and there is no evidence that deterministic factors (e.g. moisture gradients or competition) have emerged to impose order on this chaotic system. This study has implications for restoration ecology. There appear to be several alternative combinations of species in most habitats. Dispersal limitations suggest that restoration plans must attend managed introductions of species even when sources are nearby.

#### **Theoretical/Computational Models of Granular Avalanches and Debris Flows**

*Scott McCoy, Senior, Earth and Space Sciences*

*Mary Gates Scholar*

*Mentor: George Bergant, Earth and Space Sciences*

Granular avalanches and debris flows are multi-phase systems that are among the most important agents in shaping the landscape; they are also some of the most deadly and destructive. This project will attempt to reconcile differences between two different modeling approaches, a plastic soil mechanics approach and a depth averaging, Mohr-Coulomb approach. The goal is to integrate the benefits of both approaches into a unified computational framework. Numerical results obtained from the models will be compared to data from experimental granular avalanches and debris flows. Simple experimental geometries such as a granular column collapse will be used to verify model “correctness”. Next, realistic hill slope geometries will be used to validate the model against natural examples. Where and how the models deviate from the experimental data, or from each other, will be then be reconciled by looking at the difference in how the models function, such as different simplifying assumptions, different stress and strain-rate representations, different numerical solvers, etc. These comparisons will reveal how each modeling approach resolves different parts of the natural process, and will give further insights about integrating the benefits of both approaches into a more comprehensive model. If accurate and internally consistent physical models can be created, predictions

of hazards will be improved (e.g. accurate prediction of run-out distance, inundation area, and timing).

#### **Variations in Pb Isotope Ratios Across Historic Volcanic Flows on La Palma, Canary Islands**

*Brook Peterson, Senior, Earth and Space Sciences*

*Mary Gates Scholar*

*Mentor: Bruce Nelson, Earth and Space Sciences*

Natural variations in lead (Pb) isotope ratios provide crucial information about source regions of magmas. Pb isotope ratios in volcanic rocks at Earth’s surface are inherited from source regions, which – in the case of ocean island basalts – are generally located in the mantle. Therefore, variations in Pb isotope ratios of erupted lavas imply the existence of chemically distinct regions in the mantle. Previous Pb isotope studies have shown persistent chemical heterogeneities in the mantle on both large (~1000 kilometers) and small (~kilometer) scales. This study focuses on the smaller scale: are deep mantle heterogeneities manifested within a single eruption? We are focusing on La Palma (in the Canary Islands) because previous studies have suggested that in recent eruptions, magmas have moved from source regions to the surface with little mixing or pooling in central magma chambers. To test for small-scale heterogeneity, we will measure Pb isotope ratios of 10 samples from the 1712 Cumbre Vieja eruption, using high precision, multi-collector inductively-coupled plasma mass spectrometry. To provide context, we will measure Pb isotope ratios of 8 samples from eruptions spanning the past 420 years of the same volcanic system. Previous reconnaissance studies have not identified Pb isotope variability on this scale, but our more recent higher precision analyses suggest that variation may exist. Such variation could indicate a volcanic system that not only simultaneously samples different mantle source regions on a very small scale, but also preserves the inherited chemical heterogeneity through magma transport to the surface. This contrasts with the present way in which many ocean island volcanoes are modeled.

#### **Isotopic evidence for 2.7 billion year old microbial metabolism**

*Caroline Pew, Senior, Earth and Space Sciences*

*Mary Gates Scholar*

*Mentor: Roger Buick, Earth and Space Sciences*

There is evidence for life on Earth as far back as 3.5 billion years ago. As life evolved and atmospheric changes occurred, new metabolisms arose. From our analysis of isotopic data we hope to gain information about what metabolisms were utilized under differing conditions during the late Archean 2.7 billion years ago. Since organisms fractionate the isotopes of various biological elements differently under differing conditions, isotopic data should yield information on what sorts of metabolisms were used by early life forms and how these varied in diverse habitats.

Our research project will consist of sampling a lacustrine sedimentary core containing structures indicative of early microbial life called stromatolites (sediment mounds accreted by filamentous bacteria) from the Tumbiana Formation, Australia. We will be sampling sediments deposited in different micro-environments for the isotopic composition of their nitrogen, organic and carbonate carbon, and oxygen. We will analyze the samples using two differently configured Isotope Ratio Mass Spectrometers. We are currently performing a pilot study to determine proper sampling procedures and techniques. In spring we will undertake the main study. The nitrogen analysis will be central to our research, as very few analyses have been done on organic nitrogen in Archean rocks. Given the unique nature of these sediments and the limited, often contradictory, information available on Archean organic nitrogen, our interpretations and observations will likely lead to new discoveries. We anticipate these interpretations will add to the base of knowledge of nitrogen isotopes and will further geobiologic study of this fundamental time in Earth's early history.

#### **Diet of Giant Ground Sloths of the Pleistocene**

*Andrea Repetto, Senior, Earth and Space Sciences, Zoology*

*Mary Gates Scholar*

*Mentor: Elizabeth Nesbitt, Earth and Space Sciences*

Sloths are mammals that are still extant today. Giant ground sloths, however, are extinct. Under the Order Edentata, there are two families that represent ground sloths, Megalonychidae and Megatheriidae. *Megalonyx jeffersonii* falls under the Family Megalonychidae. This species thrived during the late Quaternary ice age; they began to die out about 10,000 years ago, and were effectively extinct 8,000 years ago. We excavated a *M. jeffersonii* individual's remains, found in a surficial deposit on Orcas Island in the Puget Sound of Washington state; it is expected to be late Quaternary in age, about 12,000 years old. In order to reconstruct the paleoenvironment, several fossil analyses have been conducted. Pollen has been washed and extracted from the sediment for analysis. Marine clams (*Macoma nasuta* and others) and land snails were also found in the fossil assemblage, along with three bison vertebrae and a deer anklebone (astragalus). All these fossils will provide more information about the paleoenvironment. Although *M. jeffersonii* has been well studied, no one has ever done this kind of analysis to discover information about the diet, so a project such as this is an excellent opportunity to contribute more to the known data of this Ice-Aged mammal. In order to investigate what type(s) of plants (C-3 versus C-4) *M. jeffersonii* ate, we are using stable isotope analysis of the bone material of the stable carbon isotope. Because bison and deer remains were found with the sloth, and because these animals are observable today and their diet is known, we can compare these results to the data from the sloth bones. After the stable isotope analysis is complete,

we can use the pollen that was found with the sloth to narrow down the number of species of plants the sloth must have eaten.

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## **SESSION 2C**

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**\*Note: Titles and Abstracts in order of presentation.**

### **EDUCATION, EXPRESSION AND THE FAMILY: A CROSS-CULTURAL EXAMINATION**

*Session Moderator: Ana Mari Cauce, Psychology*

*Session Assistant: Maria-Jose Bravo, Senior, Biology*

**Mary Gates Hall Room 242**

### **High School Attrition: A Preliminary Reconnaissance of Its Causes and Consequences**

*Brooke Clark, Senior, Sociology, History, American  
Ethnic Studies*

*Mentor: Charles Hirschman, Sociology*

In collaboration with Dr. Charles Hirschman, my research project is a preliminary study of the causes and consequences of high school dropout rates in the Puget Sound region. This study is an extension of a larger project entitled, "The University of Washington Beyond High School." The objective of this larger project is to describe and explain the sources of unequal access to higher education with a particular focus on race and ethnic disparities. In the course of this project, it was discovered that only 50 percent of high school freshman graduate four years later. In order to understand why so many students do not attain on-time high school graduation, I am reviewing the literature and data on high school attrition and will conduct my own field research in a local high school. Through a clearer understanding of why so many high school students drop out, it might be possible to develop or improve policies and institutional change to lower the drop out rate as much as possible. A disproportionate share of students who drop out of high school are minorities and society has a tendency of "blaming the victim." My project will reveal the underlying conditions that make it difficult for many school seniors to graduate on time. Socio-economic status, race and gender are some of the factors considered in my study. Weak school performance, grade retention, and stressful family change, even early in life, are all significant to increasing the risk that the student will drop out. When academic feedback is not positive, many children choose to disengage from school as a result. Low parent support is said to increase the risk of dropping out while high parental support is said to decrease the risk of dropping out. Dropping out is a process, not simply a choice one day that a student makes that they just decide school is not for them, but of slowly disengaging yourself and eventually fading out. Only through investigating and identifying the problem will we as a society be able to move forward and try to find a solution.

### **The Academy for Young Scholars: Student Perceptions of their Early Entrance to the UW**

*Sean Hughes, Junior, Neurobiology, Biochemistry*

*Mary Gates Scholar*

*Christina Chan, Sophomore, Economics*

*Mentor: Kate Noble, Women Studies*

The Robinson Center for Young Scholars at the University of Washington (UW) launched the *Academy for Young Scholars* (Academy) in the fall of 2002 [1]. Two cohorts of students (consisting of 34 and 35 students, respectively) entered the program, one in fall 2002 and the second in fall 2003. In April 2004, our team conducted focus groups (segregated by year of entry) soliciting student perceptions of the program's strengths and weaknesses, as well as the impact that accelerating to college had had on them. Students presented themselves as generally happy, well-rounded college students, though they noted that it had taken them some time to adjust to college and reach appropriate maturity and emotional levels, something that typically occurred in the first year of college. The majority of students felt that the Academy was a boon to them, but offered varied suggestions to improve it for future years. The impact of this entrance to college on student-family relationships was additionally interesting: students tended to view themselves as adults, while their parents still saw them as high school students. In this presentation, we will briefly discuss the Academy's structure, the ways in which the students' comments have changed the program's future, the impacts that the Academy has had on parent-student relationships, and the characterization of students that emerged.

[1] Of which Christina and Sean are both members, though Sean participated in the maiden year and Christina followed a year later.

### **"Turnaround" Students in High School Mathematics: Examining the Beliefs and Collaborative Practices of Algebra Teachers that Affect the Success of Mathematically Marginal Students**

*Monika Kasina, Sophomore, Pre-Applied and Computational Mathematical Sciences, Pre-Biology*

*Mentor: Ilana Seidel Horn, Math Education*

Inequities in our school system lead to an undue academic achievement gradient among students. Low income students and students of color are often underrepresented in the school system such that they end up with an insufficient base of mathematical knowledge upon entering high school to be successful in challenging and upper-level curriculum. Despite the odds, some algebra teachers employ effective teaching practices and methods that allow these students to succeed in college preparatory math classes. As part of a four-year longitudinal study about students' experiences in high school mathematics, our study examines the math departments of two very different schools in search of the particular teaching beliefs and practices that enabled one school to retain mathematically marginal students in

the curriculum with greater success than the other. Using both teacher survey data and teacher interviews, we are examining in depth the particulars about the school and classroom environment, the values and beliefs of the teachers, and reports of classroom practice. We are finding a strong correlation between cohesiveness of the math department and student achievement. The interrelations between teachers seem to play a significant role in sustained success of math students. This research will contribute to our understanding of the factors that go into "turning around" under-prepared math students, with the aim of creating more equitable mathematics classrooms.

### **"Democratic Education" in Minidoka Japanese Internment Camp: Intentions and Realities**

*Emily Whitmore, Senior, Social Sciences*

*Mentor: Nancy Beadie, Education*

At Minidoka, as at other Japanese internment camps during World War II, the War Relocation Authority established programs aimed at teaching ideas and practices of "democracy" to the "colonists" in the camp. Many of these programs were aimed at the Nisei, or second-generation Japanese-Americans, so that they would become agents of acculturation within their families, homes and communities. Examples of these programs included a student council at the camp's Hunt High School; a "self-government council" for the camp as a whole; Americanization classes; and a camp "extra-curriculum" of community activities and public events. Administrators of the WRA and of Camp Minidoka framed the goals of these programs in progressive terms: as a "learning by doing" approach to democratic education. They did so, however, in a context that denied residents the basic rights of democratic citizenship, a contradiction to which residents responded in a variety of ways, as indicated both by surviving records and newly collected oral histories. They also did so in a way that intentionally, and sometimes successfully, interfered in intergenerational relations between Issei and Nisei, and thus conflicted with traditional Japanese culture and family life. Documents examined in this project include oral histories collected by the Densho Digital Archive; the "Irrigator" (the official War Relocation Authority newsletter at Minidoka); curriculum materials from the War Relocation Authority available on microfilm at the University of Washington; and materials from the Japanese American Citizens League in the special collections section of the University of Washington library. These materials are analyzed with reference to two sets of secondary sources: historical studies of Japanese internment and studies of the history of democratic education in the United States during the WWII and post-war era.

### **What Factors influence Family Planning decisions in Sundar Nagari, India?**

*Nitasha Beri, Senior, Environmental and Occupational Health Sciences*

*Mentor: Matthew Keifer, Environmental and Occupational Health Sciences*

In March, 2004, I spent a quarter in Sundar Nagari, India; A village 1 hour east of New Delhi, India. Sundar Nagari is unique in that the population is evenly split between Muslims and Hindus. With guidance of the doctors at St. Stephan's hospital I created an investigational design that consisted of random sampling of clinic charts, as well as on-site interviewing. The purpose of the study was to note whether salary, occupation, income, number of children, and education played roles in methods birth control (or lack of). Also, to gain perspective on cultural feelings towards family planning based on religious background. There were 100 Hindu families and 100 Muslim families included in this study. Analysis was conducted using statistical comparison of the data collected. Excluding factors included age and salary; the target study group was of families under the age of 30 years (both father and mother), and those whose income was under 4000 rupees per month. Preliminary analysis suggests that, both Muslim and Hindu families have similar data trends in almost all categories with the exception of the method of family planning/birth control. My data suggests that Hindu families are more likely to use permanent surgical measures, while Muslim families are inclined to use temporary methods.

#### **Acculturation and Help-Seeking Behaviors of Asian American Adolescents**

*Wing Yi Chan, Senior, Psychology  
Mary Gates Scholar*

*Mentor: Ana Mari Cauce, Psychology*

Culture, race, ethnicity and other contexts (social economic status, gender and etc) influence every component of help-seeking behavior (Cauce et al., 2002). For example, acculturation level is believed to influence the help-seeking behaviors of ethnic minority group members. The research findings on acculturation and help-seeking behaviors of Asian Americans are rather mixed. Some studies found that higher acculturation level is related to more positive attitudes toward seeking professional help; however, some recent studies demonstrated the opposite relationship between acculturation and help-seeking behavior (Tata & Leong, 1994; Gim, Atkinson, & Whiteley, 1990). Traditionally, the majority of the research on the relationship between Asian Americans' acculturation and help-seeking behaviors has focused on adults. However, research has shown that Asian American youth are in need of help for various mental health issues, such as ethnic identity development, adjustment problems for immigrant youth, and intergenerational conflicts (Yeh, 2003; Lynch, 1992; Morrow, 1994). This project therefore will examine how acculturation affects Asian American adolescents' help-seeking behaviors. We hypothesize that adolescents with a higher acculturation level would be more likely to seek help

from mental health professionals for emotional problems in comparison to adolescents who have a lower acculturation level. Also adolescents with a higher acculturation level would display more positive attitudes toward seeking help from mental health professionals than those who have a lower level of acculturation. I will assess participants' level of acculturation using the Suinn-Lew Asian Self-Identity Acculturation Scale (SL-ASIA). The dependent variables will be participants' help-seeking history and attitudes toward seeking professional help from mental health practitioners. Participants will be Asian American adolescents from a community organization. Findings from this study will contribute to a greater understanding of the acculturation process and help-seeking patterns of Asian American adolescents.

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## **SESSION 2D**

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**\*Note: Titles and Abstracts in order of presentation.**

### **HISTORY, RELIGION AND THE PRODUCTION OF SPACE: DISCOVERING MEANING AND AGENCY THROUGHOUT THE GLOBE**

*Session Moderator: Phillip Thurtle, Comparative History of Ideas, Communication*

*Session Assistant: Maiensy Sanchez, Senior, Anthropology*

**Mary Gates Hall Room 251**

#### **Emergence and Mental Causation**

*Philip Woodward, Senior, Philosophy, Seattle Pacific University*

*Mentor: Patrick McDonald, Philosophy, Seattle Pacific University*

In recent literature in the philosophy of mind, some philosophers have expressed worry that the causal efficacy of mental phenomena is difficult to square with physicalism. In his Supervenience Argument, Jaegwon Kim articulates these worries as well as anyone has. He argues that mental causation is incompatible with the conjunction of three theses: The Causal Closure of the Physical Realm, Mind-Body Supervenience, and The Causal/Explanatory Exclusion Principle. Taking the reality of mental causation as axiomatic and using William Hasker's taxonomy of concepts of emergence as a springboard, I argue that if mental properties are ontologically emergent, then Kim's three theses are in fact compatible with genuine mental causation, if our conception of "the physical realm" is wide enough to allow that irreducible mental properties of a biological system (i.e. a human person) are capable of altering the behavior of the microphysical constituents of that system.

#### **A Theology of the Conjuncture: Assessing the Histori-**

### **cal Assumptions in Paul Tillich's System**

*Sohrab Ahmari, Senior, Philosophy*

*Mentor: Robert Coburn, Philosophy*

Before beginning his discussion of the role of history and its movement in his theological system, Paul Tillich lays out the basic assumptions about history and historiography that later come to define his theology of history. These are: 1) only an action with a purpose or “historical meaning” can be properly considered *historical*; 2) the “subject-object character of history”: men define situations as much as situations define men and thus there is *freedom* in history; 3) historical freedom also necessitates the creation of concretely unique and materially new situations as a result of historical actions, i.e. history does not repeat itself; 4) historical events must have meaning “in a universal, particular, and teleological sense.” From here, Tillich argues that history in the Christian sense does indeed drive towards the “Kingdom of God”; however, Tillich views this Kingdom as a grand symbolic construct that hints towards the “conquest of the negative” and the “eternalization of the temporal”—in other words, the *end of history*. This paper interrogates Tillich’s (meta-) historical assumptions, specifically questioning his reliance on the roles of “meaning” and “purpose” as the absolute determinants of any history in light of the contingency of so many histories. This interrogation also problematizes Tillich’s symbolic narrative of the end of history in-Christ. Finally, an attempt is made to defend Tillich’s fundamental emphasis on the creation of *qualitatively* new meanings and new material conditions as the *sine qua non* of any historical process: such a general view of history, theological or not, is revolutionary if only because of its consistent desire for the new.

### **Religious Revolutions: the Rise of Protestantism in the Dominican Republic**

*Daniel Escher, Senior, International Studies, Spanish*

*Mary Gates Scholar*

*Mentor: Jim Wellman, Comparative Religion, International Studies*

The Dominican Republic has the distinction of hosting the oldest cathedral in the New World. Indeed, Catholicism has enjoyed a privileged place in this Caribbean country, serving as the official state religion since 1954 and being involved in political activities. Recently, since the end of the Trujillo dictatorship in 1961, Protestantism has proven to be a challenger to Catholic favor and prevalence. I investigate the reasons behind this shift, asking what Protestant churches do to engender their rapid growth. One theory I test is that Protestant churches are able to provide religious services at lower costs than Catholic ones. To do this, I examine rates of urbanization, structures of various churches, and numbers of Catholic priests per capita. Outside of organizational efficiency, I also research the ways that Protestantism provides sub-cultural identity to Dominican and Haitian people. I use data collected from interviews

as well as the texts of speeches to test this hypothesis. Both theories provide intriguing insight into the popularity of certain social movements—and, ultimately, insight into the Dominican people themselves.

### **Religious Fundamentalism in the (Post)Modern World: cultural and ideological dialectics**

*Michael Zuver, Senior, Comparative History of Ideas, Political Science*

*Mentor: Clarke Speed, Anthropology*

For the last four years or so, much of my education has, in one way or another, revolved around the question of what exactly the current phenomenon of religious fundamentalism is—what its causes and effects are. Now that I am nearing the end of my undergraduate experience, I feel that I am able to articulate a fairly coherent, and potentially useful and beneficial, theory that can explain both how and why cultural/religious ideologies—through the efforts of devout groups and individuals—assert themselves in absolute, aggressive, and sometimes violent ways. It is my goal to demonstrate, through research and analysis of historical and contemporary factors—that culture and ideas develop in a dialectical relationship with one another. In other words, religious ideas help to shape culture, and culture then shapes religious ideas—usually to serve the needs of the culture. This should be recognized as a continuous process, but one that is not always balanced, beneficial, logical or rational (as a critical academic analysis would likely characterize it). As such, especially during periods of significant, rapid, and disorientating cultural change, religious ideologies are forced to adapt to the “new” cultural environment in order to remain relevant and ensure its survival. However, it would appear (from my preliminary research) that there is an inherent tendency, on the part of religious ideologies, to deny that such developments take place—insisting instead that they possess timeless and absolute truth. It is my hope that by better understanding how and why such dialectical relationships occur, between culture and ideas, we can move forward in a more conscious and beneficial way. This is what I hope to demonstrate and share with my fellow students and faculty.

### **Cultural Narrative and Identity Representation of Chinatown**

*Lu Chen, Junior, Urban Planning*

*Mentor: Jeffrey Hou, Landscape Architecture*

Chinatown is now a common type of international public open space in the developed world. Common as it is, it’s unfortunately not very culturally accessible with only some special Chinese stores and localized restaurants filling up the dull space. Physical appearance of buildings and street features along the streets of Chinatown is weak at telling Chinese stories although they have got a particular old Chinese building roof on top. No actual activities happen in space except people rush in to do shopping or have din-

ner and then leave quickly. My goal is to look into the cultural narrative and identity representation of Chinatown, with particular attention to its physical form, spatial awareness and activities it suggests. The core of this project consists of interviews of individual experiences in different Chinatown as well as the concepts of people in charge of Chinatown planning and design (e.g. Chinatown in Seattle, Portland, Victoria, Vancouver). I may also do some case studies of Chinese cultural sites in China as a context comparison and suggestion support.

### **An Investigation into Authorial Agency**

*Kanna Hudson, Senior, Comparative History of Ideas*

*Mary Gates Scholar, Zesbaugh Scholar*

*Mentor: Phillip Thurtell, Comparative History of Ideas*

This project investigates the critical and literary theory, literature, and philosophy that has expounded upon the problems of language. These problems are widely perceived; the most fundamental examples include the perils of translating between any combination of languages and of transcribing speech into writing, the universal inability to describe experiences of wonder and trauma, the existence of infinite possible interpretations of poetry, and everyday miscommunications. Building upon the established theoretical frameworks of critical theorists Roland Barthes and Maurice Blanchot, this project first establishes the author's lack of agency over language, meaning that the author lacks agency over the path of intended and interpreted meanings as they travel from the author to the text to the reader. This project further contends that words exist as bodies, moving, growing, and procreating as such. Finally, this project raises a possible solution to the lack of authorial agency by framing the embodied act of authorship as a productive act. The act of writing entails the interactions between embodied words and embodied authors, and this embodied experience inscribes itself on the world as agency. The work of Brazilian novelist Clarice Lispector, especially her novel *The Hour of the Star*, provides a case study for this project; and the work of French philosopher and author Hélène Cixous provides much of the foundational theory for this project. This project hopes to bring greater clarity to modern theories on the relationship of authorship, text, and meaning in literature.

### **Surrealism in Spain**

*Aaron Rux, Senior, Spanish, Comparative Literature*

*Mentor: Anthony Geist, Spanish*

Led by the French poet and intellectual Andres Breton, the First Manifesto of Surrealism was published in 1924. Using Freudian psychology, it aimed to give a conscious, waking voice to the subconscious, reconciling these two disparate spheres of the human psyche, and in the process revolutionizing our very way of life. This was accomplished primarily through exercises in automatic writing, which used literature and art as the mouthpiece for the repressed lan-

guage of the subconscious. While the movement came to an end sometime during the early 1930's the effects of surrealism can still be seen today in various forms of art and literature throughout our culture. The project Surrealism in Spain begins with the seminal literature of Breton and then heads south to the Iberian Peninsula, focusing primarily on the early films of Luis Buñuel and Salvador Dalí, the surrealist poetry of Federico Garcia Lorca and Rafael Alberti, as well as screenplay that Lorca wrote during this same period. This exploration of Spanish Surrealism not only seeks to understand the methodology of the movement through analysis of aforementioned works, but also to inspire my own creative production. The final phase of this project is the fusion of scholarly research and creative production that will give birth to my own surrealist inspired film. Like the original artists of the movement, I'm engaged in exercises in automatic writing, which provides me with the unique opportunity to approach the art from a creative perspective informed by academic research.

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## **SESSION 2E**

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**\*Note: Titles and Abstracts in order of presentation.**

### **MECHANISMS AND MODULATION OF NEURALLY-ENCODED RHYTHMS**

*Session Moderator: Marti Bosma, Biology*

*Session Assistant: Lilia Peng, Freshman, Academy for Young Scholars*

**Mary Gates Hall Room 238**

#### **How neurons keep up during high frequency stimulation**

*Selina Koch, Senior, Neurobiology*

*Mentor: Jane Sullivan, Physiology, Biophysics*

The release of neurotransmitter from synaptic vesicles requires that the vesicular protein, synaptobrevin, and plasma membrane proteins, syntaxin and SNAP25, come together to form a Snap Receptor (SNARE) complex. If any one of these proteins is disrupted transmission is blocked. After fusion, SNARE complexes must be taken apart in order to be used again in future rounds of exocytosis. Two proteins, NSF (N-Ethylmaleimide-Sensitive Factor) and its cofactor SNAP (Soluble NSF Attachment Protein), work together to dismantle SNARE complexes. NSF is an ATPase that binds to the SNARE complex in the presence of SNAP. Once bound, NSF hydrolyzes ATP providing the driving force for SNARE complex disassembly. To investigate the functional significance of SNARE complex recycling in synaptic transmission we have used Semliki Forest virus to over-express the most abundant isoform of SNAP,  $\alpha$ -SNAP, and the reporter protein, eGFP (enhanced green fluorescent protein), in cultured hippocampal mouse

neurons. Whole-cell voltage clamp technique was used to electrophysiologically characterize release from neurons over-expressing  $\alpha$ -SNAP and from controls expressing eGFP alone. These experiments have provided evidence that suggests a role for  $\alpha$ -SNAP in the maintenance of a readily releasable pool of vesicles during high frequency stimulation. Experiments involving the over-expression of NSF are currently underway.

### **Spontaneous Electrical Activity Expressed by Midline Neurons of the Embryonic Mouse Hindbrain**

*Shannon McArdel, Senior, Neurobiology, Biochemistry*

*Mary Gates Scholar*

*Mentor: Marti Bosma, Biology*

Spontaneous electrical activity of neurons in the developing brain is believed to be a necessary and highly coordinated event for proper structuring of the CNS. Unique stages of neural circuit maturity allow generation of spontaneous activity in defined regions of the brain during critical time periods. Spontaneous activity is required for establishing the number of neuronal cells during cell division, for directing migrating cells to their appropriate positions, and for establishing synaptic connections. These functions are crucial during the formation of the nervous system, but the mechanisms are not fully known. Our lab studies an example of this phenomenon in embryonic mice: during a short period of development, neurons in the animal's hindbrain exhibit highly synchronized spontaneous events of transient calcium influxes. This activity is most prominent in midline neurons of the rostral hindbrain, a region known to contain newly differentiated serotonergic cells of the raphe nuclei. These cells likely form an activity-generating network, while synaptic and gap-junctional connections synchronize activity throughout the hindbrain. My goal is to characterize the anatomical and electrophysiological features of midline cells displaying spontaneous electrical activity, as well as the electrical and pharmacological features of the activity itself. I am using the voltage-clamp technique to record currents and electrical activity, and dye filling recorded neurons to ascertain their position relative to the midline and their extent of gap-junctional coupling. I have found that spontaneous activity appears more frequently in rostral hindbrain compared to caudal hindbrain, and that the time course and frequency of electrical activity matches that of the calcium influx events. Correlations between a neuron's expression of ion currents, the degree of coupling to other neurons, and its endogenous activity indicate the presence of a unique population of neurons exhibiting—and likely propagating—spontaneous activity in this embryonic nervous system.

### **Circadian Rhythms of Temperature and Corticosterone Release in the Forced Desynchronized Rat**

*Andrea Christopher, Senior, Neurobiology*

*Mentor: Horacio de la Iglesia, Biology*

Circadian rhythms are biological oscillations with a circa-24-h period that rely on an endogenous self-sustained time-keeping mechanism, which is a “biological clock.” The mammalian hypothalamic suprachiasmatic nuclei (SCN) contain a master circadian clock that governs physiological and behavioral rhythmicity, but the output pathways by which the SCN regulates a diversity of rhythms are not fully characterized. The main goal of my research is to determine whether different rhythmic modalities are the result of the regulation of different subpopulations of SCN cells. My project exploits an unusual property of the circadian system of the rat to determine whether the specific subdivision of the SCN drive the rhythms of corticosterone release and of core body temperature. Rats exposed to a 22-h light-dark cycle express two stable circadian motor activity rhythms with different periods in individual animals. Gene expression profile in these “forced desynchronized” rats indicate that these two motor activity rhythms are associated with the separate activities of the ventrolateral and dorsomedial SCN. My project analyzes the temporal profile of core body temperature and corticosterone release in forced desynchronized rats and seeks to determine whether these two SCN rhythmic outputs are associated with activity of either the ventrolateral or dorsomedial SCN. Rats are implanted with intraperitoneal temperature sensors and jugular catheters for withdrawal of hourly blood samples. The data so far suggests that the body temperature rhythm is associated with the activity of the dorsomedial SCN and I am currently assaying blood corticosterone levels to determine its temporal profile and its association with SCN activity. The outcome of my research project will represent a significant advance in our understanding of how biological processes are temporally organized. Disorders of the circadian system are usually associated with a disruption of this temporal organization and my results may provide new tools for their treatment.

### **Biological Clock Mysteries: An Investigation of Circadian Output Pathways**

*Jennifer Lee, Junior, Neurobiology, International Studies*

*Mary Gates Scholar*

*Mentor: Horacio O. de la Iglesia, Biology*

Circadian rhythms are biological oscillations with a period of approximately 24 hours. In mammals, the master biological clock that governs these rhythms is located within the hypothalamic suprachiasmatic nucleus (SCN). Though the role of the SCN is widely accepted, the output pathways through which the SCN regulates circadian processes remain poorly understood. Our goal is to identify the neural pathway(s) by which the SCN regulates the hypothalamo-pituitary-adrenal (HPA) axis by analyzing the circadian release of cortisol and its correlation with SCN activity. Our project exploits an unusual property of the hamster's circadian system. Hamsters in constant light can exhibit “splitting” of their locomotor activity rhythm, in which the circa-24 h activity bout dissociates into two circa-

12 h bouts, which are associated with the antiphase oscillation of the left- and right-sided SCN. Our hypothesis is that the ipsilateral projections from the SCN to areas controlling release of corticotropin-releasing hormone (CRH) are responsible for the regulation of the HPA axis. Hamsters show a peak in cortisol concentration before their daily activity bout. We thus expect split hamsters to show two cortisol peaks in a 24-h period, each associated with the activation of either left- or right-sided CRH-containing neurons. In contrast, control hamsters should manifest only one peak of cortisol and symmetric activation of CRH-containing neurons. Blood cortisol levels are assayed hourly and *in situ* hybridization for *Crh* and *Per1* is used to determine activation of CRH-containing cells and lateralization of SCN oscillation, respectively. Already, we have confirmed splitting by behavioral analysis of locomotor activity as well as monitoring of core body temperature rhythms. Our experiments will not only identify clock output pathways involved in the control of the HPA axis, but will also further our understanding of how the master circadian clock of mammals governs a great diversity of biological rhythms.

#### **Circadian Rhythmicity in Crustaceans**

*Tracy Larson, Snior, Neurobiology, Biology, Psychology*

*Mary Gates Scholar*

*Mentor: Horacio de la Iglesia, Biology*

Circadian rhythms are biological oscillations with a period close to 24 hours that are synchronized to the solar day. The neural structures and molecular pathways underlying circadian rhythmicity have been studied in several species including *Drosophila*. The basic molecular clock mechanism relies on feedback loops of transcription and translation of the so-called *clock genes*, which result in the circa-24 hour oscillation of these genes' products. Intertidal crustaceans exhibit both circadian and *circatidal* rhythms, namely biological oscillations with a period close to the tidal cycle and synchronized to tides. However, the neural structures and molecular pathways underlying these rhythms in crustaceans are poorly understood. The main goal of my research project is to unravel the molecular and neural basis of circadian and *circatidal* rhythmicity in intertidal crustaceans. Using reverse transcriptase-PCR with *degenerate* primers based on the sequence of clock genes of *Drosophila* and other invertebrate species, I was able to clone a 500 bp fragment of a homolog of the clock gene *timless (tim)* in two crab species *Cancer productus* and *Hemigrapsus nudus*. Using a polyclonal antibody against the *Drosophila* gene's peptidergic product, TIM, I have been able to identify a cluster of two to five neurons within the crab brain that show TIM-like immunoreactivity. I am currently studying *tim* expression within the brain using whole mount *in situ* hybridization targeted to the mRNA. I am also seeking the cloning of three other putative crustacean clock genes. My long-term goal is to study the spatial and temporal patterns of expression of these genes' products in the central nervous system of the crab. The characteriza-

tion of the components of the circadian system of intertidal crustaceans will provide new tools for the study of biological timing, and will represent the first step toward the understanding to the biological basis of circatidal rhythmicity.

#### **The Distribution of Val<sup>1</sup>-SIFamide in the American Lobster**

*Pei Yee Soon, Senior, Biology*

*Mary Gates Scholar*

*Mentor: Andrew Christie, Biology*

A family of peptides, the SIFamides was recently discovered in the nervous system of crustaceans. The native peptide in all species was thought to be Gly<sup>1</sup>-SIFamide, as it was found in the Jonah crab *Cancer borealis*, the red swamp crayfish *Procambarus clarkii*, and the giant tiger prawn *Penaeus monodon*. However, recently another isoform, Val<sup>1</sup>-SIFamide, was found in the American lobster *Homarus americanus*. We generated a rabbit polyclonal antibody to this peptide and used it to map the distribution of it in the stomatogastric nervous system (STNS) of *H. americanus*. Our results show that Val<sup>1</sup>-SIFamide is widely distributed within the STNS. Here, about 45 somata are labeled in each of the paired commissural ganglia (CoGs). Immunopositive neuropil is seen in the CoGs, at the junction of the oesophageal, superior oesophageal and stomatogastric nerves, and in the stomatogastric ganglion. Collectively, the distribution of this peptide suggests that Val<sup>1</sup>-SIFamide serves as a local modulator in the *H. americanus* STNS. I am currently conducting a phylogenetic survey of the distribution of members of this peptide family in other local crustacean species. Thus far, SIFamide immunoreactivity has been mapped in the STNS of the Dungeness crab *Cancer magister* and the red rock crab *Cancer productus*. The distribution of labeling in these species is also consistent with SIFamide serving a local modulatory role.

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## **SESSION 2F**

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**\*Note: Titles and Abstracts in order of presentation.**

### **MODERN GRRRLS AND WOMEN: HISTORIES, IDENTITIES, AND REPRESENTATIONS**

*Session Moderator: Angela Ginorio, Women Studies*

*Session Assistant: Anna York, Program Coordinator,*

*Jackson School of International Studies*

**Mary Gates Hall Room 234**

#### **If I Can't Dance, I Don't Want to be Part of Your Revolution: An Introduction to Riot Grrl**

*Ashley Church, Senior, Comparative Religion, Sociology, Political Science*

*Mentor: Ann Powers, Women Studies*

*Mentor: Judy Howard, Women Studies*

"If I Can't Dance, I Don't Want to be Part of Your Revolution" is a introduction to the historical and cultural study of the underground feminist music movement called Riot Grrrl. Riot Grrrl originated at Evergreen College in Olympia, Washington in the early 1990's as a grassroots movement. Riot Grrrl's main platform "Revolution Girl Style Now" focused on girl-positive activity through music, meetings and photocopied handmade magazines called "zines." The movement grew exponentially in a short period of time and garnered national media attention. This project will focus on how the revolutionary impacts of this movement are undeniably present in modern culture, as well as in contemporary feminist culture. The multimedia research project will be presented to a group of high school and college students at Experience Music Project on March 11, 2005 as part of Women's History Month. The project is being supervised by Ann Powers, senior curator at Experience Music Project.

**The Birth and Growth of Modern Dance in Seattle: A look at the life and work of Martha Nishitani**

*Elizabeth Erber, Senior, Dance, Drama*

*Mentor: Betsy Cooper, Dance*

How did modern dance begin in Seattle and who and what kept it alive through the twentieth century? To date little has been written about Seattle modern dance history and there is no known comprehensive text outlining the major people and events that comprise its seventy-five years of existence. Because modern dance is a relatively young art form, there are people still alive who can reconstruct the history of Seattle modern dance from its incipience. Modern dance grew out of New York in the 1920s and first appeared in Seattle by way of Martha Graham and members of her company in 1930. Within a few years modern dance was being offered as a PE elective in several high schools in Seattle. It was in this way that the young Martha Nishitani, a Seattle modern dancer and choreographer who has been central to Seattle modern dance history, was first introduced to the form. For decades Nishitani ran the only modern dance company and studio in Seattle. In 1952, after being interned in Idaho with other Japanese-Americans, she opened her first dance studio in the University District and remained at this location until 2002, when she moved into a retirement home. Her two dance companies performed and toured for several decades in Seattle and the Pacific Northwest. Martha Nishitani, as well as others, has agreed to participate in a series of oral histories, which are aimed at reconstructing Seattle modern dance history. While Martha Nishitani is my primary point of focus, it is through her long history in Seattle that much of Seattle's modern dance history can be made apparent. My primary goal is to make my findings available to the public via an interactive multi-media website that includes audio and video recordings, visual materials and writings.

**Identity Development and Community Alliance among Queer Women with Disabilities**

*Chelsea Whitney, Senior, Women Studies, Psychology*

*Mary Gates Scholar*

*Mentor: Jane Simoni, Psychology*

Until recently the sexuality of individuals with disabilities has largely been ignored or incorrectly assumed to be non-existent. Individuals with disabilities have a range of sexual orientations encompassing both heterosexual and queer identities. In what ways do individuals with disabilities construct their sexual orientation identity? How do women who identify as both disabled and queer develop their multiple identities? Do current models of lesbian identity development or models of disability identity development address the reality of queer women with disabilities identity? This project involved interviews with approximately four queer women with disabilities to understand their subjective experiences of their identity and the process of its development. Interviews were audio-recorded, transcribed, and analyzed with Atlas software. I expect that women will vary in terms of their primary identity and that neither lesbian nor disability identity models will fully address the realities of these women's lives. Instead, I expect that multiple identity development models will need to be combined to more fully reflect the experiences of queer women with disabilities.

**Angel Hands: A Play about Trauma, Time, Memory and Meaning**

*Jeff Resta, Senior, Comparative Literature*

*Mary Gates Scholar*

*Mentor: Phillip Thurtle, Comparative History of Ideas*

*Mentor: Kari Tupper, Comparative History of Ideas*

A great deal of postmodern critical theory focuses on questions of the self and its relation to context: that is, history and memory. What are the practical applications of such theory? My play *Angel Hands* attempts to examine culture, memory and identity in the wake of shattering trauma: specifically, the horrific ten-year civil war in Sierra Leone, which was notable for some of the most brutal war crimes of the 20<sup>th</sup> century. The play's central character, Hannah, is a West African teenager now living in the United States. Her attempts to remake herself as an American, to forget the events which destroyed her family, are threatened by the very existence of her young sister, whose hands were cut off by terrorists. The hands are simultaneously an absence and a presence, phantoms of the past. To the person attempting to recover from devastating loss is modern thought destructive of identity, or does it provide new ways of taking control of our truth? Is subjective truth less true, or less useful? I posit a post-rationalist way of understanding the world, one which hearkens back to pre-Socratic (and earlier) traditions. *Angel Hands* attempts to look at postmodernism, not as an exercise for the cynical intellectual, but in terms of the oldest, most basic human ques-

tions: Who am I? And what does it all mean?

### **Depiction of Women in early 20<sup>th</sup>-century Japanese Woodblock Prints**

*Rhonda Hanson, Senior, Art History*

*Mary Gates Scholar*

*Mentor: Cynthia Bogel, Japanese Art and Architecture and Art History*

The depiction of beautiful women, or *bijin-ga*, in Japanese woodblock prints became an established genre during the Edo period (1600-1868) through the prints of masters of *ukiyo-e*, such as Harunobu, Kiyonaga, Utamaro, and Kunisada. In the late-nineteenth century, Japan opened their borders to Western trade, culture and concepts. At the turn of the century—and certainly by the Taisho era (1912-25)—Western attitudes had permeated Japan. The effects of the Westernization became problematic for printmakers of the early twentieth century, who splintered into two schools, *shin-hanga* and *sosaku-hanga*. *Shin-hanga* continued to approach printmaking in a traditional manner by preserving subject matter and the status quo division of labor among designer (“artist”), printer, block cutter, and publisher. In contrast, *sosaku-hanga* artists explored an independent method for printmaking by choosing, designing, carving and printing their own compositions. In both case the printmakers sustained the *bijin genre*; however, the type of woman depicted reflects the artistic perspective of the creator. This essay will consider the role of women in Japanese society during the early twentieth century and their portrayal in woodblock prints, with attention to the different social attitudes that seem to be suggested by differing artistic approaches or styles. It will question whether the choice of *shin-hanga* or *sosaku-hanga* came with an ideological stance toward women (traditional vs. western) as the artistic styles would suggest, or whether such parallels and alliances are not necessarily consistent between art and individual beliefs, or social norms. Research in the field of Edo period *ukiyo-e* is vast; conversely, little scholarship is available pertaining to *bijin-ga* and issues surrounding the changing attitude of and toward women in Japanese society. In 2000, Amy Reigle Newland published a comprehensive catalog of *shin-hanga* and *sosaku-hanga* prints with woman as the primary content, yet, the first essay states, “in looking at these pieces with modern eyes, it would be difficult to explain them within the context of *bijin-ga*.” In 2003 Barbara Sato provided a vehicle for such study with the release of her book *The New Japanese Woman: Modernity, Media and Women in Interwar Japan*. Her scholarship provides insight into the “modern girl” often depicted in the prints of the same era. A marriage of formal and contextual observations will be applied in my analysis of the prints to give a fresh perspective on this genre of printmaking.

### **Buffy and The Amazon Princess: Addressing Represen-**

### **tations of the Female Hero in Modern Mythology**

*Jennifer Kate Stuller, Senior, Comparative History of Ideas*  
*Mentor: Phillip Thurtle, Comparative History of Ideas*

Men have long had examples of the hero to model themselves after. Is it possible for women to look to modern mythology for empowering representations of themselves? Do the superheroes available to women reinforce stereotypes rather than break them? What defines a female hero in ways which are similar to or different from the male model? This paper will investigate the relationship between two 20<sup>th</sup> Century female heroes, Wonder Woman, created by William Moulton Marston in 1941, and Buffy The Vampire Slayer, created by Joss Whedon in 1992. These women, born of mythological lineage and endowed with superpowers, were envisioned by their makers as catalysts for upending constrictive or stereotypical views of women. And yet, Wonder Woman and Buffy have a strength that is rooted in their ability to love. The idea that a female superhero must embody a nurturing temperament might reinforce stereotypical and oppressive feminine ideals. But there is also the possibility that these dynamic women represent a liberatory reimagination of femininity. They certainly offer an alternative view of the female hero who has often had to appropriate masculine attributes in order to be seen as heroic (for example, Joan of Arc, Xena Warrior Princess or Ellen Ripley of the *Alien* films). Using the works of feminist writers such as Sherrie A. Inness, Elyce Rae Helford, Rhonda Wilcox, Frances Early and Trina Robbins, I seek to address the comparisons and contrasts between these two female superheroes. Buffy is the latest warrior in a long matrilineage—a modern day evolution of the Amazon Princess, Wonder Woman. The correlations between the two women are implicit in their just actions as well as in their mythological representations. Although their creation by men rather than women may be problematic, we can still read these characters as having awesome feminist potential. They may in fact transcend gendered boundaries altogether, offering up a 21<sup>st</sup> century model for an inclusive heroism.

### **Stress, Premenstrual Symptomatology and Spiritual Well-Being in Women: A Mediation Analysis**

*Andrea Miller, Senior, Psychology, Seattle Pacific University*

*Mentor: M. Kathleen B. Lustyk, Psychology, Seattle Pacific University*

Spirituality has been demonstrated to positively impact psychological and physiological outcomes. Yet, spirituality/religiosity has also been associated with an exacerbated impact of stressors. Of particular interest in the field of women’s health is the interface between psychological variables and the cluster of physical changes related to the woman’s reproductive cycle known as premenstrual syndrome (PMS). In order to assess the relationships among spirituality, PMS and stress in women, the following study

was performed. The severity of PMS symptoms and perceived stress were examined along with existential and spiritual well-being in 145 females, aged 18 – 33 years. The aims of these analyses were to determine whether women who felt a strong sense of spiritual well-being tended to feel less stress and PMS, than those reporting less spiritual well-being. The participants completed the Cohen Perceived Stress Scale, Shortened Premenstrual Assessment Form and the Ellison Spiritual Well-Being Scale. Results indicated that increases in spiritual or existential well-being were positively related to PMS and stress endorsement. Furthermore, a mediation analysis showed spiritual well-being to be a partial mediator between stress and PMS. One plausible explanation for these results lies in scripture. Christian women are taught from a young age that menstruation is a reminder of the punishment resulting from living in a fallen world. Being more in tune with this, when asked to recall menstrual symptoms and perceived stress, it is likely that a woman of faith would provide amplified responses rather than blunted responses. As women who scored the highest on spirituality measures also had the highest PMS endorsement, women of Christian faith may benefit from heightened self-care practices surrounding stress management.

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## SESSION 2G

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**\*Note: Titles and Abstracts in order of presentation.**

### **MOLECULAR AND CELLULAR STUDIES IN HUMANS, ARTHROPODS, BACTERIA AND VIRUSES: IT'S ALL ABOUT THE GENES AND THEIR PROTEINS**

*Session Moderator: Aimee Bakken, Biology*

*Session Assistant: Ananth Shenoy, Senior, Biochemistry*

**Mary Gates Hall Room 389**

#### **Investigating Synthetic Retinoids as Anti-cancer Agents**

*Sarah Chisholm, Junior, Neurobiology*

*Mary Gates Scholar*

*Mentor: Karen Swisshelm, Pathology*

Retinoids have long been investigated for potential use as chemotherapeutic agents because of their ability to regulate cell growth, differentiation, metastasis, angiogenesis, and apoptosis. However, many of the naturally occurring retinoids, such as retinoic acid, the active metabolite of Vitamin A, also exhibit toxic effects. For this reason a series of retinoid-like compounds were developed to mimic the regulatory effects of retinoids while reducing the harmful side effects. One such compound is called SHetA2, and it is effective in the treatment of ovarian cancer without evidence of toxic side effects in animal studies. Impressed with the promising results of SHetA2 in the treatment of ovarian cancer, we hypothesized that it would also

be effective in the treatment of breast cancer cells. The compound's effects on a variety of normal and tumor mammary epithelial cells were tested in a series of experiments that measured the proliferative abilities of cells following treatment with varying concentrations of SHetA2. The compound was found to significantly limit the proliferative abilities of mammary epithelial cells in concentrations as low as 1 $\mu$ M. The next step in the investigation of SHetA2 is to characterize the pathway(s) by which SHetA2 limits cell survival. It has been suggested by research with other types of cancer cells that SHetA2 induces apoptosis or cell death. Although my preliminary experiments, including flow cytometry and nuclear staining, have not confirmed such a mechanism, the results do suggest significant alterations in the cell cycle properties of cells treated with SHetA2. Further experiments, including flow cytometry and analysis of proteins involved in apoptosis will be necessary to make firm conclusions and provide insight into SHetA2 treatment mechanisms in order to complete the preclinical testing of the drug prior to its consideration for use in clinical trials.

#### **Determination of 3D-Structure of (BRCA1)-associated RING domain (BARD1)-BRCT domains**

*Lilyana Margaretha, Senior, Biochemistry*

*Mary Gates Scholar*

*Mentor: Rachel E. Klevit, Biochemistry*

*Mentor: David Fox, Biochemistry*

BARD1, the BRCA1 associated ring domain protein 1, is 777 amino acids in length and exists in a heterodimeric complex with a structurally-related protein BRCA1, the breast cancer associated protein 1. BARD1, similar to BRCA1, has been implicated in many cellular pathways including transcription, homologous recombination and DNA repair. Both proteins have a single N-terminal RING and two C-terminal BRCT (BRCA1 Carboxyl Terminus) domains. Mutations within these conserved domains lead to an increased risk of breast and ovarian cancer in women. The N-terminal RING domain is known to form a functional E3 ubiquitin ligase and the C-terminal BRCT domains bind phosphorylated substrates. In addition, BARD1 has three Ankyrin repeats just N-terminal to the BRCT domains. A cancer-predisposing mutation (Gln564His) located between the C-terminal Ankyrin domain and the N-terminal BRCT domain disrupts BARD1's interaction with CstF-50, a polyadenylation factor involved in 3'-mRNA processing. I have two main goals in my research project. First, I will develop a protocol for the expression, purification, and concentration of two protein constructs: the minimal BARD1-BRCT repeats and the inclusion of two C-terminal Ankyrin repeats with the BRCT domains. Second, upon completion of the protocol, I will structurally characterize the proteins through the use of Circular Dichroism (CD), limited proteolysis, and Nuclear Magnetic Resonance (NMR). BRCA1 has been the focus of most structural and functional studies, nonetheless, BARD1 is likely to have

an equally important role due to its structural and functional similarities with BRCA1, making it a promising target in the understanding and prevention of breast cancer.

### **X-linked Parkinson's Disease**

*Sophia (Jihae) Kim, Junior, Biology*

*Mary Gates Scholar*

*Nayiry Gazi, Junior, Biochemistry*

*Mentor: Parvoneh Poorkaj-Navas, Psychiatry and Behavioral Sciences*

*Mentor: Wendy Raskind, Medicine*

Our research project with Dr. Navas is an investigation into the genetic inheritance of a rare type of familial Parkinson's disease (PD). PD is a neurodegenerative disorder which presents with symptoms of muscle rigidity, slowness of movement, and resting tremor. PD is usually sporadic and affects people over the age of 50 years; however, there are exceptions. One such exception has been identified in a unique family identified here at the UW, in which several male family members in each generation are affected with a novel form of PD that presents with spasticity. We have strong evidence that this disease is transmitted on the X chromosome; because only males are affected and all affected family members share an identical region on the X chromosome. Our goal is to identify the gene and the mutation in this critical region that causes PD in this family. We have already identified hundreds of the known genes within the critical region and selected plausible candidate genes for this disease based on the known functions of the protein and on the expression of the genes in the brain. We are continually re-evaluating the available databases to identify new candidate genes and will continue to do so, until we find the mutated gene. Once we find a mutation that is shared by the affected male family members and the "carrier" unaffected females, we will evaluate DNA from unaffected and unrelated control subjects to differentiate actual mutations from normal variations in the general population. So far, we have sequenced twelve genes and initiated sequencing for an additional ten genes in the critical region. Identification of the disease gene that results in this unique form of PD will help to further the understanding of PD in general and may provide clues for identifying disease treatments.

### **Delta Is the "Timer" That Halts Cell Division in Drosophila Ovarian Follicle Cells**

*Elizabeth Gray, Senior, Biology*

*Mary Gates Scholar, Space Grant Scholar,*

*Gates-Cambridge Scholar*

*Mentor: Hannele Ruohola-Baker, Biochemistry*

In order to keep our cells in check, there are "timers" that tell our cells when to divide and when to stop dividing. If these cell division "timers" are disrupted, tumors may develop. Specifically, Notch signaling helps control division

in epithelial cells. In mouse skin and *Drosophila* (fruit fly) ovarian follicle cells, Notch has been implicated as a tumor suppressor: when Notch is ablated, mice develop skin tumors, and *Drosophila* epithelial cells continue dividing inappropriately. Research which helps to increase our understanding of the Notch pathway will therefore increase our understanding of Notch's role as a tumor suppressor, and, more specifically, the role of the Notch pathway in the pathogenesis of skin tumors. Here, I show that, in *Drosophila*, Delta is the "timer" that activates the Notch pathway and halts cell division. In *Drosophila* fruit flies, somatic follicle cells divide during stages 1-6 of oogenesis. At this point, Notch signaling induces the follicle cells to stop dividing and simply replicate their DNA. Previous work has demonstrated that Delta, which activates Notch signaling, is required to halt cell division, and that Delta levels increase prior to stage 6. However, it was not known whether Delta alone was sufficient to halt cell division. To answer this question, Delta was expressed prematurely at stage 4, and the follicle cells were examined for premature endocycle (no cell division). Delta was able to halt cell division prematurely, indicating that its expression is necessary and sufficient to halt cell division. This indicates that Delta is the critical "timer" that tells these follicle cells to stop dividing. Therefore, Delta, in addition to Notch, as mentioned above, may play an important role in the pathogenesis of mouse skin tumors.

### **Anatomical Assessment of Possible Local vs. Hormonal Serotonin Modulation in *Cancer productus***

*Vi Le, Senior, Biology, Physiology, English*

*Mary Gates Scholar*

*Mentor: Andrew Christie, Biology*

In the crustacean stomatogastric ganglion (STG), neuromodulators reach target neurons via two pathways: 1) release from intrinsic STG neurons and/or the arborizations of neurons projecting to the ganglion, and 2) from neuroendocrine sites via the hemolymph. A number of modulators are delivered via both routes, including the monoamine transmitter serotonin (5-HT). In *Cancer* crabs, four homologous stretch receptors, the gastropyloric receptor neurons (GPRs), provide the STG with its sole source of 5-HT. Additionally, the pericardia organs (POs) provide a hormonal source of 5 source of 5-HT to the STG. Certain neurons are modulated by both GPR stimulation and superfusion of 5-HT; these two processes elicit distinct effects. Previous morphological analysis suggests many STG neurons possess a spatial organization of their neuropilar processes resulting in distinct compartments. If defined regions are preferentially targeted by locally released vs. hormonally delivered 5-HT, this compartmentalization may account for the distinct effects reported for neuronal release vs. bath application of the amine. Serotonergic stimulation to the *Cancer borealis* STG originates solely from the GPR terminals. The POs are its sole source of hemolymph-borne 5-HT. The same situation exists in *Can-*

*cer productus*. Recently I obtained an antibody to crustacean 5-HT receptors (5-HTR) and am using it to map the distribution of 5-HTRs in the STG neuropil. If some 5-HTR labeling is in close apposition to GPR terminals while other labeling is isolated from them, it will be indicative of distinct populations of local vs. hormonal receptors. If so, it will strengthen the notion that distinct local vs. hormonal 5-HT receptors provide a possible mechanism for the distinct actions of local vs. hormonally delivered 5-HT.

### **Identification of New Virulence Genes in *Agrobacterium Tumefaciens***

*Rula Green Gladden, Junior, Biochemistry*

*Mary Gates Scholar*

*Mentor: Eugene Nester, Microbiology*

*Mentor: Derek Wood, Microbiology*

*Agrobacterium tumefaciens* was first studied as the causative agent of a plant disease known as Crown Gall. Infecting 90 families of dicotyledonous plants, *A. tumefaciens* is responsible for significant annual losses in the fruit, ornamental and grape industries. The mechanism by which *A. tumefaciens* infects its plant host involves the transfer and integration of bacterial DNA (T-DNA) into the genomic DNA of the plant. After the sequencing of the 5.67-Mb genome of *A. tumefaciens*, analysis revealed the hypothetical presence of 5419 protein-coding genes, 35.9% of which have unknown function. To shed light on the importance of these previously unidentified genes to the virulence of the bacterium, the Nester lab conducted a micro-array study to compare the activity of previously unidentified genes with already characterized genes under virulence inducing condition vs. non-virulence inducing conditions. *A. tumefaciens* C58 was cultured in both virulence and non-virulence inducing conditions. The total RNA of both types of cultures was extracted, converted to cDNA, and labeled with fluorescent tags. These were competitively hybridized to wells containing pure single stranded DNA of each gene of interest. Statistical analysis revealed 20 previously unidentified genes that were significantly up- or down-regulated. Real-Time PCR was performed to confirm these findings. Currently, we are using an unmarked recombination system to create deletions of five of the newly identified genes of interest. Plants will then be inoculated with the mutants to determine if the loss of gene function affects tumorigenesis. It is hoped that this work may lead to the identification of new genes involved in pathogenesis.

### **Regulation of Foamy Virus Pol Protein Expression and Cleavage by the Carboxyl-terminus of Gag**

*Starlyn Okada, Senior, Microbiology, Japanese*

*Mary Gates Scholar*

*Mentor: Maxine Linial, Microbiology*

Foamy viruses are complex retroviruses, which differ radically from other retroviruses, such as human immunodeficiency virus (HIV), in their viral life cycle and their subse-

quent host cell interactions. FVs can infect a wide variety of species however infection has not been linked to disease in their respective animal hosts. All retroviruses, including FVs, encode three structural genes (*gag*, *env*, and *pol*) essential for viral replication and budding from host cell. Unlike other retroviruses, which synthesize Gag and Pol as a single fused polyprotein, FV Gag and Pol are translated individually via a genomic splicing event beginning upstream of the *gag* gene and ending prior to the Pol start codon. Previous studies have determined that the Pol cleavage into a stable Pol protein occurs even in the absence of the FV Gag protein. Without the conventional Gag-Pol fusion protein mechanism to ensure the incorporation of Pol protein into new virus particles, FVs must utilize another method to assemble FV Pol into new particles, which is still poorly understood. Gag contains three unique glycine-arginine-rich domains at the carboxyl-terminal region of the protein called GR boxes. Gag carboxyl-terminus truncation mutants were constructed by inserting a stop codon immediately upstream of the three GR boxes and downstream of each of GR box. The observed decrease in FV Pol protein expression and inhibition of Pol cleavage has been an enigma. I am currently investigating the viral mechanism by which Gag carboxyl-terminus truncation mutants dramatically affect Pol expression, inhibits Pol cleavage, and Pol packaging into virions. My research will determine if the variant FV Pol expression levels and Pol cleavage stem from a change in the abundance of FV Pol messenger RNA or the translation efficiency of the Pol messenger RNA into protein.

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## **SESSION 2H**

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### **PUTTING BIOLOGY TO WORK: INNOVATIVE BIOENGINEERING APPROACHES**

*Session Moderator: Elena Garcia, Bioengineering*

*Session Assistant: Christopher Weeg, Senior, Comparative Literature*

**Mary Gates Hall Room 287**

#### **A Controlled Release Formulation for Localized Osteopontin Gene Delivery**

*Shinn-Huey (Shirley) Chou, Senior, Bioengineering, Biochemistry*

*Mary Gates Scholar*

*Mentor: Suzie Pun, Bioengineering*

Aortic stenosis, a serious heart condition that can result in heart failure, affects 3% of the population over age 75. In aortic stenosis, obstruction of the aortic heart valve impedes blood flow that is pumped out of the left ventricle to the rest of the body. In addition to stenotic heart valves that cannot open completely, defective heart valves also include those, which fail to close completely, resulting in regurgitation of the blood flow in the heart. To treat patients affected by these heart defects, more than 80,000 replace-

ment valves are implanted annually in recent years. Two major types of replacement heart valves are the mechanical and the bioprosthetic valves. Mechanical valves are long-lasting, but the patient is required to take life-long anticoagulant to prevent blood clotting induced by the manufactured material of the valve, which increases the patient's risk of hemorrhage. Bioprosthetic valves, commonly from animal tissues, are much less thromboembolic. However, their proneness to ectopic calcification greatly reduces their durability to merely 5 to 15 years. Previous research has shown that an increased presence of the osteopontin protein at the site of bioprosthetic valve implant limited the calcification damage. In this project, glutaraldehyde-fixed bovine pericardium (GFBP), a common material for tissue valves, is modified to incorporate non-viral vectors that deliver the osteopontin gene. The delivery vehicle is the cyclodextrin-grafted-polyethylenimine (CD-PEI) cationic polymer that has previously demonstrated lower toxicity both *in vitro* and *in vivo*. The formulation capitalizes on the affinity between cyclodextrin molecules and the adamantane-modified tissue valve to successfully load CD-PEI polyplexes onto the GFBP tissue. Ultimately, the controlled release of osteopontin gene-containing polyplexes from the valves would transfect the nearby tissue cells, thereby increasing their osteopontin production and diminishing calcification processes.

#### **Surface Characterization of Functional Groups Responsible for Fibrinogen and Albumin Adsorption Using ESCA, ToF-SIMS, and Radiolabeling**

*Ryan Hartmaier, Senior, Bioengineering*

*Mary Gates Scholar*

*Mentor: Dave Castner, Bioengineering*

*Mentor: Dan Graham, Bioengineering*

Determining the specific chemical properties that reduce protein adsorption is of enormous importance for the production of effective biomaterials. This study reports the testing of specific polymer functional groups on protein adsorption. Polymers used in this study were generated so that only 1 structural variable changed, the side chain length (octyl, butyl, ethyl, methyl), on a common polyarylate backbone. Samples were prepared by first spin casting a double layer of ema silane. The polymer layer was then spin cast on top of this. Protein adsorption was performed at 37°C for 2 hours using a total protein concentration of 0.1 mg/ml in CPBSz buffer. Various ratios of fibrinogen to albumin were used in order to compare the competitive adsorption of protein on these surfaces. ESCA and ToF-SIMS data were acquired on all samples after protein adsorption. Radiolabeled protein data will be used to quantify the total amount of protein adsorbed on each surface. Together it is hoped that these analysis techniques will allow investigation of the structural function relationship of protein adsorption and surface chemistry. Initial results show some adsorption differences between polymers, but more work must be finished for this to be conclusive. We hope that

this initial study will give some insight into how the carbon chain length of a side group can affect protein adsorption. Future work will then continue with different functional group variations.

#### **RF-Plasma Deposition of Tetraglyme on Subcutaneous Glucose Monitors**

*Iva Jovanovic, Senior, Bioengineering*

*Mentor: Thomas Horbett, Bioengineering*

Non-fouling surfaces resist the protein adsorption and cell adhesion, and are thus considered useful for coatings of devices to be used as implants in humans. The human body's reaction to accidentally introduced objects is a reaction called the Foreign Body Response (FBR), which causes a collagen rich fibrous capsule to form around the object, and as a result helping isolate it from the body and protecting the body from harm by the object. However in case of medically desirable implants such as catheters, drug pumps, pacemakers, or glucose sensors, it would be preferable to avoid the encapsulation mechanism. Thus, the objective of this project is to reduce cell adhesion to a polyurethane copolymer used by our collaborator Dr. K. Ward (Legacy Research, Portland OR) as the interface between the body and the sensing electrodes in the subcutaneous glucose sensors intended for use in diabetic patients. Animal studies show that protein encapsulation of the polyurethane coated sensors occurs after approximately 30 days which results in the loss of glucose sensing. In this work RF-plasma deposition method is being used to coat the copolymer surfaces with plasma polymerized tetraglyme formed at a series of RF powers. Previous tetraglyme deposition studies on glass and FEP surfaces show that coatings made at low RF powers produce surfaces that exhibit low protein adhesion. If similar results could be obtained by depositing tetraglyme on the polyurethane copolymer, it might reduce encapsulation and thus result in longer life of the implant in the body. Radioactively labeled fibrinogen is used to measure the amount of protein adsorption, which is our measure of how non-fouling the surface is. ESCA analysis (Electron Spectroscopy for Chemical Analysis) is also being used to characterize at the functional group composition of the coated surfaces and gauge the quality of the coatings. Legacy Research will use well-coated samples for *in vivo* implant studies.

#### **Water Probes: A Novel Fluorescence Based Assay for Water Content Measurement of Dry Reagents Immobilized in Microfluidic Medical Devices**

*Michael Look, Senior, Bioengineering*

*Mentor: Elena Garcia, Bioengineering*

*Mentor: Paul Yager, Bioengineering*

Dry reagent technologies may improve global health by improving the portability of diagnostic microdevices for patients who do not have easy access to a medical facility. Many microfluidic (or "lab-on-a-chip") devices that can

analyze a patient's blood or saliva sample use proteins to perform diagnostic assays. However, the susceptibility of proteins to degradation limits their long-term storage in diagnostic devices that can be portable in a wider range of environments, from air-conditioned offices to tropical jungles. One way to prevent the degradation of proteins is to preserve them in a dry reagent formulation consisting of an anhydrous glass of the sugar trehalose. The ability to measure the water content in dry reagents may provide information that is useful for optimizing the preparation of dry reagents. However, no suitable assay currently exists that allows one to nondestructively and easily measure the water content of a dry reagent immobilized in a microfluidic device. We report our efforts in developing a novel fluorescence based assay for measuring water content in dry reagents, by using the fluorescent probe Prodan. The emission spectrum of Prodan is sensitive to the polarity of its molecular environment. By utilizing this unique property, we demonstrate the feasibility of measuring the Prodan emission spectrum to quantify the water content in a dry reagent. In addition, we report the quality of protein preservation in trehalose glass using different formulations and how the quality of protein preservation is affected by water content in the trehalose glass. The results of our studies reflect our progress in adopting dry reagent technologies for micromedical devices that can improve point-of-care diagnostics and ultimately global health care.

#### **Use of RNA Interference to Inhibit Osteoprotegerin Expression in Endothelial Cells**

*Robert Wu, Senior, Bioengineering*

*Mary Gates Scholar*

*Mentor: Joseph Mcgonigle, Bioengineering*

*Mentor: Marta Scatena, Bioengineering*

Angiogenesis is the process by which new capillaries are formed by sprouting from pre-existing blood vessels. It occurs as an essential component of growth and development, reproduction and tissue repair. The process of angiogenesis is tightly controlled by regulating factors that control the migration, proliferation and survival of sprouting endothelial cells. Our lab has identified osteoprotegerin (OPG) as a novel endothelial cell survival factor, which can promote angiogenesis. Endothelial cells cultured on the extracellular matrix protein osteopontin (OPN) upregulate expression of OPG and are protected from apoptotic cell death. OPG has also been shown to promote angiogenesis in the rat aortic ring model. However, it is unknown if OPG is required for OPN-induced endothelial cell survival or angiogenesis. The goal of this project is to generate endothelial cells with lowered expression of OPG using RNA interference. We have generated short hairpin RNA expression constructs that target 3 different regions of the rat OPG mRNA and are using retrovirus to deliver these constructs to rat aortic endothelial cells (RAECs). We expect one of these constructs to significantly lower the levels of OPG expression in RAECs. The effectiveness of

the method will be established by measuring OPG mRNA levels by real-time PCR and OPG protein levels by western blot. If successful, these cells could be used in various experiments designed to determine the angiogenic behavior of cells with impaired OPG expression. This would be valuable in uncovering the role of OPG in angiogenesis.

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## **SESSION 2I**

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### **SYNTHESIS AND CHARACTERIZATION OF NANOMATERIALS**

*Session Moderator: Rajendra Bordia, Materials Science and Engineering*

*Session Assistant: Robert Snoeberger, Senior, Chemistry, Mathematics*

**Mary Gates Hall Room 295**

#### **Design, synthesis, and characterization of ligands for use on lanthanide cored light emitting metal complexes**

*Kolby Allen, Junior, Chemistry*

*Mentor: Gregory D. Phelan, Chemistry*

Lanthanide metals have been investigated for use in Organic Light Emitting Devices (OLED's) for many reasons. They have a narrow emission band (fwhm ~ 5 nm), bright emissions, and fairly short lifetime of emission. We have been studying Europium, which has a characteristic sharp emission band at approximately 615 nm. To optimize the emission of these complexes, we have attached three equivalents of a  $\beta$ -diketone and one equivalent of a phenanthroline derivative. The  $\beta$ -diketones were synthesized by a Claisen Condensation between an alkyl ester and a methyl ketone. For the alkyl esters we used a fluorinated organic acid and then attached a methyl ketone. The methyl ketones used were 2-acetylphenanthrene and 3-acetylphenanthrene. The Phenanthroline derivatives that we used were 1,10-phenanthroline, 4,7-diphenyl-1,10-phenanthroline (bathophenanthroline) and 4,7-bis(p-bromophenyl)-1,10-phenanthroline. All synthesized complexes showed characteristic 615 nm emission spectra. Data on the quantum yields and the effect of ligand choice on the properties of the complexes will be presented.

#### **Polyol Synthesis of Silver Nanoparticles**

*Leslie Au, Senior, Chemistry, Biochemistry, Biology*

*Mary Gates Scholar*

*Mentor: Younan Xia, Chemistry*

*Mentor: Benjamin Wiley, Chemical Engineering*

Silver nanoparticles have unique catalytic, optic, and electrical properties. Our goal is to control the shape of silver nanoparticles to tune these properties. Specifically I synthesized single crystal silver nanocubes in a range of sizes (20-150 nm) that have previously been difficult to synthesize due the energetically favored and irreversible forma

tion of twin defects. Relatively uniform and monodispersed silver nanocubes were synthesized through a polyol process, which used silver nitrate as the precursor, ethylene glycol as the solvent and reducing agent, poly(vinylpyrrolidone) as the capping agent, and a trace amount of NaCl for selective etching of the twinned particles. We then convert silver nanocubes to gold nanocages for use as a contrast and thermal therapeutic agent in the imaging and treatment of tumor cells.

### **Isotherms of Gases Adsorbed on a Carbon Nanotube Substrate**

*Ashley Batchelor, Senior, Physics*

*Mary Gates Scholar*

*Mentor: Oscar Vilches, Physics*

Our purpose is to study the thermal properties of thin films adsorbed on single-walled, open-ended carbon nanotubes. I have measured isotherms of several gases at liquid nitrogen temperature, i.e. 77.4 K. The isotherms show the amount of gas adsorbed, expressed in units of cc at Standard Temperature and Pressure, for a given gas pressure. An isotherm gives us a slice of the overall phase properties of an adsorbate. For example, we can find the amount of atoms or molecules required to form a monolayer on the nanotube sample. Such a measurement can give us an estimate of the surface area of the sample. We are also interested in finding transitions from an incommensurate to a commensurate structure as well as mixed states. Such transitions will appear as a small bump in the isotherm curve.

### **Synthesis and Surface Chemistry of CdSe Nanocrystals**

*Marsha Ng, Junior, Chemistry*

*Mentor: David S. Ginger, Chemistry*

*Mentor: Andrea M. Munro, Chemistry*

Semiconductor nanocrystals possess size-tunable optical and electronic properties that make them promising candidates for use in electronic devices, such as light emitting diodes (LEDs), and in biological applications, such as fluorescent tagging. Many such applications require nanocrystals with high photoluminescence quantum efficiencies. The quantum efficiency of a nanocrystal is particularly sensitive to its surface chemistry because of the large surface-to-volume ratio and high number of dangling bond surface states it possesses. To study the effect that different surface ligands and ligand concentrations have on the photoluminescence of semiconductor nanocrystals, we synthesize cadmium selenide nanocrystals using tributylphosphine selenide and cadmium stearate as precursors. We then passivate the surfaces of these particles with either an inorganic shell of a higher bandgap semiconductor or a variety of different organic ligands. Specifically, we study the effect of relative solution and sur-

face concentrations of two ligands, 1-octadecylamine and 1-octadecanethiol on the photoluminescence of different sizes of CdSe nanocrystals. The optical and surface properties of the particles are further characterized by UV-Vis absorbance, photoluminescence, fourier transform infrared spectroscopy, and nuclear magnetic resonance. These results will allow us to better understand the changes that different surface ligands induce in the electronic structure of the nanocrystals.

### **Synthesis and Characterization of BaF Nanoparticles**

*Derrick Speaks, Senior, Materials Science and Engineering*

*Mary Gates Scholar, Department of Homeland Security Scholar*

*Mentor: Fumio Ohuchi, Materials Science and Engineering*

*Mentor: Nerine Cherepy, Lawrence Livermore National Laboratory*

Creating new radiation detectors that can accurately measure alpha, beta and gamma radiation is an important homeland security issue. An effective radiation detection system is vital to the effort to prevent a radiological terrorist attack. In order to meet the needs of military and law enforcement agencies, these new detectors must be portable, inexpensive, easy to use and very sensitive. BaF nanoparticles were investigated to see if a hybrid plastic/BaF system might meet these requirements. BaF nanoparticles were synthesized using reverse microemulsions. The particles were characterized using x-ray diffraction and scanning electron microscopy. The optimal processing temperature, time and surfactant/alcohol/water mixture were determined. The BaF particles were found to be cubic with particle size in the range of 10-25 nm.

### **Carbon Nanotube Reinforced Ceramics**

*Craig Terry, Senior Undergraduate, Materials Science and Engineering*

*Mentor: Rajendra Bordia, Materials Science and Engineering*

*Mentor: Michael Scheffler, Materials Science and Engineering*

The properties of ceramics can be significantly enhanced by reinforcing them with carbon nanotubes (CNTs). In our group, we have shown that the fracture toughness and elastic modulus is increased by as much as 200 %. Others have shown similar improvements in other properties like electrical conductivity. One of the problems in developing these materials is proper dispersion of CNTs and avoiding their degradation during high temperature processing. This research is focused on addressing these problems by working on polymers as precursors to ceramics. Polymer derived ceramics (PDCs) can offer several advantages including lower temperature processing and ability to disperse

CNTs in the liquid. Results will be presented on both dense ceramics and ceramic foams. Microcellular ceramic foams are being considered for a wide variety of applications where ceramics have traditionally been too brittle to use. They could be a lighter and cheaper alternative to super alloys in many high temperature corrosive environments. The goal of our research is to obtain ceramics with well-controlled dispersion of CNTs and to evaluate their properties. We are achieving this by growing CNTs *in-situ* by using a nickel metal catalyst with the polymer. Due to the presence of the catalyst and the hydrocarbon gases that evolve during polymer decomposition, CNTs grow. Our most recent research is focused on controlling the location of CNTs. Results from this study will also be presented.

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## SESSION 2J

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**\*Note: Titles and Abstracts in order of presentation.**

### THE CONTOURS OF POLICY: STRATEGY, CHALLENGES, AND COMMUNICATION

*Session Moderator: Gerald Baldasty, Communication*  
*Session Assistant: Clay Schwenn, Academic Counselor,*  
*Undergraduate Education*

**Mary Gates Hall Room 231**

#### U.S. Policy Toward Iran

*Nicole Guidry, Senior, International Studies*  
*Elena Reitman, Junior, International Studies*  
*Dustin Andres, Senior, International Studies*  
*Kendra Gossell, Junior, International Studies*  
*Steve Collins, Senior, International Studies*  
*Nathaniel Polky, Senior, International Studies*  
*Sara Engesser, Senior, International Studies*  
*Gina Guyer, Junior, International Studies*  
*Arjun Dutta, Senior, International Studies*  
*Kevin Hastings, Senior, International Studies*  
*Dina Hilal, Senior, International Studies*  
*Vanja Skoric, Senior, International Studies*  
*John Martin, Senior, International Studies*  
*Rana San, Senior, International Studies*  
*Deborah Chamberlin, Senior, International Studies*  
*Mentor: Resat Kasaba, Jackson School of International Studies*

U.S. policy towards Iran is a major foreign policy challenge for the United States in the coming months. American interests that affect Iran include preventing nuclear proliferation, maintaining unrestricted access to the Persian Gulf region, stabilizing conflict in the Middle East, and promoting human rights. These American interests are all trials to accomplish because conservatives who have taken over the Iranian government in recent elections have established policies that oppose American interests, such as enhancing their nuclear programs and involvement in regional

conflicts. If Iran continues along this line, its policies are bound to clash with U.S. interests in the region. The United States finds itself having to confront this issue at a time when its military assets are tied up in Iraq and Afghanistan, its alliances are frayed, and its economic trends have made it particularly vulnerable to global pressures. The purpose of this Task Force report is to provide recommendations for a new United States policy towards the Islamic Republic of Iran. This report's objective is examining political, economic, security and cultural barriers between the U.S. and Iran, specifically those barriers that hinder progress of U.S. interests, preventing nuclear proliferation, maintaining unrestricted access to the Gulf, stabilizing the Middle East and promoting human rights. Through extensive research using journals, books, multi-lingual sources, and by paying close attention to daily developments in the current situation, this Task Force report has produced recommendations regarding these obstacles, such as economic negotiations or renegotiating the Non-Nuclear Proliferation Treaty.

#### Counterinsurgency Doctrine and U.S Army Transformation: Historic Examples in Combating Asymmetric Threats

*Quincy Castro, Senior, Economics*  
*Mentor: Robert Farley, Political Science*

In its history, the U.S Army has repeatedly come into conflict with opponents utilizing asymmetrical warfare tactics, often with devastating effects. For a variety of reasons, and unlike colonial powers such as England and France, the U.S. Army has traditionally resisted doctrinal changes which would allow them to fight more effectively against these threats. Instead it has chosen over the span of the Cold War to prepare for massive land battles with the Red Army. As we have seen in conflicts such as Iraq and Vietnam, while such a force can easily defeat 'regular' opponents fighting in a traditional battle space, it is to a large extent ineffective against irregular forces utilizing guerrilla tactics. As the U.S. Army is called to action against more and more such asymmetrical threats in a post-Cold War world, how can it best prepare to counter such threats? Historical examples show that effective counterinsurgency strategies, while differing from theater to theater, share similar doctrinal approaches in flexibility, intelligence gathering and dealing with civilians and non-combatants. In preparing to meet current and future threats, insurgent tactics must be studied and specific responses developed. It is critical that past conflicts be examined for both successes and failures and that technological investment by the Pentagon be made in an effort to support traditionally successful counterinsurgency techniques, not replace rigorous training and discipline.

#### U.S. Policy on Nation-Building

*Zack Barnett-Howell, Senior, International Studies, Political Science, Comparative Literature*

*Francesca Battistelli, Senior, International Studies*  
*Courtney Capellan, Senior, International Studies*  
*Adam Coady, Senior, International Studies*  
*Sean Duggan, Senior, International Studies*  
*Heather Harms, Senior, International Studies*  
*Melinda Hudson, Senior, International Studies*  
*Holly Hulst, Senior, International Studies*  
*Hannah Janeway, Senior, International Studies, Comparative History of Ideas*  
*Chelsey McKnight, Senior, International Studies*  
*Sabina Popa, Senior, International Studies, English*  
*Rebecca Rogers, Senior, International Studies*  
*Dafny Sibay, Senior, International Studies*  
*Joseph Wright, Senior, International Studies, Economics*  
*Alex Yates, Senior, International Studies*  
*Alexis Youngs, Senior, International Studies*  
*Mentor: Professor Joel Migdal, International Studies*

The research took place in an International Studies Task Force, consisting of 16 students. The purpose of this task force was to recommend to the Democratic Party when and how the United States should engage in nation-building. Nation-building is the process of creating secure environments and stable, self-sustaining institutions in deeply-divided societies, where state authority and major institutions have collapsed. Our researchers examined the specific tasks and conditions that are necessary when nation-building. These tasks include the creation of security, stable political and economic institutions, and a participatory society. Based on our study of current and historical cases, the report recommended the circumstances that should govern U.S. engagement in nation-building, including if the target country presents an imminent security threat to the United States or one of its close allies, the costs of participation, and the U.S. ability and willingness to guarantee a substantial commitment in terms of time, resources, and manpower. In order to share the substantial burden of nation-building, the report concluded that the United States should act multilaterally through the establishment of regional coalitions.

### **Relationship Between the Income Tax and State Spending Levels with an Emphasis on the Washington State Tax Structure**

*Cecilie Wathne, Senior, Economics, Political Science*  
*Mentor: Neil Bruce, Economics*

A recurring debate in our state involves the question of adopting an income tax. While many think this is the best solution to our fiscal needs, opponents fear that a state income tax would increase the ability of states to extract revenue, thus leading to higher levels of government spending. In order to either support or refute this hypothesis, my professor and I have created a model to analyze the role of the state tax structure in determining state spending levels. More specifically, we are using regression analysis with spending as a percent of Gross State Product as the dependent variable, the percentage of state tax revenue collected

by means of a state income tax as the independent explanatory variable, and a series of control variables. According to our preliminary results, the fear of increased government spending is not warranted because it is the economic, political, and structural components rather than the tax structure that determines the level of state and local government expenditure. Currently, we are working to improve our results by using panel data in order to compare similar variables over a period of time as well as across states. Going forward we are also focusing on three additional questions: First, what are the ramifications of having an income tax? Does the ability to deduct state income taxes from federal taxes change the “price” of state spending to the average taxpayer and, if so, how does this affect the level of state spending? Second, what affect do federal matching rates have on taxation levels? And lastly, does a more balanced and less concentrated tax structure have any effect on state spending rates?

### **The Media and the 2004 Campaign**

*Theda Braddock, Senior, Journalism, Political Science, French*  
*Mentor: Lance Bennett, Political Science, Communication*

In my project I am seeking to determine how the media’s role in the 2004 Presidential election, George W. Bush and John Kerry. First, I would like to know whether the media accurately covered the two principal candidates and then how the treatment affected the public. I am examining how three leading newspapers, the *Los Angeles Times*, *New York Times*, and *Washington Post* wrote about the campaigns. I have limited the time frame to when it was clear that Kerry was going to be the Democratic candidate so I’ve searched for articles between March 1<sup>st</sup> through day after the election. Knowing that I cannot review all of these pieces, I have chosen to survey articles from every Wednesday and every Sunday edition that reflect recent press releases and/or speeches. In addition I have chosen several key points in the election that affected both candidates and will look at what articles the papers produced for these events. I am comparing articles to campaign events, press releases and speeches, looking at reporting errors and misinformation, word choice and biases. I am not only looking at the contents of the stories but their placement in the papers as well. Furthermore, I am using Gallup polls produced throughout the campaign to gauge the audience’s response to the topics discussed to see if they understood what was being written. When I am through with my project I plan on writing a thesis, which addresses the following, whether or not these newspapers accurately covered the Bush and Kerry campaigns, whether there was any bias towards either one of the candidates and whether the publishing of their stories helped the population in making their decision.

### **‘Flip-Flop,’ A Rhetorical Analysis of the 2004 Presidential Election’s Stickiest Catch Phrase**

*Cammie Croft, Senior, Communication, Political Science*

*Mentor: Leah Ceccarelli, Communication*

The term “flip-flop” gained tremendous recognition in the campaign leading up to the 2004 Presidential Election. From a scholarly standpoint, the popularity of this term is puzzling. Why did a seemingly unsophisticated term stick to Democratic Party nominee John Kerry and how did it appeal to the American electorate? To answer this question, a collection of “flip-flop” artifacts in a variety of mediums from t-shirts to television commercials was gathered and an analysis of these samples is being conducted. The project involves: 1) an historical investigation of key terms from past presidential campaigns, 2) a study of the rhetorical situation which gave rise to the term “flip-flop” in the 2004 campaign, 3) a review of each political party’s efforts to define John Kerry, 4) a look at how the term “flip-flop” clashes with the American electorate’s preconceived notions of what qualify as ‘presidential’ characteristics, and 5) an examination of the multitude of mediums in which “flip-flop” appeared. Within each of these areas, tools of rhetorical analysis will be employed. It is anticipated that this study will grant insight into the celebrity of the term “flip-flop” and will further our scholarly understanding of the power of such terms in campaign rhetoric.

### **Politics Too is an Art: Art and Propaganda in Nazi Germany**

*Claire Tarlson, Senior, History, English, Seattle University*  
*Mentor: Tom Taylor, History, Seattle University*

This paper addresses the complex interrelation between art and propaganda in Nazi Germany. Customarily in the modern era, visual art is understood as the product of individual expression; propaganda, by contrast, is calculated ideological persuasion. I argue, however, that because of the nature and policies of the Fascist German state, art and propaganda take on very different meanings within this context. Through an examination of paintings and sculptures from this period, the diaries of Josef Goebbels (cultural and ideological mastermind of the Nazi party), and examples of bureaucratic legislation relating to German artists, I claim that the Nazi state politicized and policed the German artist in a manner uniquely central to the state’s agenda. I offer a comparative analysis of art and government policy in Germany in the late 1930’s and early 1940’s that demonstrates the deep connections between the cultural policy of the Reich and the officially sanctioned art that resulted.

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## **SESSION 2K**

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### **UNDERSTANDING ISSUES AND ADDRESSING SPECIAL NEEDS**

*Session Moderator: Harry Bruce, Information School*  
*Session Assistant: Katya Yefimova, Freshman, Comparative Literature*

## **Mary Gates Hall Room 228**

### **The Economic and Legal Aspects of Open Source Software**

*Jonathon Jude Frost, Senior, Economics*

*Mentor: Keith Leffler, Economics*

*Mentor: Robert Gomulkiewicz, School of Law*

*Mentor: Dan Laster, School of Law*

The emergence of open source software as a viable economic model has risen to the forefront in the debate on the future of the information technology industry. However, at first glance, the open source software development model is strikingly enigmatic and counterintuitive. To help better understand this phenomenon, my paper, through market data and economic theory, proceeds to ask and answer three related questions. First, what is the economic dynamic between open source software communities and proprietary software firms? Second, what are the resulting effects on market innovation and innovation incentives? And third, what legal mechanisms allow for the sustainability of open source software and should they be expanded or reduced?

### **A Structure Editor for Diagnostic Educational Assessment**

*Cy Khormae, Senior, Computer Science*

*Mentor: Steven Tanimoto, Computer Science and Engineering*

The **Structure Editor for Diagnostic Educational Assessment** Project (SEFDEA) is a part of the ongoing research by the Online Learning Environments Laboratory, which is currently investigating methods for diagnostic assessment on the basis of online learning artifacts and log files. More specifically, SEFDEA is concerned with developing an application in C# to facilitate the process of constraining and assessing student’s rhetorical responses for diagnostic analysis by the instructor. The structure editor will constrain student input to a set of syntactically correct responses. This will permit the diagnostic analysis mechanism to readily infer semantic content of the writing and subsequently infer facets of student understanding. In order to avoid having only a narrow field of applicability, the editor will accept template files from an instructor or educational technologist that define classes of permissible documents. When the editor prototype is working, it will undergo usability testing. The goal of the project is to provide instructors with a versatile tool to streamline and enhance the diagnostic assessment process.

### **A Study of Tactile Graphics Production**

*Amelia Lacenski, Senior, Informatics, Spanish*

*Mentor: Melody Ivory, Information School*

Blind students need tactile graphics (raised images that are designed to be read by the fingers) to help them to comprehend complex concepts in their math, science, and engi-

neering courses. Often these students do not have timely access to tactile graphics, because they take considerable time and effort to produce. We conducted a study to examine how people produce tactile graphics and, in particular, how software applications are used in the production process. Using a questionnaire and a series of in-depth observation sessions with tactile graphics producers, we found that these specialists shy away from using software to help them in their work, even though their production methods are labor-intensive and repetitive. There exist several full-featured graphics applications whose advanced image-processing tools could streamline the production process and improve production rates. Nonetheless, many tactile graphics producers perceive them as cumbersome, non-intuitive, and poorly suited to incorporating Braille text into the tactile graphics. Through our study, we identified several ways in which software could better suit their needs and derived guidelines for the design of a next-generation software solution. We are using these findings to develop software to simplify the production of tactile graphics. The software will make it possible for blind students to have adequate access to course materials.

### **An Exploratory Study on How Users Get Help with Technology**

*Andrew Martin, Junior, Informatics*

*Mary Gates Scholar*

*Mentor: Melody Y. Ivory-Ndiaye, Information School*

Although help systems are prevalent, studies have shown that existing systems are not effective. Consequently, users are reluctant to use help systems to resolve problems that they encounter with technology, and they typically consult them as a last resort. To identify potential areas for innovation and improvement, we conducted a study to understand the current state of help from the perspectives of users. We developed a questionnaire based on the major themes that emerged from prior help user studies. Common themes included: non-intuitive terminology and organization, too broad or too specific content, not knowing how to access help, navigation difficulty, and unusable interfaces. We asked users a total of 45 questions about their use of help within three domains: (1) software applications that are used on personal computers (i.e., desktop, laptop, or tablet computers); (2) web sites, applications, or search engines (the Web); and (3) mobile devices or small, portable computers that allow users to store, organize, and access information that is stored on the device or online (e.g., PDA, pocket PC, iPod, handheld PC, or electronic book reader). We report trends across users with respect to their use of and satisfaction with help. We also describe three groups of help seekers that we identified by applying clustering algorithms to users' responses. One major result is that users prefer to use the Web to resolve technology problems. Results suggest the need to simplify help seeking via the Web.

### **Automated Tactilization of Graphical Images**

*Matthew Renzelmann, Senior, Compute Science and Engineering*

*Mary Gates Scholar*

*Mentor: Professor Richard Ladner, Computer Science and Engineering*

Ideas are routinely communicated using a variety of techniques: words, sounds, and images are but a few. Some of these techniques, however, are ineffective if the person being communicated with has a disability, such as blindness. In many science and engineering fields, blind persons face tremendous obstacles in their effort to perceive such forms of communication as diagrams, charts, and graphs. The primary goal of our research is to develop computer software capable of automating the conversion of figures and diagrams in a book to a tactile format that blind persons can readily perceive. Among the challenges posed by this goal is the need to find and remove text from the figures and diagrams for eventual conversion to Braille. It is this challenge on which my work focuses. Since conventional optical character recognition (OCR) software is poorly suited to the task of finding short pieces of text embedded within images, we are exploring new methods based on training and statistics. Because the figures and diagrams in a book are of a similar style, we can exploit this similarity to improve text recognition accuracy. The software we have written is able to recognize a high percentage of the text once provided with a small training set from which to base its predictions. We will discuss the techniques used in our software and make comparisons with alternatives, such as existing commercial OCR software.

## STUDENTS TALK ABOUT THEIR RESEARCH

*“Undergraduate research has provided me with such a unique opportunity, available at only a few public institutions. I feel that the experience I have gained has helped solidify subject material from my classes and will help guide me into the world of my post-undergraduate career.”*

*- Megan Striplin, Senior, Microbiology*

*“Research has been an invaluable component of my education at the UW. It gives me a new pair of glasses with which to stare at any problem, in any field. It has also reaffirmed and redirected my ultimate goals, and I feel confident in pursuing them because of the support of my lab and my mentor.”*

*- Eliana Hechter, Junior, Mathematics and Computer Science*

*“I worked on three research projects as an undergraduate, and each provided me with hands-on, experiential learning, but also directed my goals and plans. Through research, I refined my view of what I want to do with my life. Simultaneously I worked on issues of interest to nonprofits, government agencies, business, and the public, such that I made a difference not just for myself, but also for the region.”*

*- Jacqueline White, Senior, Biology and Environmental Studies*

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## STUDENTS TALK ABOUT THEIR RESEARCH

*“Research has definitely been the defining aspect of my education experience at the University of Washington. I love having the opportunity to attempt to answer questions that have yet to be answered and in the process begin asking questions that may never have been asked.”*

*- Sara Van Nortwick, Sophomore, Bioengineering*

*“My most important learning experiences have been the times that I have been able to take the concepts I learn in the classroom and apply them to hands on research. My experience as a research assistant, research fellow, and Mary Gates Scholar has opened incredible doors for me. I feel that my ability to apply my learning in research was really the most amazing learning experience that I have had at the University of Washington.”*

*- Lindsay Scola, Senior, Political Science*

*“The Undergraduate Research Program has provided me with a goal, a deadline, and a forum in which to share my academic pursuits.”*

*- Michael Zuver, Senior, Comparative History of Ideas, Political Science*

## ACKNOWLEDGEMENTS

The Undergraduate Research Program wishes to recognize all of the faculty members, staff, and graduate students who have contributed to the education of the undergraduate researchers featured in this symposium.

None of this would have been possible without you.



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