

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

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

14 May 2004

**MARY GATES HALL**

12:00 – 5:00 PM

**PROCEEDINGS**

***Sponsors: The UW Office of the President, Office of the Provost, Office of Research, Office of Undergraduate Education and the Undergraduate Research Program***

*The Seventh 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 310 for an appointment or send 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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### TABLE OF CONTENTS

<b>POSTER SESSIONS</b>	<b>4</b>
<b>PRESENTATION SESSIONS</b>	<b>75</b>
1A. CHALLENGING FAMILIAR CONTEXTS IN LEARNING	76
1B. CELLULAR MECHANISMS OF DEVELOPMENT AND DISEASE	77
1C. CULTURE AND GLOBALIZATION	79
1D. ENVIRONMENTAL AND BIOCHEMICAL ASPECTS OF ECOLOGY	81
1E. INDIVIDUAL AND SOCIETY ISSUES IN PARENT AND CHILD DEVELOPMENT	83
1F. INNOVATIVE STRUCTURES, SYSTEMS, SOLUTIONS	85
1G. IN VIVO, IN VITRO, IN SILICO: EXPLORATIONS IN BIOLOGY AND BIOCHEMISTRY	87
1H. LIVING SYSTEMS	88
1I. MOVEMENT, MEDIA, AND THE ART OF RUG WEAVING	90
1J. PEOPLE, PLACE, AND CULTURE: DISCOURSES OF SOCIAL JUSTICE	92
1K. REDUCED GRAVITY	94
1L. TRANSLATIONAL BIOENGINEERING	95
2A. ADVANCED MATERIALS AND SYSTEMS	97
2B. BIOLOGICAL AND GEOLOGICAL FEATURES OF ECOSYSTEMS	99
2C. COMPUTING ALGORITHMS FOR DATA AND SCIENTIFIC ANALYSIS	101
2D. GENES, IMMUNITY, AND METHODS OF STUDY	102
2E. HUMAN EXPRESSION AND BEHAVIOR	104
2F. ENVIRONMENTAL POLICY, ECONOMICS, AND ETHICS	106
2G. MAKING SENSE OF HISTORY	108
2H. PHYLOGENETICS, BEHAVIOR, AND ENVIRONMENTAL BIOLOGY	110
2I. SHAPING OUTCOMES: POLITICS AND ECONOMICS	112
2J. THE ENVIRONMENT AS POLICY, PLANS, AND SOCIAL PRACTICES	114
2K. THE GENETIC AND BIOCHEMICAL BASIS OF HUMAN DISEASE	115
2L. USE OF MODEL SYSTEMS IN BIOLOGY	117
<b>INDEX</b>	<b>121</b>
<b>ACKNOWLEDGEMENTS</b>	<b>127</b>

#### PLEASE NOTE

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

## **ANNOUNCING NEW OPPORTUNITIES FOR UNDERGRADUATE RESEARCH!**

### **Research Fellowships for Advanced Undergraduates**

*Sponsored by the Washington Research Foundation and UW Undergraduate Research Program*

These new \$5000 fellowships support undergraduates who have shown promise as dedicated and creative researchers to continue their work in a science or engineering field throughout the academic year 2004-05. Students who plan to graduate no earlier than June, 2005 and who have completed at least three quarters of research are encouraged to apply. Applications are due June 4, 2004. For more information visit the Undergraduate Research Program website: [www.washington.edu/research/urp/rfau.html](http://www.washington.edu/research/urp/rfau.html).

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

*Sponsored by the UW Office of Research, Undergraduate Research Program and the Mary Gates Endowment for Students*

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).

# POSTER SESSIONS

## PLEASE NOTE

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

## STUDENTS HONOR THEIR MENTORS

*“This research project would not have been possible without the help of Professor Mark Holmes, who tirelessly worked to clarify the murky and illuminate the indecipherable. Also, Prof. Chuck Nittrouer has been very kind in lending both his expertise and equipment to this study.”*

*- Maureen Davies, Senior, Earth and Space Sciences  
Mentor: Mark Holmes, Oceanography*

*“Professor Batya Friedman saw potential in me that no one else, including me, saw. Before being invited by Prof. Friedman to do research in her lab, I was unsure of my specific interests in my major. Now, in my third quarter with her, she has encouraged and challenged my thoughts and ideas. I truly appreciate the opportunity she has given me to expand my knowledge in such a creative way.”*

*- Robin Sodeman, Senior, Informatics  
Mentor: Batya Friedman, Information School*

*“I would like to thank Professor Nikhil Singh for providing immense help with my research project by pushing me to go further than I first thought I could go.”*

*- Doug Jensen, Senior, History  
Mentor: Nikhil Singh, History*



### **My Multiple Life: Personal Information Management Across Different Computer Environments**

*Adonis Acuario, Senior, Informatics, Psychology*  
*Mentor: Melody Ivory-Ndiaye, Information School*

Current research involving the use of personal information management tools has focused on studying people's organizational patterns in a very general sense. One important aspect that needs to be addressed is the diversity of people's lives. Current research does not take under consideration the different situations and environments in which people's organizational patterns may be different. How one arranges documents in one environment may be dissimilar from how it is arranged in another. Thus, the goal of this research is to investigate how people manage electronic information across different working environments. Through interviews and observations, the organizational patterns of people's electronic documents, email and internet bookmarks on two different computer settings will be examined individually and then compared. Such research can have an effect on the development of future information management tools. The results can be used to develop better tools that support stability in the management of personal information across both the information forms and the environments that make up our lives.

### **The Effect of Wnt 3a and Wnt 5a on the Proliferation and Migration of Mouse Fibroblasts**

*Bobby Ahmadi, Senior, Biology*  
*Mentor: Anne Hocking, Plastic Surgery*

Our lab's focus is on the role of Wnt genes in wound healing. The Wnt gene family encodes a number of secreted glycoproteins that are involved in the cell-cell signaling of many basic developmental pathways. Two important processes that occur in wound healing are cell proliferation and migration. The goal of my project is to determine whether specific Wnt genes affect the proliferation and migration of fibroblast cells, a cell type found in the skin. Fibroblasts have been implicated in the wound-healing pathway as cells that can help regenerate tissue that has been damaged. Fibroblast cells, specifically the mouse-derived NIH3T3 cells, were plated and sustained through normal tissue culture protocol. For the establishment of Wnt conditioned media, mouse fibroblast L-cells were used that were stably transfected with Wnt expression vector. These cells secrete our desired Wnt protein into the surrounding conditioned medium. To observe proliferation patterns in the presence of Wnt, cells were counted via a counting chamber. To study the effects of Wnt on cell migration, a scratch wound assay was performed. Wounds were made at marked locations on confluent NIH3T3 cells using a cell scraper or pipette. At specific time points, migration was observed in relation to how fast the cells moved to close the wound. My preliminary data suggest

that NIH3T3 cells in Wnt3a conditioned medium have an increased influence on the proliferation and migration versus parental (control) media and Wnt5a conditioned media. These results have been proven to be statistically significant using the t-test for a paired two sample. I am currently investigating the mechanism into how Wnt signaling causes an increase in fibroblast proliferation and migration.

### **Powerful Writers Impact Study: Beacon Hill Elementary**

*Jonathan Aldanese, Senior, Sociology*  
*Zesbaugh Scholar*  
*Mentor: Gary Troia, Special Education*

From August of 2003, I have worked with Professor Gary Troia in investigating writing workshop instruction at Beacon Hill Elementary. Our main mission in the project is to find out how children learn to write best. To do this, we observe teachers while they teach language arts and collect and score children's writing samples. Teachers also participate in semi-annual focus groups that tell us how they view writing instruction and what they feel are factors that affect their students' writing achievement. The results of this study will help us decide what most influences children's writing and what are the best ways to teach writing. The research is in collaboration with a community-based non-profit program called Powerful Writers, which helps teachers implement quality-writing instruction by providing ongoing professional development, grade-appropriate instructional materials, opportunities to interact with visiting authors, and celebratory events for students to share their writing. Using writing traits such as organization, sentence fluency, and word choice, we are evaluating the writing samples of six target students (3 low achievers, 3 high achievers) collected by teachers in portfolios. The portfolios contain two essays and two stories the students have written during the course of the school year. My personal role in working with the study has included being a contributor to scoring writing samples, entering data we have gathered, and visiting the school occasionally for observations and focus group meetings with teachers involved in the study. I have gained knowledge regarding teaching writing and scoring writing samples, essential skills for my future career in teaching. In addition, I have acquired experience using important statistical software (SPSS) and have developed an appreciation for the importance of writing in schools. As a Zesbaugh Scholar, I have gained a tremendous amount of respect for the research done at the University of Washington.

### **Effects of Small Neutral Osmolytes on the Supercoiling Free Energy and Intrinsic Twist and Torsional Rigidity of p30' DNA**

*Theresa Aliwarga, Senior, Biochemistry, Chemistry*  
*Mentor: J.M. Schurr, Chemistry*

Fluorescence spectroscopy and gel electrophoresis are used to study the effects of the small neutral osmolytes, ethylene glycol and acetamide, on several physical properties of DNA: the torsion elastic constant ( $\pm$ ), the intrinsic twist ( $-!$ ), and the twist energy parameter ( $E_T$ ). Data for the two osmolytes at 37°C are interpreted in terms of a model wherein the DNA exhibits an equilibrium between two distinct conformational states. The states possess different numbers of bound water molecules and exhibit different intrinsic twists and torsion and bending elastic constants. Equations for this model are derived to relate the effective  $E_T$  and  $-!$  to the equilibrium constant, water activity ( $a_w$ ) and number ( $n$ ) of bound water molecules released in the transition between the two DNA states. The variations of  $E_T$  and  $-!$  with  $-\ln(a_w)$ , as measured by a topoisomerization/gel electrophoresis protocol, are similar for acetamide and ethylene glycol at 37°C. Fitting the model equations to these data yields a range of bound water;  $n=103-125$  for ethylene glycol and  $n=71-113$  for acetamide, depending on the assumed value for  $E_T$  for the dehydrated state. Between 0 and 20 w/v % ethylene glycol, the torsion elastic constant, measured by time-resolved fluorescence polarization anisotropy (FPA), increases by 37%, whereas the measured  $E_T$  decreases by 13% over that same range. This implies that the bending rigidity must decrease over that range by a factor about 0.7. The variations of  $E_T$  and  $-!$  with increasing  $-\ln(a_w)$  (due to the presence of ethylene glycol) at 37°C are considerably smaller than the corresponding variations observed previously at 14 and 15°C. However, at 21°C, upon adding either osmolyte,  $E_T$  and  $-!$  initially decline steeply with slopes comparable to those seen at 14 and 15°C, but then flatten out and follow curves similar to those at 37°C. The origins of this mixed behavior are explored in continuing experiments and discussed in terms of the findings.

### **Parenting and Marriage: Comparing Parenting Satisfaction of Males and Females and Its Effects on Marriage Quality of New Parents**

*Jeanne Allen, Senior, Psychology, Communication*  
*Mentor: Sybil Carrere, Family and Child Nursing*

When married couples become parents for the first time new challenges and rewards are added to the couples' relationship. As a result parenting role quality may have an effect on factors in the couples' relationship such as loneliness, the husband and wife's marital role quality, emotional flooding from the other partner, and to what degree they lead separate lives. It was hypothesized that lower satisfaction with parenting would predict lower satisfaction with the marital relationship for both males and females. The results reported in this paper come from the examination of questionnaire data collected from legally married couples ( $n=24$ ). Data was only collected from couples who had been married five to seven years. Balance scores were computed for marital and parenting domains, reflecting the extent to which rewards in the domain

outweighed concerns. Correlational analysis showed the wife's parallel lives score had a strong relationship with the wife's parenting role quality score (-.522). There was, however, no significant correlation between the husband's parallel lives score and the husband's parenting role quality (-.140). There was no significant correlation for either spouse between their own parenting role quality and the parallel lives score of their partner. The wife's parenting role quality score had a strong relationship with the wife's marital role quality (.459), as did the wife's loneliness score and her parenting role quality (-.536). Surprisingly, no significant correlation between the wife's parenting role quality and the husband's parenting role quality was found. Neither the wife's emotional flooding score (.038) or her loneliness score (.041) was predictive of the husband's parenting role quality. The wife's emotional flooding score was not related to her parenting role quality (-.051). The wife's marital role quality was not related to the husband's parenting role quality (-.014). These results suggest that factors in marital relationships are more predictive of parenting role quality for females than for males.

### **Building a Soft X-Ray Diagnostic to View Magnetohydrodynamic Instabilities in Spherical Tokamaks**

*Annamarie Askren, Junior, Aeronautics and Astronautics*  
*Mary Gates Scholar, Space Grant Scholar*  
*Mentor: Thomas Jarboe, Aeronautics and Astronautics*  
*Mentor: Roger Smith, Aeronautics and Astronautics*

The Helicity Injected Torus Experiment (HIT) aims to develop better plasma sustainment methods in Spherical Tokamaks. To quantify the plasma's temperature within the HIT-II tokamak, a Soft X-ray diagnostic has been constructed to collect X-ray spectrum Bremsstrahlung radiation. Prior to construction, the Soft X-ray Camera was modeled in 3D using the program SolidWorks. The Soft X-ray diagnostic includes a hexagonal carousel mounted with metal films less than 1 micron thick for filtering out visible radiation. A port is currently being machined to attach the diagnostic to the new plasma chamber, HIT-SI. Data shall begin to be collected in a few months.

### **Shape Control Synthesis of Palladium Nanoparticles**

*Leslie Au, Senior, Chemistry, Biochemistry*  
*Mentor: Younan Xia, Chemistry*  
*Mentor: Jingyi Chen, Chemistry*

Shape control synthesis of palladium colloids was developed via polyol process. This reaction was investigated with varying molar ratio of the polyvinylpyrrolidone to palladium colloid over a temperature range between 80°C to 160°C using different starting salts such as  $\text{Na}_2\text{PdCl}_4$ ,  $\text{PdCl}_2$ , and  $\text{Pd}(\text{NO}_3)_2$ . The colloids were characterized using Tunneling Electron Microscopy and X-Ray Diffraction. The stabilized polymer

was characterized by Fourier Transform Infrared Spectroscopy before and after the reaction to understand the adsorption of the polymer on the surface of the colloids. The mechanism of this shape control synthesis was proposed. Finally, the catalytic properties of different shaped nanoparticles were examined in hydrogenation reaction. The significance of this research was to improve the design of palladium catalysts.

### **Imitation Learning in a Robotic Head**

*Chris L. Baker, Senior, Computer Science, Statistics,  
Mary Gates Scholar, McNair Scholar*

*Mentor: Rajesh P. N. Rao, Computer Science and  
Engineering*

From birth, humans use imitation to acquire new skills. In contrast, computer systems require extensive programming to learn new tasks. Endowing computers with the ability to imitate reduces the burden on human programmers, and allows computers and robots to learn without explicit teaching – a potentially huge benefit. Our research offers a computational model for imitation learning in robots that is inspired by studies of human imitation learning. Our model combines statistical techniques from computer vision and motor control to achieve accurate results in complex, real-world environments. We present results from our imitation learning framework implemented in a robotic head. The robotic head learns novel head gestures from human teachers, and demonstrates its understanding by imitating human head movements in real time. This is an important step toward achieving automatic inference of human intention by robots.

### **How the Ocean Affects the Wind**

*Brandon Ballinger, Sophomore, Physics, Computer  
Science*

*Mary Gates Scholar, Space Grant Scholar  
Mentor: Kathie Kelly, Applied Physics Laboratory*

The wind is strongly coupled to the ocean: the ocean pushes, twists, and overturns the winds blowing above it. Current computer models poorly account for this air-sea coupling, in part because their low-resolution smooths out the ocean effects. New, high-resolution satellites allow these effects to be studied in detail. We examined how a popular computer model, NCEP, would improve if it better accounted for air-sea coupling. We studied two particular coupling processes: ocean currents and ocean temperatures. Ocean currents are assumed zero by the computer model. Since the satellites measure the relative speed between the wind and ocean, in regions of fast currents, this assumption creates large differences between the model and radar measurement. Fast currents tend to appear alongside large ocean temperature gradients, which also affect the wind. A cold ocean tends to stratify the air above it, whereas a warm ocean has the opposite effect: it overturns and mixes the air above it, bringing faster winds down to the surface

and pushing slower winds up. In an energetic region like the Gulf Stream, these two effects are critical. Plots of differences between model and measured winds show detailed structures, indicating that the neglect of air-sea coupling creates systemic errors in the NCEP model. To remedy this, we created some simple numerical methods which modified the NCEP winds with the effects of ocean currents and temperatures. We used the LKB algorithm to simulate the effect of high-resolution ocean temperature; we converted the absolute NCEP velocity into a relative one by subtracting the ocean currents. I found that the effect of currents dominates in the Gulf Stream region.

### **Assessing Interest Groups Influence on Congressional Decision Making: A Case Study of AIPAC**

*Rachel Bender, Senior, Political Science  
Mary Gates Scholar*

*Mentor: Bryan Jones, Political Science  
Mentor: John Wilkerson, Political Science*

Special interest or lobby groups have been facets of the American political system since the colonial era. Researchers have shown that powerful interest groups play an influential role in policy making, often helping to shape what does and does not make it on to the political agenda. Is this where the influence stops? In my research I am attempting to determine whether or not interest groups play a role in American politics beyond agenda setting. Does the support of a powerful interest group really make a difference in whether or not a bill is successful in Congress? This study will be focusing on one well known foreign policy interest group in particular—the American Israel Public Affairs Committee (AIPAC), the largest and most well known pro-Israel interest group—and assessing its impact on U.S. policy in the Middle East. I hypothesize that bills supported by AIPAC will not pass with greater frequency than the average bill. I will be comparing two success rates, that of my dependent variable, AIPAC-sponsored bills affecting U.S. policy in the Middle East, to that of my baseline, the success of “the average bill,” computed by taking a random sample of all bills introduced in both the House and Senate. If any difference between the two is statistically significant, it will suggest that AIPAC may indeed have an impact on the legislative process. I am obtaining data through the Center for American Politics and Public Policy and AIPAC’s biweekly newspaper, *The Near East Report*. To isolate AIPAC’s affect on Congressional decision making, I will control for presidential preference by defining a “passing” bill as one which is passed in both the House and Senate, regardless of whether or not it is vetoed by the President.

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

*Kristina Bezold, Junior, Bioengineering*

*Space Grant 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 affect the 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  $\text{Ca}^{2+}$  activated force ( $F_{\max}$ ) produced in skeletal muscle decreases. Most previous studies have focused on a particular muscle fiber type, and little is known about the Pi sensitivity of  $F_{\max}$  across muscle types. To study how Pi affects different muscle types we have measured  $F_{\max}$  in demembrated muscle cells exposed to varying [Pi] from 0.5-75mM under maximal  $\text{Ca}^{2+}$  activation conditions (pCa 4.0, 15°C). Under physiological conditions, Pi levels normally range from 3-8mM, but can increase dramatically during exercise. Rat adductor, gracilis, TFL, and psoas fibers (all fast-type myosin isoforms; determined by gel electrophoresis) were inhibited to 0.5  $F_{\max}$  (KJ) at 24.6, 28.2, 17.1, and 24.7mM Pi, respectively, and inhibition was not saturated at 75 mM Pi. Rat soleus fiber (slow-type myosin isoform) KJ 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 37°C for comparisons to skeletal muscle. At 15°C  $K_1$  for cardiac muscle 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. 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.

### **A Somatic Palindrome Formation Profile in Pediatric Neuroblastoma Cell Lines**

*N. Teresa Bleakly, Senior, Neurobiology*

*Mary Gates Scholar*

*Mentors: Meng-Chao Yao, Biology*

*Mentor: Hisashi Tanaka, Biology*

The most common solid extracranial tumor that affects children is neuroblastoma. Derived from cells of the sympathetic nervous system, neuroblastoma patients older than the age of infancy have a poor prognosis. This study focuses on the tumor subset with the most unfavorable prognosis, which is characterized by genomic instability and amplification of the oncogene, N-Myc. Three neuroblastoma cell lines, NSH, NLF and NGP, were tested for amplification of the proto-oncogene, N-Myc. In the cell lines where N-Myc is amplified, gene expression was

also tested. In addition, we then tested the N-Myc amplified cell lines for palindrome DNA sequence formation using a new microarray-based approach, Genome-wide Analysis of Palindrome Formation (GAPF). Formation of palindromes, which is initially caused by chromosome breakage, is believed to play a role in the initiation of oncogene amplification. With this microarray assay we looked for a pattern of palindrome formation that could be responsible for N-Myc amplification and attempted to identify other genomic loci that may also rely on palindromic sequence formation as a means of gene amplification in neuroblastoma. Through this study, we were able to observe, define, and quantify a gene amplification phenomenon (somatic palindrome sequence formation), as well as use the assay to screen whole human genomes to further identify other loci that form somatic palindromes in neuroblastoma cell lines. The eventual hope is to identify the loci that are commonly susceptible to chromosome breakage and palindrome formation in neuroblastoma, which may uncover genotoxic stresses specific for the development of the sympathetic nervous system.

### **Robust Statistical Analysis of cDNA Microarrays Utilizing Open-Source Software Packages.**

*Stuart Bowers, Junior, Chemical Engineering*

*Space Grant Scholar*

*Mentor: Hannele Ruohola-Baker, Biochemistry*

With the large bodies of data now generated from microarray experiments a robust statistical analysis is integral to interpreting results. This, however, does not obligate the researcher to licensing multiple software packages and spending hundreds of hours learning the minutiae of their operation. It can be expensive to have the data analyzed professionally yet very time consuming to do personally. A researcher should instead be free to learn the statistics that he or she would like to perform and translate those statistics quickly and efficiently into results. The poster is a quick, straightforward and comprehensive guide on how to download appropriate software, use specific portions of that software unique to microarray analysis, and visualize results both for analysis and publication. The software highlighted will be R, an open-source version of S+, using select Bioconductor packages. GenePix, although not open source, will be treated as the primary form of analyzing the .tif files. Spot, an open-source package, can also analyze .tif files and has a nearly parallel command set in R to perform the statistical analysis required. While the analysis will focus on a Windows operating system many of the commands carry over to Linux quite easily. The command sets within R will be covered for all of the following functions: importing data from the results of Genepix; setting this data up as a set of replicate arrays with dye swap pairs considered; removing outliers and/or filtering empties and blanks out of further analysis; viewing spatial plots of data for easily visualizing

arrays; running Print-tip specific loess regression to normalize M values; scaling across a set of replicate arrays by median absolute deviation; identifying differential expression across a set of replicate arrays; identifying differential expression within only a single array, and plotting data to visualize any of the above functions for publication

### **Mapping the History of First Nations' Education in the Pacific Northwest**

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

*Mentor: Nancy Beadie, Education*

In the late 1800s, The United States government forced hundreds of thousands of First Nations children out of their homes and into off-reservation boarding schools. The idea was to “civilize” First Nations and teach them the “white” ways. Those children not sent to boarding schools attended day schools on and off the reservation, also ran by the United States government. In the Pacific Northwest, First Nation children were sent to a huge variety of types and locations of schools. From 1870-1970, students went to local public schools, boarding schools, on-reservation day schools, and off-reservation day schools. The goal of our project is to map out where children from specific tribes attended schools during 1870-1970 in the Pacific Northwest and the history behind their schooling. We plan on doing this through archival research at the Pacific Northwest Special Collections and the National Archives. Eventually, we hope to contact primary sources and conduct oral interviews. Our research is still in progress so no definitive conclusions have been made.

### **Balancing Academics with Activism: The Everyday Lives of Female Graduate Students**

*Alicia Barbara Braman, Senior, Women Studies,  
Geography*

*Mentor: Lucy Jarosz, Geography*

Literature regarding women's resistance often conceptualizes the form of this resistance somewhat narrowly and myopically as the negotiation of power (between the less powerful and the more powerful). The concept of women and resistance is frequently racialized in the literature – where poor, disenfranchised women of color in the global South (and Latin America in particular) – are purported to be enacting examples of resistance on a daily basis. In the milieu of my Women Studies senior thesis project this year, I have chosen to contextualize and broaden this problematic, limited definition of resistance to a divergent population in the United States – female graduate students. I will be undertaking a series of semi-structured interviews with three female graduate students from the Geography department at the University of Washington who participate in what I will call ‘community activism work.’ In my research, I am informed by feminist

and post-structuralist theories of the situated and multiple locations of power and the consequential effects on one's dynamic positionality. My research is guided by a compilation of questions, including how does one negotiate the challenging of power dynamics as well as the subversive actions inherent in activist work with their position as a graduate student in a large university in Seattle, WA? I hope that the results of my study will help to better contextualize the ways in which a sample of female graduate students in the Geography department balance the demands of academic studies with community activist work.

### **Swelling Kinetics of Mucin Secretion in a Cystic Fibrosis Goblet Cells Line**

*Maria-Jose Bravo, Junior, Cell Molecular and  
Developmental Biology*

*Howard Hughes Scholar*

*Mentor: Pedro Verdugo, Bioengineering, Internal  
Medicine*

Cystic Fibrosis (CF) is a genetic disease caused by mutations in a 230 kilobase (kb) gene on chromosome 7 encoding a 1480 amino acid polypeptide called cystic fibrosis transmembrane conductance regulator (CFTR). The prominent feature in CF is the defective mucociliary transport and subsequent infection of the airways. Mucus is a polymer gel made of mucins and it is stored in condensed phase in secretory granules of goblet cells. The critical factor affecting mucociliary transport in CF is defective rheological properties of mucus. Water content is the paramount factor that defines mucus rheology. Upon release from the secretory granule, the condensed mucus polymer network undergoes a characteristic polymer gel phase transition from condensed to hydrated phase. The swelling that accompanies this process follows a typical first order kinetics that can be used to assess the hydration properties of mucus. Previous results indicate that swelling is defective in CF cells derived from primary cultures. The experiments described here were designed to evaluate a CF cell line to develop a simpler and more practical cellular model to investigate the physicochemistry and polymer physics of the CF mucus gel. Results of the preliminary validation of this model are presented here.

### **Dielectrical Sensing For Industrial Applications**

*Leslie Edward Byrd II, Junior, Materials Science and  
Engineering*

*McNair Scholar*

*Mentor: Kishore Sundara-Rajan, Electrical Engineering*

The main focus for the two projects presented here is non-destructive, non-invasive testing. This is an important concept for industry because it addresses the issue of controlling the composition or state of products during their production process, as opposed to stopping the process and testing or completing the process and testing afterwards.

It has been brought to attention that paper-manufacturing companies would like to have a greater knowledge of the moisture, titanium dioxide, and other components' content in their paper pulp during their paper making process. The sensors that measure the paper now do not perform well in the early stages of the process when there are large amounts of moisture and titanium dioxide in the paper pulp, so this is the portion of the manufacturing process, on which the project focuses. The system is developed to conduct real time capacitive spectroscopy sensing in order to determine the composition and feed back the information. The non-destructive nature of sensor works well with the feed forward control and the dimensions for the sensor will work well in the paper machines. Pharmaceutical companies have recently had strict regulations placed upon them concerning the accuracy of the composition of the tablets. Specifically, the coating thickness they put on their tablets is one of the new regulations. Experimentally the coating thickness of the tablets is in the order of 50 micrometers. The overall design of the sensor is a MEMS (Micro Electrical Mechanical System) application using the dielectric spectroscopy concept coupled with a thermal expansion concept. In order to determine the coating thickness of the tablet readings must be taken at different distances, and because of the small nature of the tablets, thermal expansion of the sensor is the route we have chosen.

#### **Computational Gene-Finding in Trypanosoma Utilizing Multiple Identification Algorithms with Consideration of Gene Organization**

*Eithon Cadag, Senior, Informatics*

*Mentor: Peter Myler, Pathobiology, Biomedical and Health Informatics*

Gene-identification is a field of research which lends itself well to the applied use of bioinformatics. Previous studies have shown that using several different algorithms on a genome via union-intersection can significantly improve automated gene-finding. These algorithms, however, often approach gene-finding purely from a statistical level, and by themselves do not account for possible effects overall gene organization may have on locations of coding regions. This study applies both an automated statistical and gene organization-based approach to the related trypanosomes *L. Major*, *T. Cruzi*, and *T. Brucei*, organisms whose genomes have strand-clustering gene characteristics. Codon usage, Fourier transformations (Genescan), interpolated Markov models (Glimmer), and Testcode algorithms are used to locate the open-reading frames in individual chromosomes. A likely gene organization map is created utilizing nucleotide-based skews and strand-switch regions. Several filters based on thresholds and gene densities are used to extrapolate a set of candidate genes. The candidate genes are then applied to the organization map, to create an identification set for the chromosome. Usage on *L. Major*, *T. Cruzi*, and *T. Brucei* has yielded average accurate

identification rates of 95%, higher results than usage of only statistically based algorithms without gene organization inclusion. This method of gene finding has been used to identify and annotate the *L. Major* chromosome by the Seattle Biomedical Research Institute, and will be used as the official prediction platforms for *T. Cruzi* and *T. Brucei*.

#### **Calculating Capacitance for LISA**

*Rogan Carr, Senior, Physics*

*Mary Gates Scholar*

*Mentor: Jens Gundlach, Physics*

NASA and the European Space Agency will jointly launch three satellites into solar orbit in 2012 to form the Laser Interferometer Space Antennae (LISA). LISA will look for gravitational waves as they pass by measuring minute changes in the distance between the satellites. Gravitational waves are emitted, for example, by coalescing black holes. These distances are defined by a cubic test-mass floating freely inside each satellite. The problem is that at the precision necessary to see gravitational waves, the cube may not exactly be freely floating – it may be accelerated by ultra-small forces acting between the cube and the satellite itself. Such forces could be due to the residual gases inside the satellite and the thermal radiation from the electrodes near the test-mass. We at the UW's Eöt-Wash Group are performing torsion-balance experiments using similar test-masses to measure these effects in the lab so that we can obtain certainty that the LISA experiment will function in space. I have made electrostatic model calculations predicting the capacitance between the test mass and our pendulum as a function of distance and orientation of the pendulum. These calculations are essential in determining the geometry of our test setup.

#### **HiVE – A Honeywall Data Analysis System**

*Linda Casey, Senior, Informatics*

*Jeremy Hyland, Senior, Informatics*

*Ashley Lam, Senior, Informatics*

*Mentor: David McDonald, Information School*

*Mentor: Dave Dittrich, Information School*

A Honeynet is an information security system that the Honeynet Project research organization developed to collect network exploit information. The system consists of two computers, one dummy production machine called the Honeypot designed to be attacked, and one logging machine called the Honeywall that collects all network packets entering or leaving the Honeypot. The data captured allows security professionals to learn about how attacks are carried out and what they look like at the lowest level. Unfortunately, data analysis on the current Honeywall system is very tedious and time consuming. The tools available are difficult to set up and use. The user interface is counter-intuitive and the data is hard to understand. To answer these problems, we

wanted to create a centralized system that enables users to collect and correlate data from distributed Honeynets and then analyze the data in a powerful yet intuitive Honeynet data analysis interface. This interface should be simple enough for inexperienced users, but powerful enough to support detailed analysis. To gather the requirements for our system, we did detailed interviews and ethnography with three Honeynet users of very different skill and experience levels. Using this data, we created a persona of target user and several wire frames which would be used to justify our design choices. Our final system is a web-based interface using a combination of state of the industry open-source web technologies to tie into a database that stores Honeynet data. After creating an initial system, we presented it to Honeynet users to gather their feedback. This gave us many insights into where our system may need to improve, but also gave us hope that we are on the right track. We hope to incorporate our user feedback into the next iteration of our system.

### **Oxygen Detection using Luminescent Microspheres**

*Charles Chang, Junior, Biochemistry*

*Mentor: Gamal Khalil, Chemistry*

My research is focused on the synthesis and characterization of polymer microspheres (beads) with embedded phosphorescent probes, which can be utilized as oxygen sensors. The microspheres are made of long chains of carbon called polystyrene and are approximately 1  $\mu\text{m}$  in size. Embedded within these spheres are phosphorescent molecules, Pt-tetrafluorophenyl porphyrin, whose phosphorescence intensity and lifetime is proportional to the local oxygen concentration. The goal of my research is to optimize the process of dyeing the probes into microspheres such that our product has uniform functional properties, dye concentration, structure, size, and stability suited for our applications. The dyeing procedure involves first mixing fluorescent probes with the normal commercial polystyrene microspheres in water, and then slowly adding a selected organic solvent, which swells/loosens the microspheres structure at a proper strength and allows the probes to diffuse into the opened structure. As solvents are evaporated, microspheres are back to the original form with fluorescent probes reliably trapped. This process requires careful control because ideal interactions are required to swell the beads just enough for probes to diffuse, preventing major disfiguration in the sphere structure and minimizing aggregation. Our plan is to study the oxygen consumption in microfabricated devices for cell culture analysis (i.e., oxygen consumption of single cells). When the oxygen concentration is high, it decreases the intensity and lifetime of the phosphorescent emission. (Oxygen quenches the triplet-excited state of the probe.) In future applications, we would like to study oxygen consumption in different parts of living systems by injecting microspheres into the circulatory system. As microspheres

travel to cells undergoing respiration, where less oxygen is available, greater intensity of phosphorescent emission should be observed. Additional plan is elaborating on surface modification technique to perfect the linkage between desired biomolecules (proteins, hormones, or drugs) to microspheres' surfaces groups (carboxyl, amino, or streptavidin).

### **Effects of Nutrient Enrichment on Open and Closed Ecological Systems**

*Aaron Chan, Senior, Psychology*

*Mentor: Frieda Taub, Aquatic and Fishery Sciences*

Closed Ecological Systems offer the chance to explore limiting factors on algae and grazer (*Daphnia magna*) populations. The essential difference between open and closed systems is the lack of gas (i.e. carbon dioxide and oxygen) exchange in the latter. While closed systems allow light and heat exchange, all material exchange is restricted, meaning that the system must supply all other requirements to maintain the algal and grazer populations. This experiment tested two possible limiting factors, nitrate and phosphate, in open and closed containers (6 replicates each). In each condition, a liquid containing an algal medium (containing nitrate, phosphate, and trace metals) was combined with "Kent Cichlid" salts (containing bicarbonate). The two treatment groups enriched with additional nitrate and phosphate exhibited greater algal growth (indicated by greater fluorescence), with the open enriched treatment groups showing the most algal growth. Both open and closed normal (unenriched) treatment groups, while exhibiting less algal growth, maintained more persistent *Daphnia* populations. The large algal populations under nitrate and phosphate enriched conditions may have contributed to the increased *Daphnia* mortality by increasing pH, particularly in the case of the carbon-limited closed treatment.

### **Recombinant Erythropoietin (Epo) Decreases the Severity of Necrotizing Enterocolitis (NEC) In A Neonatal Rat Model**

*Michelle Chan, Junior, Biology*

*Mentor: Sandra Juul, Neonatology*

Necrotizing enterocolitis (NEC) is a common intestinal complication affecting preterm infants, and it carries a 30% mortality risk. The cause is unknown, and there are no effective treatments. Receptors for the erythropoietic hormone Epo are found on mammalian intestinal cells. Epo activation decreases apoptosis, increases cell migration, and stimulates intestinal growth. We tested the hypothesis that Epo will protect the intestine from injury in a neonatal rat model of NEC. Rats were hand raised from birth. Intestinal injury was induced by twice daily exposures to the following sequence: asphyxia (100%  $\text{N}_2$  for 60 seconds), hyperoxia (100%  $\text{O}_2$  for 5 minutes), followed by cold stress (4°C for 10 minutes). In a pilot experiment

designed to detect any rEpo effects, placebo-treated animals given daily saline injections were compared to rEpo-treated animals that received 200U/kg/day subcutaneous *plus* oral rEpo. In experiment 2, placebo-treated animals were compared to Epo-treated animals that received either subcutaneous or oral rEpo. On day 5, animals were euthanized and their intestines were formalin fixed. Hematoxylin and eosin-stained sections of duodenum, jejunum, and ileum were evaluated and given an overall score by two independent, blinded observers using a 5 point injury scale: 1= no damage; 5= full wall necrosis and loss of villus structure. In experiment 1, Epo (n=25) reduced injury scores compared to placebo (n=16),  $p < 0.05$ . In experiment 2, both routes of Epo administration were effective ( $p < 0.05$ ); subcutaneous Epo was more effective than oral Epo. Epo effects were greatest in the proximal intestine ( $p < 0.05$ ). No harmful side effects of rEpo were noted. We conclude that Epo treatment protected small intestine from injury in a neonatal rat model of NEC. More research is indicated to fully investigate this phenomenon, but these preliminary findings suggest Epo might provide some benefit for preterm infants at risk for NEC.

### **The Evolution of Left-Right Asymmetry in the Chordates**

*Helen K. Chea, Senior, Cellular and Molecular Biology, Biochemistry*

*Howard Hughes Scholar, Mary Gates Scholar*

*Mentor: Billie J. Swalla, Biology*

Communication between cells during early embryogenesis is essential in establishing the basic organization of the vertebrate body plan. The formation of the left-right axis is critical to the development and morphology of the adult internal organs. Failure to differentiate between the normal left and right sides of the body during embryonic development may lead to serious and often fatal consequences, such as visceral heterotaxy (also called situs ambiguus), the morphologically random arrangement of organs in the body. Patterning of left-right asymmetry depends upon a cascade of inductive and repressive interactions between asymmetrically expressed genes. The earliest conserved feature of the cascade is the left-sided expression of *Nodal* in embryos. Studies with *Nodal* in embryos have revealed that cell-cell communication through gap junctions plays an essential role in coordinating asymmetric gene expression. In addition, the asymmetric activation of Notch, and therefore *Nodal*, depends on the transient accumulation of extracellular calcium and left-right differences in  $H^+/K^+$ -ATPase activity. Recently, studies with non-vertebrate chordates have revealed that the involvement of *Nodal* in left-right axis determination is not unique to the vertebrate phylum. The *Nodal* signaling pathway is actually highly conserved among vertebrates, urochordates, and echinoderms, suggesting that *Nodal* evolved within the deuterostomes by gene duplication. By studying *Nodal* expression and other factors involved in establishing left-

right asymmetry in the urochordate ascidian, *Boltenia villosa*, we can gain a better insight into the evolution of the *Nodal* signaling pathway. We show that *Nodal* is expressed asymmetrically in the ectoderm in ascidian tailbud embryos and have conducted experiments to test the importance of this expression to ascidian development.

### **Color Progressive Image Compression using JPEG2000**

*Andrew Chekerylla, Junior, Electrical Engineering*

*Mentor: Agnieszka Miguel, Electrical Engineering*

In this research, we use the framework of the latest image compression standard, JPEG2000, to investigate color progressive image coding. Currently, progressive image compression allows database users to quickly view low quality approximations to desired images. Such a method allows for fast data transfer yet initially communicates only low-frequency information (omitting high-frequency details). As more bits are received, additional information regarding edges and high frequency detail is integrated and the original image is eventually completely reconstructed. Such quality scalability is one of the most important features in JPEG2000. In addition, JPEG2000 implements resolution scalability, where early bits in the embedded bit stream correspond to a low-resolution thumbnail image and as more bits are received, a larger image can be recovered. We propose an alternate method to quality and resolution-based progressive transmission. With color progressive image compression, the initially transmitted information has only a few colors. As more bits are decoded, more colors are realized. Our algorithm allows information regarding edges to be transmitted much sooner, and therefore, the high frequency details may be resolved much sooner than when using current progressive compression methods. The received image is already sharp, and needs little refinement to realize complete high frequency detail. This allows the user to more quickly envision the original image without blurring out the high frequency features. The proposed approach allows for seamless progression from two colors initially to many millions of colors in the final image.

### **Math In Engineering**

*Peter Cheng, Senior, Mathematics*

*Zesbaugh Scholar*

*Mentor: Reed Stevens, Education*

Most math classes offered to undergraduates teach students to solve math problems through various methods of computation. Beginning engineers receive intensive training in computational mathematics as undergraduates. However, professional engineers often find computational mathematics of little help in their everyday work. The goal of our project is to analyze the applicability of engineering math curriculum to the engineering profession. Engineering undergraduates study a broad range of

mathematics including algebra, geometry, calculus, differential equations, matrix algebra, and statistics. Often the content of these courses consists of little more than repetitive computational exercises. This is in stark contrast to the nature of professional engineers' work, which relies heavily on complex problem solving, analytical thinking, and social skills, and not so much on math computations. To see how well undergraduate math courses prepare engineers for their careers, we analyzed the course content of each math class required for admissions to the College of Engineering. We noted what types of problems were assigned (computational, word problems, projects, etc.) and cataloged them in a spreadsheet. We also noted how each instructor wanted the problems done (individually, in groups, or both). Next we interviewed a panel of ten undergraduate and graduated engineering students. We asked them to describe their experience with undergraduate math and how applicable it was to their discipline or career. Finally, in the spring, we plan to interview several engineers at a local engineering firm and videotape their workdays for ten weeks. We will compile our findings in a paper either this summer or next year. We hypothesize that much of computational math skills that engineers learn as undergraduates, will seldom apply in the engineering profession. If our hypothesis is correct, we may advocate for more math classes that emphasize critical and analytical thinking to better prepare the engineers of tomorrow.

### **Gene Transfer of Factor VIIa for Treating Hemophilia A Mice**

*Steven Chen, Senior, Biochemistry, Cellular and Molecular Biology, Music*  
*Mentor: Carol Miao, Pediatrics*

Current treatments of uncontrolled bleeding associated with hemophilia involve the usage of factor VIII. Most hemophilia patients are deficient in clotting factor VIII, thus the influx of this missing factor can rescue normal clotting function; however, over time, an immunological resistance to factor VIII can develop. This occurs because to certain hemophilia patients, factor VIII is foreign and unrecognizable. Thus, for the patients, continuous treatment is impossible with factor VIII, despite its efficiency in counteracting the symptoms of hemophilia. Due to this immunological resistance, research is ongoing to find alternative treatment. Factor VII and factor VIII are involved in clotting via two different pathways, thus the usage of factor VII can bypass the genetic deficiency of factor VIII and clotting can occur. Hemophilia A mice that are treated with factor VIII develop a similar immunological resistance just as humans, and their clotting pathways are the same, thus making mice an ideal organism to study. In this experiment, we introduced human factor VII into mice via naked gene transfer. We made two constructs containing human factor VII, pBS-HCRHPI-hFVIIA, and human factor VII mutant, pBS-HCRHPI-hFVIIAmut. The human factor VII mutant was made by

inserting a proteolytic cleavage site which could then produce the activated human factor VII protein. After introduction of these constructs via naked gene transfer, we then measured the levels of human factor VII in mouse plasma via an enzyme linked immunosorbent assay or ELISA; and high levels of factor VII were detected in hemophilia A mice. Additionally, when we performed a clotting assay, we observed that clotting time was reduced in the mice with the activated factor VII. This leads us to conclude that the introduction of our factor VII construct is able to help correct the hemophilic phenotype of these mice.

### **The Gas Leak Detection Project: A Simulation of Pressure Sensitive Paint as a Remote Sensor in Gas Pipelines**

*Alice Chin, Senior, Chemistry*  
*Mentor: Gamal Khalil, Chemistry*

In the United States, natural gas has been a preferred choice as a clean and fuel-efficient source. It is estimated that 1.2 million miles of natural gas pipeline are woven into our geographic landscape. The major composition of natural gas is methane, a volatile organic compound (VOC). There are growing concerns regarding more susceptibility to leaking with aging pipelines. The focus of this project is to supply the community with a safer way to monitor the condition of a pipeline through remote sensing. At the University of Washington Chemistry department, the Gouterman/Khalil group has been industriously working on the technology and various applications of Pressure Sensitive Paint (PSP) as a remote sensor. The goal of this project is an application to demonstrate the performance of PSP as a gas leak detection sensor in an embedded pipeline. PSP is the polymeric paint complex of a porphyrin dye, which has the ability to measure the change in oxygen concentration in an environment. The sensor system consists of a fiber optic cable (FOC) with PSP painted on a portion of the cable then which is coiled around a simulated pipeline. In this project, the FOC provides the specific wavelength light, which is then propagated through an evanescent field, exciting the porphyrin molecules in the paint complex. The paint complex will luminesce and a computer will record its intensity in time intervals, known as lifetime measurements. A lifetime measurement is a calculated ratio of real time intensity to the initial intensity. When oxygen is being displaced by methane, the lifetime measurement will increase which signals a leak. The advantages of this project will provide real time measurements for continuous monitoring of a pipeline and also provide a quicker response to repair leaking problems.

### **Effectiveness of Data Visualization versus Text Presentation for Pattern Recognition and Data Retrieval in Large Data Sets**

*Irene Chin, Senior, Informatics, Electrical Engineering*  
*Mary Gates Scholar, Space Grant Scholar*

*Lisabeth Cron, Junior, Informatics*  
*Trevor Iwaszuk, Senior, Informatics, Drama*  
*Meredith Skeels, Senior, Informatics*  
*Mary Gates Scholar*  
*Mentor: David Hendry, Information School*

In this empirical study a comparison is made between visual and textual representations of a large data set. The visual representation was rendered by Treemap and the textual representation was rendered by Query Builder. Treemap [1, 2] is a space-constrained hierarchical browser for exploratory data analysis of large data sets. Query Builder, created specifically for this study, is a SQL-based data filter that provides aggregate values such as sums and counts based on selected attributes. The hypothesis was that participants would prefer Treemap for tasks involving relationship detection among attributes while preferring Query Builder for computing specific aggregate values of selected attributes. A within-subjects design was employed where all participants used both applications. Half the participants used Query Builder first and half used Treemap first and questions were matched, consisting of two *relationship-detection* questions and two *value-retrieval* questions. The data set consisted of 2391 records and 33 attributes of demographic information about computer users. After using both applications, participants were given an additional question of each type and allowed to select which application to use to accomplish the task. Approximately 69% of the participants chose Treemap for tasks involving relationship detection, while 75% preferred Query Builder for tasks involving value retrieval. These results support the hypothesis. The data was inconclusive, however, about which application was more effective in terms of task efficiency. The average time participants spent on tasks was about the same, regardless of the application used. Further studies are needed to reach definitive conclusions on which application is most effective for viewing large data sets based on the particular types of task.

1. Johnson, B., Shneiderman, B. Treemaps: a space-filling approach to the visualization of hierarchical information structures *Proc. Of the 2<sup>nd</sup> International IEEE Visualization Conference*. San Diego, Oct. 1991. 284-291.
2. Human-Computer Interaction Lab, University of Maryland, [Treemap: Home Page](http://www.cs.umd.edu/hcil/treemap/). Downloaded: February 26, 2004, <http://www.cs.umd.edu/hcil/treemap/>.

**Saddam, Iraq and the American News Media**  
*Maria Crossman, Junior, Communication*  
*Mentor: David Domke, Communication*

Most of the general public tends to get their national and international news from second hand or even third hand sources such as newspapers, magazines, radio and TV news

programs. These sources have the power to control or shape what the audience thinks about a given situation, place, or person. In autumn 2002, one critically important news story was about Iraq and its alleged threat to the United States. With this in mind, editorials published in 15 leading U.S. newspapers between September 2002 and November 2002 were analyzed to observe the picture of Iraq and Saddam Hussein that was constructed. This time frame was chosen because the president gave an address on Iraq to the United Nations on September 12<sup>th</sup>, while the Congress and the U.N. passed Iraq resolutions by early November. Almost 200 editorials were examined. A number of specific phrases or words such as an urgent need to act now, threat, dangerous villains, and evil were found to be commonplace. Overall, these editorials-which, notably, were the voices of newspapers not the voices of the U.S. government-present Saddam and Iraq as a threat to American readers wishing to gain information on current events.

### **What Should the Court Decide: An Analysis of the Legal Debate over Same-Sex Marriage**

*Sarah L. Crowder, Senior, Women Studies, Sociology*  
*Mentor: Pat Novotny, Women Studies*  
*Mentor: Angela Ginorio, Women Studies*

Should same-sex couples have the right to marry? What are the legal arguments both advocates and opponents have advanced? What will the Supreme Court decide? The status of same-sex relationships and, specifically, the issue of same-sex marriage have become hotly disputed in recent months and, indeed, weeks. The goal of my research is to propose an educated hypothesis regarding what the United States Supreme Court will decide upon hearing its first same-sex marriage case. Examining case law addressing same-sex relationships from the 1970's to present, I will focus on six particular cases and analyze the appellate court's findings in each case. I will then attempt to follow the progression of these six decisions and make a prediction to explain the United States Supreme Court's decision and reasoning in hearing its first same-sex marriage case. This research is in progress; I therefore cannot report any conclusions at this time.

### **Brain Cholinesterase Inhibition in Juvenile Rainbow Trout Exposed to Carbaryl- Benchmark Concentrations for Active Ingredients vs Formulated Products**

*Catherine Curran, Senior, Fisheries*  
*Mary Gates Scholar*  
*Toby Black, Senior, Fisheries, Biology: Conservation Biology, Ecology and Evolution*  
*Bram Granger, Senior, Wildlife Science*  
*Zach Guerrette, Senior, Biochemistry, Zoology, Biology: Conservation Biology, Ecology and Evolution*  
*Kathy Ireland, Senior, Fisheries*

*Emily Marchesini, Senior, Environmental Studies:  
Ecology and Conservation*  
*Robert Schneider, Senior, Biology: Conservation  
Biology, Ecology and Evolution*  
*Carrie Spradlin, Senior, Wildlife Science*  
*Morgan Sternberg, Senior, Fisheries*  
*Mentor: Dr. Christian E. Grue, Aquatic and Fishery  
Sciences*

A variety of pesticides have been detected in surface waters within agricultural and urban areas. In most cases, their biological significance (singly or in combination) to aquatic communities is not known. In the Pacific Northwest, the potential impact of low levels of pesticides in surface waters on efforts to enhance or restore habitats for juvenile and adult salmon is of particular concern. Several of the most commonly reported pesticides are cholinesterase-inhibitors and carbaryl (1-naphthyl N-methylcarbamate; trade name Sevin®) is the most commonly reported carbamate. Acetylcholinesterase (AChE) activity in brain tissue is the primary biomarker in fish and wildlife for diagnosing exposure to, and mortality from, pesticides that are cholinesterase-inhibitors. The enzyme is critical for normal nerve function and therefore reductions in enzyme activity may result in changes in physiology and behaviors essential for survival and reproduction. Studies by our laboratory and others suggest that “end products” may be significantly more toxic than active ingredients (ai) alone. Our objectives are: (1) determine dose response curves and threshold concentrations (benchmarks) for AChE inhibition in juvenile rainbow trout (*Oncorhynchus mykiss*) exposed to carbaryl as active ingredient and two formulated products (Sevin®) for 96-h, (2) determine differences in inhibition between soluble and membrane-bound forms of the enzyme, and (3) compare these values to concentrations reported in surface waters. Preliminary results suggest that benchmarks are ca. 15 ppb ai for the formulated products and technical grade material with inhibition similar between the soluble and membrane-bound forms.

### **Speech and Music Applications of Modulation Spectral Filtering**

*Jonathan Cutter, Senior, Electrical Engineering*  
*Mary Gates Scholar*  
*Mentor: Les Atlas, Electrical Engineering*

Conventional frequency transforms are used to investigate signal characteristics, such as the pitch of speech, but these transforms do not offer information about the long-term behavior of a signal. Recent research has provided a way to access long-term modulation frequencies, apply filters, and synthesize the resulting signal. The purpose of this work was to use this new system to determine interesting applications of modulation spectral filtering. In order to determine noteworthy effects of modulation spectral filtering, speech and music signals with particular dynamic qualities were developed. Based on the characteristics of

these audible signals, modulation frequency filters were designed and applied to each audio excerpt. Notable results were found for both speech and music signals where in one case, a piano was made to sound like a violin. Another very useful result removed invasive helicopter noise from a speech signal while maintaining a high degree of speech intelligibility. These results have shown that modulation spectral analysis can provide a new and unique way to analyze and characterize speech and music signals.

### **A Hypothesis on the Role of Modern Sedimentation and Particulate Transport in the Formation of the Submarine Central Rises in the Bathymetry of Puget Sound, Washington**

*Maureen Davies, Senior, Oceanography, Earth and  
Space Sciences*  
*Mentor: Mark L. Holmes, Oceanography*

At three locations in Puget Sound the bottom is characterized by deep ( $\leq 300$  m) marginal troughs and a relatively shallow ( $\sim 215$  m) central region, which form a striking W-shaped cross-section atypical of glaciated fjord-type estuaries. At all of these locations, the width of the Sound is narrowed, either by bulges in the shoreline or by submarine shoals. The hypothesis to be tested is that the W-shaped cross-section is due to modern (post-glacial) sedimentary processes governed by the tidally induced current regime. Stronger near-bottom currents along the flanks, produced by the restricted width of the Sound, would result in low sediment accumulation rates compared to rates in the low energy axial area. Additionally, sediments in the troughs should be coarser than those from the axial high. This hypothesis will be tested by a detailed examination of the unique W-shaped bottom morphology in the Main Basin of Puget Sound southwest of Edmonds. Seismic reflection profiles will be examined for indications of glacial scouring and nearby large-scale submarine landslides. Bottom samples will be obtained in late March 2004 along a transect crossing the W-shaped morphology. A Van Veen grab will be used to collect surface sediment at nine stations from both flanking depressions and the axial shoal. Granulometric analyses will be performed to determine the surface sediment size and sorting characteristics; these data will in turn be used to evaluate the carrying capacity of the tidally induced near-bottom currents. Three piston cores will be collected from the flank depressions and the axial shoal in order to examine the sedimentation history over the past  $\sim 400$  years. Accumulation rates will be determined using analyses of  $^{210}\text{Pb}$  and  $^{137}\text{Cs}$  from the core samples. The granulometry and accumulation rates will have implications on the present understanding of the morphology, sediment transport, and transport of particulate pollutants.

### **Understanding Racial Biases In Pre-Adoptive Parents**

*Madalene Day, Senior, Psychology*  
*McNair Scholar*

*Mentor: Anthony Greenwald, Psychology*

Transracial adoption, which is defined as an adoption of a child who is of a different race or ethnic group from the adoptive parents, is becoming increasingly more common. With this comes a need for understanding how racial biases will impact the lives of both the adopted child and adoptive family. I am assessing racial biases in pre-adoptive parents through explicit and implicit measures to gain a greater understanding of how racial biases relate to the desire to transracially adopt. The participants in this study are pre-adoptive parents from Antioch Adoptions in Redmond, WA. The explicit measures will consist of asking the participants to choose statements that best fit their feelings on issues of race, ethnicity and identity. Additionally I will be using the Modern Racism Scale and asking participants to rate their personal feelings about transracial adoption on a 9-point likert scale. The implicit measure will consist of three implicit attitude tests (IATs). The IATs will compare pictures of black children vs. white children, dark-skinned black children vs. light-skinned black children and light-skinned black children vs. white children. I am currently collecting the data, however, from the literature published about racial attitudes I am expecting to see that people will have a stronger preference for white children and I hypothesize that there will be a preference for light-skinned black children as well. I also expect to find that the strengths of people's associations with white children will inversely correlate with the strength of their desire to transracially adopt. The results from this project will help Antioch Adoptions to better understand how to direct their teaching and preparation of pre-adoptive parents. Furthermore the methods of this project may be a useful tool for the agency to use in their counseling of the pre-adoptive parents who wish to transracially adopt.

### **Variation in DNA Polymerase $\beta$ in Pediatric Brain Tumors: Implications to Tumor Resistance**

*Jill Dearing, Junior, Chemistry, Pre-Pharmacy*

*Mary Gates Scholar*

*Mentor: Michael S. Bobola, Neurosurgery*

In the Neurological Surgery Department of Children's Hospital, the research project that I am a part of deals directly with surgically resected brain tumor tissues. DNA repair proteins, associated with both normal and tumor cells, are the focal point of my research. DNA Polymerase  $\beta$  (pol  $\beta$ ) is a repair protein that fills and corrects small gaps in DNA resulting from DNA damage caused by chemotherapy or radiation. In comparison to many other polymerases, pol  $\beta$  is relatively error prone, which may increase mutation rates and enhance the tumors ability to adapt to and resist therapy. Our goal is to compare the pol  $\beta$  repair activity in different tumor types so that we may understand its variability and potential contribution to resistance. In my experimental procedure, I separate pol  $\beta$  from the other tumor proteins in a polyacrylamide gel

containing damaged DNA through the process of electrophoresis. The gel is exposed to a reaction solution containing radioactively labeled p<sup>32</sup>-dTTP. Pol  $\beta$  will repair the damaged DNA incorporating the radiolabeled dTTP into the DNA. The gel containing the labeled DNA is exposed to a phosphor screen and the activity of pol  $\beta$  is quantitated based on the intensity of the radioactive band. We will use this data to hopefully link different attributes, such as tumor type, sex, age and race of the patient, to the activity level of the repair protein pol  $\beta$  present in the tumor. In the future, this information will help determine the best and most precise treatments available to maximize the anti-tumor effect and minimize detrimental and unnecessary side effects.

### **Flexible Micromachined Optical Sensor for Measurement of Pressure and Shear Force Distribution**

*Jeffrey Dee, Senior, Chemical Engineering*

*Mary Gates Scholar*

*Mentor: Wei-Chih Wang, Mechanical Engineering*

Diabetes mellitus is a disease that impacts the lives of millions of Americans. Lower limb complications associated with diabetes include the development of plantar ulcers that can lead to infection and subsequent amputation. Additionally, plantar pressure has been associated with the development of ulcers. Research studies previously conducted by others have postulated that shear stress is an important component of ulcer development. Unfortunately, the exact role that shear stress plays in plantar ulceration is not completely understood, mostly because shear stress has not been quantitatively studied in a wide scale manner. One reason these data have not been obtained previously is the lack of a validated, widely used, commercially available shear sensor, due in part to the various technical issues associated with shear measurement. These issues include the need for a continuous rather than discrete sensor, the specific method of transduction, and the need for a thin, flexible, temperature independent, moisture resistant sensor that can work reliably in the hostile environment of a shoe. Therefore, the purpose of our study is to develop a novel means of transducing plantar shear stress via a flexible polymer based sensor array. The current objective of the project is to develop a distributive optical sensor capable of simultaneously measuring the direction and magnitude of pressure and shear forces.

### **Non-invasive DC EEG: Development of a bedside method for clinical practice**

*Asanka Dewaraja, Senior, Bioengineering*

*Mary Gates Scholar*

*Mentor: John Miller, Neurology*

I participate in a research project that aims at developing direct current electroencephalography (DC-EEG) into a clinical investigation method. This is conducted at

Harborview Medical Center in collaboration with the University of Helsinki (Finland). Conventional clinical electroencephalography is bandwidth limited to 0.5 – 50Hz due to technical problems related to baseline stability, and signal to noise ratio. Thus the detection of slow EEG activities i.e. < 0.5 Hz requires DC-stable electrodes and a DC-EEG amplifier with a bandwidth starting at zero. Such slow EEG activities have been observed both during physiological functions such as sleep and cognitive functions and pathological states such as epilepsy and stroke. There has been virtually no literature about DC-EEG used in clinical applications due to previous methodological difficulties. Our group has been successful in developing a bedside DC-EEG recording method. We use a custom designed 16 channel DC-EEG amplifier with, a long term stability (better than 1 $\mu$ V/h) bandwidth DC-160 Hz, high input impedance differential preamplifiers equipped with automatic electrode offset voltage compensation and testing of electrode skin –contact impedance. Signals are acquired at 500Hz. The software used both in acquisition and analysis was custom designed in LabView (National instruments). Ag/AgCl electrodes were tested and confirmed to have stable electrode potentials compatible for DC-EEG recordings. Electrodes made with silver, tin, gold, stainless steel or platinum were found to be not suitable due to high variable electrode potentials and high polarizations. We have also found that skin short circuiting is essential during DC recordings. Constant sweating and other sympathetic skin potentials cause transients in the mV scale. In terms of artifacts, we have demonstrated that even the modest tongue and eye movements cause significant scalp potentials. Up till now our group has conducted bedside recordings on 3 major patient groups, neonatal babies, epileptic patients and sleeping subject.

#### **Synthesis of a Novel Anti-Malarial Drug Based upon the Conjugation of a Siderophore to a Derivative of Artemisinin**

*Jean Dinh, Senior, Biochemistry, Chemistry*

*Jason Kam, Senior, Biochemistry*

*Mary Gates Scholar*

*Mentor: Tomikazu Sasaki, Chemistry*

The emergence of drug-resistant malarial strains has led to the urgent need to develop new antibiotics. The major chemical in our novel antibiotic is artemisinin, which is a compound that originates from the sweet wormwood plant. Artemisinin has been used, with some degree of success, in treating malaria. The ability of artemisinin to destroy bacteria cells is because of its endoperoxide bond. This bond, in the presence of iron, can disassociate to form radicals that can break up the cell wall of the bacteria, and thus cause death to the bacteria. We propose that a more effective drug could be made using a derivative of artemisinin, called artelinic acid, and conjugating it to a siderophore with an iron residue chelated to it. A

siderophore is a molecule that bacteria retrieve when in need of iron. Once the siderophore is ingested, the artemisinin residue can form free radicals, within the iron-rich environment of the interior of the bacteria, to break up the cell wall. The siderophore was synthesized using Merrifield peptide synthesis. A serine derivative peptide, containing Fmoc and Boc protecting groups, was anchored to MBHA-resin. Through subsequent deprotection of the Fmoc groups in alkaline conditions, two more serine derivative peptides were added on, elongating the chain to a tripeptide. The final deprotecting step of the Boc group allowed for the conjugation of dihydroxybenzoic acid, which is critical to the siderophores iron binding abilities, and removal from the MBHA-resin. The siderophore and artemisinin derivative were dissolved in methanol to allow for conjugation of the two molecules, and was purified using an LH-20 column. The siderophore-artemisinin conjugate was then dissolved in methanol again, this time with iron, to form the final product. This antibiotic, has the potential to improve the lives of malarial patients around the world.

#### **Extraction and Quantification of Phosphorus in the Form of Aluminophosphate Minerals in Sediment Taken from the Gulf of Mexico**

*Logan Ditto, Senior, Earth and Space Sciences*

*Mary Gates Scholar*

*Mentor: Roger Buick, Earth and Space Sciences*

Very little is understood about aluminophosphate minerals and the potential role they play in long-term storage of phosphorus. There are three well-known sinks for phosphorus in marine sediments: 1) organic phosphorus (from dead organic matter) 2) mineral phosphorus (such as iron-bound or that found in authigenic apatite) and 3) phosphorus sorbed onto clay. However, calculations show an imbalance in the phosphorus cycle (Rasmussen 1996), which may be partially due to an under-researched and poorly understood 4<sup>th</sup> phosphorus sink: aluminophosphates. To investigate the formation of these minerals, marine sediment samples have been acquired from drill cores 3 to 5 meters long, which transect the Gulf of Mexico east to west. From analysis of these samples we hope to help answer some of the following questions: 1) Are aluminophosphate minerals present in unlithified ocean floor sediments? 2) At what point after deposition do they form? 3) How much does the formation of these minerals account for the total phosphorus stored in the sediment? To answer these questions, a modified SEDEX (Ruttenberg 1992) procedure for measuring the presence of aluminophosphates in the sediment will be used. Analyzing different depths in the drill cores may give an indication to the timing of formation. The results of the extraction procedure quantify the total phosphorus stored in the sediment from which the weight percent of aluminophosphate present can be calculated. The results will constrain our understanding of the availability of

phosphorus, a critical nutrient, to marine ecosystems.

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### **Tuning of Genetic Algorithm Fitness Function Parameters for Robots with Evolving Communication**

*Todd Drullinger, Junior, Electrical Engineering*  
*Mentor: Linda Bushnell, Electrical Engineering*

Genetic algorithms used to evolve control strategies for robots can require many iterations and a large amount of computer time to do so. This research seeks to understand how different values in the fitness function used by the genetic algorithm affect the number of iterations needed to find an acceptable solution. The problem being studied is optimization of communication between two predator agents attempting to capture a prey agent. A Matlab simulation is being developed to test the following hypotheses: (1) rewarding the use of communication when evaluating fitness will result in an effective capture strategy but one that relies heavily on communication; (2) penalizing the use of communication will cause communication to fall off but may result in no effective capture strategy being found; (3) rewarding the use of communication initially then transitioning to penalizing it will result in an effective capture strategy that uses communication more efficiently than in hypothesis (1). The efficacy of the evolved strategies will be reevaluated by using them to control two predator robots in a hardware version of the simulation. Since this research is in progress, concrete conclusions cannot be made.

### **Cosmic Ray Muon Rates for WALTA Detectors**

*Paul Edmon, Senior, Physics*  
*Mentor: Jeffrey Wilkes, Physics*

Cosmic rays are high-energy atomic nuclei that come from outer space. The Washington Area Large-scale Time coincidence Array (WALTA) intends to collect data on the highest energy cosmic rays, which can carry the energy of a fastball in a single proton. Knowing where these particles are coming from and how they interact will tell the scientific community more about how the universe works and how current models in particle physics and cosmology are doing at describing the universe. To gather data on these high-energy cosmic rays, particle detectors are being placed in Seattle area high schools in order to look for particle "showers" associated with a high-energy cosmic ray hitting

the upper atmosphere. These particles showers produce particles called muons that are 200 times the mass of an electron but have the same charge. Muons are highly penetrating and rain down at high energies. These muons rain down on the Earth at a well-determined rate. This experiment was designed to detect these muons and compare the rates seen with the WALTA detectors to the rates that are calculated to actually be there by past experiments. The result of this test tells us how good our detectors are at picking up muons. Accordingly we can use the results to better calibrate the WALTA detectors and increase our efficiency at detecting actual particles instead of just noise. This project will also serve as a model for a project in Colorado. There, local high schools are cooperating with UW physicists in surveying the cosmic ray muon rates in a deep mine, which is under consideration as a site for UNO (Underground Neutrino Observatory), a proposed large underground neutrino detector.

### **Rapid, Low-cost Prototyping of Microstructures by Microscope Projection Photolithography and High Resolution Printed Masks**

*Jeffrey Edwards, Junior, Bioengineering*  
*Mary Gates Scholar*  
*Mentor: Henry Hess, Bioengineering*

In our lab, we are trying to use microtubules and Kinesin to make a miniature railway, with microtubules being able to go along a set path and pick up and drop off cargo. In trying to control their path, one of the ways is to create nano-scale walls that they would bump into. To make these walls, we use the process of photolithography. In photolithography, you have an un-polymerized compound, known as photoresist, which polymerizes under UV light. If you shine the UV light through a mask, then whatever pattern is on the mask will block the UV light from reaching that section and keep that area from polymerizing. The standard way of creating microstructures using photolithography is to make a chrome mask of the pattern using an electron beam for fine patterns, and replicate the mask pattern in a photoresist. However, chrome masks are expensive (around \$1000 each), particularly for the creation of prototypes. Two approaches to replace chrome masks are Microscope Projection Photolithography (MPP) and photolithography using high-resolution printed masks. In MPP, a low-resolution transparency printed with an inkjet printer is de-magnified ten- to hundredfold through a fluorescence microscope, and used to pattern photoresist placed in front of the objective. With clear mask costs being cheap and fluorescence microscopes being common in a lab environment, this process is low-cost for a small number of structures. The other approach is to take advantage of the dramatically increased resolution of printers. A 20,000 DPI printer (dot size of 1.3 micrometer) can produce a high-resolution transparent mask with only 5 times larger features than a chrome mask. I am experimenting with and comparing both processes using the facilities in the

Center for Applied Microtechnology, the products of which applied to using microtubules and Kinesin as potential transport system in nano-scale devices.

### **The Book of Fusion: The Lesbian Coming-to-Identity Fictional Narrative**

*Zaedryn Ensor-Estes, Senior, Women Studies, English*  
*Mentor: Shirley Yee, Women Studies*

As a lesbian and a writer, I seek to personally situate myself in a context of the history of lesbian writers, and specifically to examine the genre of the lesbian novel as it has significantly evolved in the twentieth century. As also reader of lesbian novels, I have noticed a significant shift in the characters and the plots of these novels since the 1970s. I believe that is because the lesbian community is in a new stage of identity development that is beyond coming out. Through Jessica Morris's breakdown of the process of developing lesbian identity – i.e. coming out – I examine the genre of the lesbian novel. Though there are many other models of homosexual identity development, Morris's was chosen because of her multidimensional approach and her focus on lesbians specifically. I focus my studies primarily on approximately one dozen of the most prominent and influential lesbian novels since the creation of the sexual orientation "homosexual" by the psychological community in the 1920s. I situate these novels' characters and plots within Morris's stages of identity development. I discovered that the stages of development correspond with the genre of the lesbian novel – that the lesbian novel is in fact going through these stages of coming out. As the novel simultaneously shapes society and is shaped by society, I believe that we in the lesbian community have been going through the stages of developing a firm identity, and integrating ourselves into the heteronormative society around us. Close examination of lesbian novels would indicate that this is indeed true, and that we are evolving into a new, exciting time, where we are beyond coming out and developing and integrating our identities.

### **Thermal Actuation of Microfluidic Devices using a Silicone Elastomer Bimorph**

*Aziel C. Epilepsia, Junior, Electrical Engineering*  
*Jian Liu, Graduate Student, Applied Physics, Caltech*  
*Mentor: Stephen R. Quake, Applied Physics Laboratory*

A goal of research in microfluidics is the production of an effective drug delivery system that can be implanted in a human. Current actuation methods in microfluidic technology rely on pneumatic control lines, posing problems in terms of remote actuation from outside a body. A thermal actuation solution was investigated in the use of thermal bimorphs. Thermal bimorphs were fabricated by spinning two different silicone elastomers onto a silicon wafer. Experiments were conducted by bonding the bimorph to the bottom of a microfluidic device and heating

the material. Deflection into the device was observed and measured by varying channel width and depth.

### **Coalescent Analyses of Population Genetic Data Concerning African Elephants**

*Celia R. Fairbourn, Senior, Zoology*  
*Mentor: Benjamin D. Hall, Biology, Genome Sciences*

The purpose of this project is to determine the evolutionary history of the African elephant using a variety of population genetic methods based on coalescent theory. The analyses will be performed on nuclear microsatellite and mitochondrial DNA (mtDNA) sequence data that I obtained from previous research. Many evolutionary uncertainties concerning the relationship between the two African elephant races (forest-dwelling and savannah-dwelling), as well as among populations, can be described more accurately by coalescent rather than traditional F-statistic based methods. Nuclear microsatellite data from seven loci and 14 populations will be used to estimate the effective number of migrants under two separate models, the infinite allele model (IAM) and the ladder model, in the program MIGRATE. These estimates are based on the long-term averages of gene flow among populations over the time span of the genealogy. Similar analyses will be conducted using mtDNA haplotype sequences from 10 populations. These haplotype data also will be used in molecular clock analyses, performed in the program r8s, to determine dates of haplotype origination and potentially population separation with 95% confidence intervals. Estimates of long-term population sizes and potential growth rates for all populations combined and by region will be obtained with the LAMARC and GENIE programs; this will test the assumptions of the methods made in the analyses from MIGRATE. So far, microsatellite analyses show early divergence of many haplotypes. Due to the population-specific patterns of haplotype occurrence, these results establish maximum times of population separation. The gene flow analyses are currently underway. I believe that previous reports pertaining to the evolutionary history of the African elephant can be refined by the anticipated results from the coalescent methods mentioned. The impetus of this research is motivated both by the challenge in understanding and using these methods and by my personal admiration for this animal.

### **Is there a Burden of "Acting White" Keeping African American Students from Academic Success?**

*Oluwatope Fashola, Senior, Sociology, American Ethnic Studies*

*Mary Gates Scholar*  
*Mentor: Charles Hirschman, Sociology*

The threat behind the oversimplification of the oppositional culture theory is that it puts full responsibility of the educational gap on involuntary minority groups. The purpose of this project is to test the oppositional culture

theory as a method of uncovering larger questions regarding minority education. In order to test this hypothesis I will use data from the 2000 and 2002 Beyond High School Project survey data. Data collected from this project will be analyzed according to the stipulations made by the oppositional culture theory, specifically testing the effect of family, economic, and school factors that may be helping to perpetuate an educational disparity between white students and black students. Within Ogbu's hypothesis he acknowledges racial inequality, stagnate occupational mobility, and unequal treatment within education institutions, bringing together evidence that this historical injustices are having a present effect on African Americans. However, Ogbu's conclusion based on these ethnographic findings explicitly state that it is the African American creation of a "folk theory of success" which keeps African American students from succeeding, this anecdote is one of many observations which aid in the confusion and oversimplification surrounding the theory. Horvat and Lewis (2003) believe that the oppositional culture theory has been oversimplified into a culture of poverty theory which focuses on a "burden of acting white," leading policymakers to overlook the collaboration and culmination of multiple forces on the educational outcomes of black students. Others (Foley 1991; Slaughter-Defoe 1990) have argued that Fordham and Ogbu's (1986) oppositional culture theory overlooks or minimizes within group variation. Ainsworth-Darnell and Downey worry that the oppositional culture model has become so respected in the academic community that it threatens to divert attention from other explanations for the racial gap in school performance (1998). The reason that this theory is so controversial is that the black-white achievement gap has been and continues to be one of the most important issues regarding education in America. Therefore, understanding how to improve the academic achievement of black students and how to remove roadblocks to their success are crucial.

### **Molecular Mobility Study of Non-Linear Optical Polymers using Nano-Tribological Technique**

*Karl Fincken, Sophomore, Chemical Engineering*  
*Mentor: Renè Overney, Chemical Engineering*

The second half of the twentieth century has shifted much of our demand in materials from metals and wood to polymers. Polymers are economic, easily processed, and can be tailored to have the desired properties, which metals could not offer. During the coming decades polymers will encroach more in electronic device applications as the material of choice. Non-linear optical (NLO) polymers are one of promising materials, which are currently extensively studied as they show great potential in high-speed, wide bandwidth, and low-drive voltage applications for photonic communications systems. In order to compete with the currently used devices, however, one needs to improve the stability and the efficiency of the photonic devices. One of

the key parameters in approaching these challenges is by obtaining a fundamental understanding of the "molecular mobility" of polymers *in situ*. Particularly, in NLO polymers, one has to study the mobility of the electro-optical moiety, or otherwise known as the chromophores. Here we will investigate the mobility in NLO polymer thin films. We will employ a nano-tribological technique, which is based on scanning force microscopy (SFM). This technique allows us to approach the origin and degree of the mobility in the thin films, offering the direction to improve the molecular design and processing conditions for photonic devices.

### **Why Special Education Teachers Leave Teaching Jobs**

*Audrey Flemming, Junior, History*  
*Zesbaugh Scholar*  
*Mentor: Gene Edgar, Education*

Research has constantly shown that there is a national shortage of special education teachers. The greatest area of teacher shortage throughout Washington State lies in special education. Studies have shown that up to 50% of special education teachers leave the teaching profession; this is a consistently higher percentage compared to general education teachers. Other studies have suggested that special education teachers may be leaving one teaching position to pursue another position in a different school district. The goal of this research project was to strive to determine why special education teachers leave the teaching profession. This report will focus on the potential factors that play a role in why special education teachers chose to leave the teaching profession. Three local school districts, have participated in this research study. Data were collected during the 2003-2004 academic school year. There were a total of 121 Special Education teachers within the three school districts. Questionnaires were mailed to the teachers asking them to report all the special education teaching positions that they had held along with reasons why they left previous positions. The questionnaires were returned and entered into a database. The results for why the special education teachers left previous teaching positions fell into the following categories: family reasons, parenting, closer to home/commute, adventure, permanent job, administrative action, administrative support, hard kids, bad school and living environment.

### **An Investigation of WW Domain-Mediated Protein-Protein Interactions in Yeast**

*Anna L. Fortin, Senior, Cellular and Molecular Biology*  
*Mentor: John P. Miller, Genome Sciences*  
*Mentor: Stanley Fields, Genome Sciences, Howard Hughes Medical Institute*

The WW domain, a protein domain that is conserved from yeast to humans, is a 40-amino acid sequence distinguished by two tryptophan residues spaced 20 to 22 residues apart.

It is one of the smallest protein modules known to fold stably on its own and has previously been shown to mediate protein-protein interactions in diverse pathways including transcription activation, modulation of RNA polymerase II activity, the cell cycle, viral budding, and limb development. The goal of our project is to further characterize the protein-protein interactions mediated by each of the 13 WW domains in yeast. Toward that end, we are using two assays to elicit WW domain protein binding partners. The first is the yeast 2-hybrid, an in-vivo assay in which the interaction of two proteins is signaled by the growth of a yeast strain. In this assay, we are screening the yeast WW domains for interactions with about 6000 yeast proteins. Because in past experiments the yeast 2 hybrid assay has given variable results with WW domains, we are also using an in vitro assay. In this assay, we apply the purified WW domains to a small "protein chip," a glass slide that has about 85% of the predicted yeast proteins bound to it. Binding of a labeled WW domain to a protein on the chip is detected by measuring fluorescence. Thus far, we have applied three WW domains to the protein chip. Two of these domains were from the same yeast protein, involved in targeting proteins for degradation, and were found to bind to 11 of the same proteins. We will continue to test the other yeast WW domains in both the yeast 2 hybrid and the protein chip assays in order to identify previously unknown binding partners and to confirm interacting proteins previously identified.

### **Coupling Agents for the Clinical Application of High Intensity Focused Ultrasound**

*Carie Frantz, Junior, Pre-Engineering*

*Mary Gates Scholar, Space Grant Scholar*

*Mentor: Shahram Vaezy, Bioengineering*

The objective of this research has been to find and test materials that can serve as a coupling media between soft tissue and ultrasound transducers in a clinical setting. In high intensity focused ultrasound (HIFU), where high-amplitude ultrasound waves are focused to an elliptical area about the size of a grain of rice to perform non-invasive subcutaneous surgeries, improper coupling can result in skin burns and significant loss of ultrasound power and efficacy. Other problems currently associated with HIFU coupling agents are the toxicity of certain materials, the degradation or mechanical frailty of the material, and sterilization issues. Ideally, we wish to find a medium that has acoustic properties that are identical to soft tissue, is nontoxic, biocompatible, biodegradable, sterile, relatively simple and inexpensive to make, and mechanically strong enough to tolerate clinical use. Hydrogels, because of their high water content (and resulting favorable acoustic properties), are likely candidates for coupling media. An ongoing literature search as well as consultation with materials scientists has turned up several hydrogels that may potentially be useful as coupling agents in clinical HIFU. Poly (vinyl alcohol) [PVA] in particular seems to

have the right acoustic properties, is nontoxic, and can possibly be prepared to the required mechanical strength to be useful. Gels are tested for their relative acoustic properties using an acoustic-transmission method, their toxicity assessed in *in vitro* and possible *in vivo* toxicology tests, and their mechanical properties analyzed in a simulated clinical setting. Currently, I am experimenting with how acoustic and mechanical properties of PVA gel change with different methods of preparation and varying concentrations.

### **Mission Design for the Mars Gravity Biosatellite**

*Michael Frostad, Senior, Aeronautics and Astronautics*

*Mentor: Charlie Vaughan, Aeronautics and Astronautics*

The Mars Gravity Biosatellite Project is a student-led space mission that will gather data on the effects of Martian-level gravity on mammals. The Project has evolved and built up a knowledge base through the collaborative effort of students at the University of Washington, Massachusetts Institute of Technology, and the University of Queensland (Australia). The spacecraft must meet rigorous requirements in order to support fifteen mice for 35 days in a simulated Martian gravity environment. Project participants face the daunting task of designing a satellite and presenting that design to NASA engineers; mission design is an important portion of this task for systems engineers involved in the project. All major tasks to be completed throughout the mission are defined by the systems engineering team. Issues that deal with scientific aspects of the mission such as providing artificial gravity require an appropriate sequence of events. This sequence in turn creates engineering issues, which must be integrated with each other to provide the necessary scientific information. Understanding the mission's operational structure allows engineers at every level develop designs that meet mission requirements optimally in terms of scientific objectives, cost, and reliability. This poster will incorporate scientific, programmatic, and engineering interface requirements used to develop an operational sequence for the mission that delivers requirement satisfaction.

### **Microprinting On-Chip Culture: An Investigation of Concanavalin A Adhesion for Yeast.**

*Tracy Fung, Junior, Electrical Engineering*

*Ian Ball, Freshman, University of California, Berkeley*

*Mentor: Sarah McQuaide, Electrical Engineering*

*Mentor: Joseph Chao, Electrical Engineering*

*Mentor: Deirdre Meldrum, Electrical Engineering*

In contrast to conventional cellular researches that perform with bulk amounts of cells, the Microscale Life Sciences Center (MLSC) at UW seeks to study at a single cell level. This approach avoids the misleading data from large populations while variations among cells can be attained. 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 simpler, and cost effective solution. Our microprinting process involves the use of softlithography 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 40 $\mu\text{m}$ . Yeast cell sizes range from 5-10 $\mu\text{m}$  and the goal of stamping a single cell 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 of con-A, and the support of the National Human Genome Research Institute through Centers of Excellence in Genomic Sciences program.

### **Using Entropy and Graph Theory to Determine Disorder in Stochastic Structures**

*Noah Giansiracusa, Sophomore, Mathematics*

*Mary Gates Scholar, Space Grant Scholar*

*Mentor: Gerald T. Seidler, Physics*

In 1948 Claude Shannon published a landmark paper on coding and communication theory in which he developed a new field of mathematics named *information theory*. One of the main features of this discipline is a probabilistic measure of uncertainty known as *entropy*. This quantity bears the same name as its thermodynamic counterpart because it was later found to be a mathematical generalization of the traditional thermodynamic quantity of entropy. We are investigating the applications of this concept to structures and materials that were generated in a pseudo-random fashion, and hence have a configurational entropy associated with them. The first goal of this project is to develop a method to measure the entropy of randomly generated heterogeneous materials, such as foams, in order to produce a convenient measure of disorder for these structures. Secondly, we are interested in using this entropic estimate to understand which correlation functions are most relevant to determining various physical properties, such as conductivity, of these foams and other materials. We have been studying the 2-dimensional Poisson-Voronoi tessellation, for which we have developed an algorithm to determine the complete entropy of this system. We have also been investigating an algorithm that

was recently proposed in Physical Review Letters to estimate entropy based on sampling subgraphs of a network-forming material. We found that the proposed method for sampling has some significant limitations, for which the authors of the PRL article attempt to compensate by introducing a correction term in their estimate. We are currently developing more sophisticated methods for sampling graphs in randomly generated heterogeneous networks that will not require any such correction term.

### **A Novel Method of Combating the Foreign Body Reaction through Tissue Engineering**

*Stephen Gingrich, Senior, Bioengineering*

*Mary Gates Scholar*

*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 affixing either 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 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, respectively. The PLLA film was then augmented with a porous PLLA cell scaffold, prepared with a salt-leaching technique. SEM (Scanning Electron Microscopy) illustrated interconnected pores on the surface and in cross section of the scaffolds approximately 75-150  $\mu\text{m}$  in diameter. Studies are underway to seed the PLLA scaffolds with mesenchymal stem cells (MSCs) for murine *in vivo* implantation. With the known differentiation properties of MSCs, we predict that the new tissue coating the biomaterial will be identical to the implant site's surrounding tissue and therefore minimize the FBR.

### **Lichenometric Dating of Little Ice Age Features at Emmons Glacier, Mount Rainier, WA**

*Brent Goehring, Senior, Geology*

*Mentor: Michael O'Neal, Earth and Space Sciences*

Lichenometric-dating techniques allow for a more accurate construction of Little Ice Age (LIA) glacial chronologies than other common age-dating techniques, such as dendrochronology and  $^{14}\text{C}$  dating. This could be important to determine past climate impacts resulting from short period climate changes like the Pacific Decadal Oscillation.

Dating of three LIA moraines and one LIA melt-water channel was completed in the Emmons Glacier foreland on Mount Rainier, WA, using lichenometric-dating techniques. The Emmons Glacier foreland was selected because previous dendrochronologic studies were applied there and allow for direct comparison of these two dating methods. Three sets of moraines and one melt-water channel within the Emmons Glacier foreland were assigned stabilization ages using the largest lichen technique and a calibration curve recently developed for the Washington and Oregon Cascade Mountains. Results indicate that lichenometric dating techniques provide more accurate ages for Emmons Glacier foreland features than do dendrochronologic techniques because living trees do not appear large enough to be the reported age of the feature. Resulting lichenometric-ages for the three moraines were 1950 AD, 1891 AD, and 1838 AD, and 1852 for the melt-water channel. Differences in resulting ages were as small as 10 years for the 1891 moraine and greater than 50 years for the melt-water channel. Using lichenometric ages of moraine stabilization to approximate ice margin position, the synchronicity of glacier fluctuations between Emmons Glacier and other glaciers on Mount Rainier was investigated. Comparison indicates that glacier fluctuations were nearly synchronous during the LIA on all sides of the mountain, which indicates that glaciers on Mount Rainier respond to climate changes synchronously.

#### ***Bricolage: A Literary and Arts Journal***

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

*Laura Bylenok, Senior, English*

*Veronica Lujan, Senior, English*

*Mary Gates Scholar*

*Rita Safariants, Senior, English*

*Czarín Chan, Senior, Communication, Japanese*

*Mentor: Kimberly Swayze, English*

*Mentor: Robert McNamara, English*

Due to the nature of the publication industry, and considering print publication in particular, it is difficult for artists and authors to gain the validation and exposure provided by publication in a conventional journal or collection of works. *Bricolage*, an annual journal of literary and visual art as well as a Registered Student Organization sponsored by the English Department, endeavors to provide that opportunity for publication to all members of the University of Washington community. The publication is produced via a three-stage process: In the fall, the all-undergraduate staff members of *Bricolage* solicit high quality content with a competitive call for submissions from UW students, staff, faculty, and alumni. The pieces slated for inclusion in the journal are selected during winter quarter of each year. *Bricolage* is always comprised of an eclectic array of works, including photography, poetry, one-act plays, lithographs, short stories, and essays. Each spring, the staff assembles a professionally bound book and

sponsors a well-attended reading as the journal's presentation. Published quarterly and now annually for more than twenty years at the University of Washington, *Bricolage* has evolved from a simple folio serving English majors to a substantial volume featuring the creative efforts of the entire university community. Given a reciprocal relationship between art and culture, *Bricolage's* encouragement of art causes a cognate progression of local culture. More than two decades of support by *Bricolage* have aimed to draw attention to the University of Washington's status as possessing not only a strong contribution to research in science and technology, but also a rich and varied culture of creativity through communication of literature and the arts.

#### **Design and Installation of an Engine Torque Sensor for Power-Required Flight Testing of an Unmanned Aerial Vehicle**

*Richard Golob, Senior, Aeronautics and Astronautics*

*Mary Gates Scholar*

*Mentor: Scott Eberhardt, Aeronautics and Astronautics*

The purpose of this experiment was to instrument a UAV engine to collect data for a power-required flight test of the Telemaster, a department research UAV. In order to measure the power-required from the engine during test flights, a torque sensor was fastened to the engine mount. I was involved in the design, installation, and calibration of this torque sensor and data acquisition system enabling the power-required for flight to be derived during test flights. In addition to presenting the methodology and theory behind this technique, I will also be presenting additional flight-testing projects we are currently equipping the Telemaster aircraft to perform. When fully equipped, the Telemaster will be used during the senior flight testing course to complete flight testing when weather, conditions, or other specific testing are not suitable for student-manned flight. In flight, the data from the sensors is taken with a Tattletale computer and relayed to a ground station computer where it can be observed in real-time. From the torque sensor on the engine, a simple engine RPM gauge and a flight speed indicator, the corresponding profile drag and Oswald efficiency of the aircraft can be calculated.

#### **Using High Intensity Focused Ultrasound to Fragment Kidney Stones**

*Erin Graf, Junior, Psychology*

*Space Grant Scholar*

*Mentor: Michael Bailey, Applied Physics Laboratory*

Currently, the most popular kidney stone treatment is Extracorporeal Shockwave Lithotripsy (ESWL). ESWL uses an electrical discharge of a high-voltage current which occurs across a spark-gap electrode located in a water bath. When the shockwave is reflected off an ellipsoid reflector, a portion of the wave is transmitted through the stone, causing the stone to fragment. The focusing of the

shockwave also causes bubble activity, and the impact pressure with bubble collapse damages not only the stone but also the surrounding body tissues. In a standard ESWL machine, the success rate is only 60%-70%, and if unsuccessful, multiple treatments may be required and more damage may be done to the kidney. My experiment was to see whether or not high intensity focused ultrasound (HIFU) could be used as a more effective, alternative lithotripsy treatment. I tried to find the optimum settings for maximum kidney stone fragmentation while using a 250 kHz HIFU transducer. HIFU uses a high-intensity convergent ultrasound beam generated by high power transducers to produce heat. It has many applications thus far, including stopping the flow of blood from wounds, halting internal bleeding, thermally necrosing tumors, and treating glaucoma. HIFU transducers can be run in “burst” mode, which has less dangerous heating effects, meaning a possible lower amount of surrounding tissue damage. The hope is that using the transducer in “burst” mode will be an effective treatment while posing minimal risk to the kidney.

### **Leadership for Learning**

*Anne Grant, Senior, Political Science*

*Mary Gates Scholar, Zesbaugh Scholar*

*Mentor: Brad Portin, Education*

Researchers from the U.K., Austria, Denmark, Norway, Sweden, Greece, Australia, and the United States have sought out three schools from their own countries to participate in a study of how shared leadership among administrators, teachers, and students impact student learning. The focus of our research is on leadership for learning, which we have defined as “the role of school leadership in creating a stimulating learning environment for pupils and a rewarding environment for those who teach them and support them in their learning.” Our research also has a particular emphasis on democratic education, in which leadership and learning are considered to be shared experiences between administrators, teachers, students, parents, and other individuals that play a role in education. The goal of our research is to learn how leadership can improve learning, and what strategies are most effective in creating learning centered leadership. We are examining survey data, focus group feedback, interviews, and school portraits to analyze the way in which schools are sharing leadership and how the extent of shared leadership is impacting student learning according to students, teachers, and administrators. Reaching our goals will provide valuable research findings to educators while creating real change and building relationships between the schools that we are studying in our own region and around the world.

### **A Novel Secretion Pathway for Virulence Proteins in *Agrobacterium tumefaciens***

*Rula Green Gladden, Sophomore, Biochemistry*

*Mary Gates Scholar*

*Mentor: Derek Wood, Microbiology*

*Agrobacterium tumefaciens* is a plant pathogen that incorporates part of its DNA into the genome of host plants. Based on this property, *Agrobacterium* is widely used in the genetic engineering of plants. The genome of *Agrobacterium* has recently been sequenced and the functions of many important genes have yet to be discerned. My project focuses on identifying a new protein secretion system. It is thought that the secretion of virulence proteins by the type IV secretion system of *Agrobacterium* occurs via a two-step process. While the classic VirB type IV secretion system has been well characterized and is responsible for the second step of the secretion process, it is unclear what mediates the first step, namely secretion into the periplasm. I am taking two approaches to identify this system. First, I am making protein fusions between a secreted protein, VirF, and the protein PhoA. The product of PhoA provides a biochemical assay to determine if the VirF fusion has been secreted. The fusion protein has been constructed and I am awaiting sequencing results to discern whether there are mutations in the *PhoA-VirF* gene fusion construct. The functioning *PhoA-VirF* gene will then be used as part of a genetic screen in concert with a chemically mutagenized library of *Agrobacterium*. The desired secretion deficient mutants will then be isolated and characterized. The second approach, in progress, takes advantage of the fact that a protein called OSA blocks the secretion of virulence proteins at the first step, and in doing so likely interacts directly with components of the secretion pathway. For this aspect I am labeling the OSA protein with an epitope tag (flg). I am also generating an epitope fusion to another secreted protein, VirD2. Once complete, each of these constructs will be expressed in *Agrobacterium* and antibody-mediated separation will be used identify proteins that interact with them, presumably components of the secretion apparatus.

### **Structure Based Drug Design Targeting Cholera Toxin**

*Nathaniel Greene, Senior, Biochemistry*

*Howard Hughes Scholar, Mary Gates Scholar*

*Mentor: Wim Hol, Biochemistry and Biological Structure*

The causative agent of cholera is cholera toxin, a heterohexameric AB<sub>5</sub> toxin. Previous crystal structures have only shown cholera toxin in an inactive form. In order to design an inhibitory drug, only structures of cholera in an active form would be of relevant use. The mutant CTY30S, discovered through a mutational analysis, was found to be constitutively active in vitro. To initiate drug design efforts, protein crystals of CTY30S were soaked with β-NAD<sup>+</sup> (Nicotinamide adenosine dinucleotide) leading to convincing data on the first structure of cholera toxin bound to substrate. Further purification of the AB<sub>5</sub> complex has enhanced the reproducibility of our

crystallization efforts. With this further purified form, experiments could lead to co-crystallization of CTY30S with an inhibitor for purposes of drug design. The A1 subunit of cholera toxin is believed to bind to ARF protein in human cells. When bound, ARF lowers the  $K_m$  value of the toxin for  $NAD^+$ , and increases the  $K_{cat}$  value of the enzymatic reaction<sup>1</sup>. We have been able to express and purify CTA1:ARF6 in *E. coli* expression systems, and are in the process of obtaining crystals of the CTA1:ARF6 complex through exhaustive analysis of different environments to favor crystallization. Experiments are underway with two different forms of A1, from cholera toxin (CT), and heat-labile enterotoxin (LT), and four different forms of ARF protein: ARF1, ARF3, ARF4, and ARF6. New constructs should increase our chances of obtaining a crystallizable complex as well as help us further study the interactions between CT and LT A1 subunits and the human ARF variants.

<sup>1</sup> Tsai SC, et al., "Stimulation of cholera enzymatic activities by GTP and two soluble proteins purified from bovine brain." *Journal of Biological Chemistry*, 1988, 263(4):1768-72.

**Corticosterone May Influence Chick Feather Growth**  
*Meridith Grogan, Junior, Conservation Biology*  
*Mentor: John C. Wingfield, Biology*

Japanese quails (*Coturnix japonica*), like all vertebrates, experience increased levels of circulating glucocorticoids in response to environmental disturbances. In a previous experiment, the yolks of eggs laid by stressed Japanese quails contained more than double the concentration of corticosterone found in control eggs. Using this information, we experimentally elevated the primary avian glucocorticoid, corticosterone, in Japanese quail eggs, and found that chicks grew more slowly than those from control eggs. Furthermore, corticosteroid-treated chicks showed increased asymmetry in leg growth. In the next experiment, I will be looking at initiation of pre-juvinal molt and feather growth rate in corticosteroid versus control chicks during a fourteen-day period. At the end of this period, I will prepare skins from the quails and use these to determine down and feather quality, and pin asymmetry in feather tracts. These results should give a greater understanding of the role of corticosterone in chick development. On an evolutionary scale, the data may address why corticosterone is transferred from mother to egg.

**The Making of the GLAST Gamma Ray Observatory**  
*Scott Hanes, Freshman, Pre-Sciences*  
*Space Grant Scholar*  
*Mentor: Toby Burnett, Physics*

The gamma ray spectrum is among the most poorly understood in particle astrophysics, in part because the high energies make them difficult to measure to any significant

degree of accuracy. A first step was provided by the EGRET satellite, launched in 1991, but its limited capabilities resulted in more questions unanswered than answered. The GLAST (Gamma ray Large Area Space Telescope), which will be launched in 2006, seeks to build upon the foundation laid out by its predecessor, as well as resolving the mysteries EGRET was unable to solve. One example is the phenomenon of so-called "gamma ray bursts," about which we know little more than the name. We are currently designing a program that will train the system to accurately accept and measure data. This is done by fabricating data and finding methods to partition the data through a classification tree program. I am exploring S-Plus, a data analysis program, to see how well it meets our needs in executing the classification process and graphically representing processed data.

**Interpreting Serial Magnetic Resonance Imaging (MRI) of a Treated Glioblastoma: A Quantitative Modeling Perspective**

*Hana Harpold, Junior, Engineering*  
*Mentor: Kristin Swanson, Pathology*

This year approximately 17,000 new cases of primary brain tumors will be treated in America. Gliomas are the most common of all primary brain tumors and arise from the supportive tissue of the brain. Gliomas are a prominent medical problem because of their unclear in vivo dynamics and 100% fatality rate. In order to grasp a better understanding of their growth, we have developed a mathematical model based on the proliferation and migration of tumor cells.<sup>1</sup> We have tracked a glioma patient by a series of magnetic resonance images (MRI) to validate the ability of the mathematical model to simulate and predict tumor growth in vivo. The patient underwent eight routine MRI's, obtained both after resection and during chemo- and radio-therapies. Analysis of the time evolution of the MRI-detectable portion of the patient's tumor revealed an equal rate of progression before and after resection in the absence of treatment. During treatment, there is a transient decrease in the MRI-detectable growth rate. Additionally, the model can characterize the relative contribution of the glioma cells migration rate ( $D$ ) to net proliferation rate ( $\rho$ ). During treatment this ratio ( $D/\rho$ ) increases, signaling less of a contribution from the proliferation of tumor cells. By analyzing the model-derived evolution of  $D/\rho$  we are able to understand the specific characteristics of individual tumor cell dynamics in various environments. Our generated mathematical model of tumor growth in a treated and untreated environment gives an accurate dynamic representation of how tumors proliferate and invade in the brain. From the model characteristics, the future growth of a glioma can be predicted. This model can also serve to quantitatively describe and compare the effect of individual treatments on tumor growth rate. These conclusions provide practical

implications for both the clinic and for further research into better understanding these aggressive tumors.

<sup>1</sup> KR Swanson, EC Alvord Jr., JD Murray: Virtual Brain Tumor [Gliomas] Enhance the Reality of Medical Imaging and Highlights Inadequacies of Current Therapy, *Br J Can*, 86:14-18, 2002

### **Tactilization of Graphical Images**

*Eileen Hash, Senior, Computer Science*

*Mary Gates Scholar, Space Grant Scholar*

*Mentor: Richard Ladner, Computer Science and Engineering*

Graphs, diagrams, and illustrations – graphical images – in math, science and engineering textbooks and other publications are visualizations that help readers understand difficult concepts. However, this is a serious barrier to the success of blind persons because of the difficulties in converting these visual representations to an accessible form for the blind. The conversion is currently a labor-intensive process that is very slow. This makes it hard to produce accessible graphical images of high quality in a timely manner. The goal of our project is to alleviate these difficulties by developing software that translates graphical images to tactile format as automatically as possible, and by providing a guideline to produce high quality tactile forms of graphical images. There are many steps along the way to completing this goal. I have been working on the problem of translating a visual image with high resolution to a tactile image (which is required to have low resolution). Most methods to reduce resolution are optimized for the eye and include averaging. We have found that such methods do not produce high quality tactile images. I am creating and evaluating a resolution reduction method based on wavelet image reduction with adaptive thresholding. The goal is to reduce the resolution of an image without losing important information, such as lines or color regions.

### **Vortex Breakdown on Aircraft Wings**

*Justin Hatcher, Senior, Aeronautics and Astronautics*

*Mary Gates Scholar*

*Mentor: Dana Dabiri, Aeronautics and Astronautics*

A vortex flow is defined as a swirling fluid such as a tornado and is encountered in aircraft flight. A vortex flow, like that on the suction surface of an F/A-18 wing, generates a strong component of axial velocity along the centerline of the vortex. This is beneficial to the aircraft's performance at high angles of attack because the higher velocities decrease pressure, thus increasing the lift. The kinetic energy of the vortex also energizes the flow in the boundary layer to help delay separation. Thus, a vortex increases the aircraft's maximum angle of attack and its maximum lift coefficient, which are advantageous to aircraft performance. Aircraft that fly at high angles of attack

encounter vortex breakdown. Vortex breakdown leads to aircraft instabilities and structural problems. These problems are especially common on twin-tailed aircraft such as the F/A-18, since the instabilities and structural problems associated with vortex breakdown cause millions of dollars in damage. With the current unknowns associated with vortex breakdown, these damages will keep occurring until some practical method of controlling vortex breakdown is established. My role in researching vortex breakdown is to continue forming a computer simulation from previous graduate work using the vortex filament method based on induction by the Biot-Savart Law. The current simulation does provide proper motion of the vortex filaments through self-induction but it does not properly set up its initial and boundary conditions. Therefore, I am changing the initial and boundary conditions to properly setup the simulation to correctly simulate vortex breakdown. In order to validate the simulation, the results are compared to experimental data. The goal of researching vortex breakdown is to accurately simulate breakdown. Once vortex breakdown is accurately simulated, control can be added in order to reduce, delay, or ultimately prevent vortex breakdown.

### **Control System for Image-Guided Treatment of Uterine Fibroids using Phased Array High Intensity Focused Ultrasound**

*Robert Held, Senior, Bioengineering*

*Mary Gates Scholar*

*Mentor: Professor Shahram Vaezy, Bioengineering*

Previous studies have shown that high intensity focused ultrasound (HIFU) that can cause tissue necrosis at a small focal spot may serve as a non-invasive tool for the treatment of uterine fibroids in women. Such a tool requires accurate targeting of the focal location using diagnostic imaging. We present the latest generation of our computer-controlled HIFU targeting system as a reliable solution for guiding the treatment. Our first device used a fixed-focus HIFU transducer (4 MHz) coupled with an ultrasound imaging probe (C4-2, Philips), that could be moved relative to each other to adjust the targeting location, using position encoders to specify the HIFU focus dynamically. The new device includes a variable focus HIFU array (11 elements, 3 MHz) fixed firmly to an imaging probe (C9-5 Philips). Focal adjustments are achieved using phase correction for each element, requiring no mechanical movement of the device. The software, developed in the LabView programming environment, allows the user to click directly on a real-time diagnostic ultrasound image to designate multiple HIFU foci. The locations, ranging between 3.5 and 6.0 cm away from the transducer, may then be successively employed to ablate a larger volume of tissue than a single focus. The program computes the necessary phase angles for the transducer and starts the treatment. The functionality of the driving software has been demonstrated in a 50 ohm resistive load, which imitates

the transducer. Integration of the imaging algorithm will continue, followed by tests in tissue-mimicking gel phantoms, in-vitro tissue (e.g. turkey breast), and an *in vivo* pig model. We expect this device to show increased accuracy over the previous version and reinforce the feasibility of HIFU in the treatment of uterine fibroids.

### **A Social History of Childhood Depression**

*Jenna Henderson, Senior, Sociology*

*Mentor: Jerald Herting, Sociology*

During the late 1950s and 1960s, trace numbers of research articles that focused on childhood depression began to appear in psychiatric journals. By the mid-1980s, the number of references to the same subject appearing in academic disciplines had increased dramatically. During this same period, advertisements for anti-depressant medications had begun to appear in magazines that clearly target certain populations, such as working mothers, by marketing stability and harmony in the family. By tracing the emergence of references to “childhood depression” through academic and mainstream literature, one is able to study the evolution of a controversial and conflicting dialogue regarding mental illness. The social history of what is today referred to as “depression” is rich with interactions - and often conflicts - among academic disciplines and social and economic interests. By constructing a detailed history, I hope to better analyze the contemporary issues and debates that have arisen from assigning the medical model mental health generally, and children’s mental health specifically.

### **Human Factor IX Plasmids Containing Replication Sequences Show Increased Levels of Gene Expression in Mice with Hemophilia B**

*Alicia Herem, Senior, Cellular and Molecular Biology*

*Mary Gates Scholar*

*Mentor: Carol Miao, Pediatrics*

Hemophilia B is a common model for studying the effectiveness of gene therapy. In order to reduce the level of toxicity that can be induced by the use of viral vectors, a naked human factor IX (hFIX) plasmid was applied to hepatocytes in vitro and in vivo. Through trials of various replication sequences in the plasmid cassette, the goal is to reach a therapeutic level of hFIX expressed in mice liver that is comparable to that of wild type mice. This level must not be transient, however. The plasmid should replicate in order to have mammalian-specific methylation on the DNA and be expressed throughout the organism’s life. This replication might also aid in the resistance of silencing of gene expression. Mice were injected with hFIX plasmid containing the replication sequences PBILB-RepA or PBILB-RepB. Partial hepatectomy was done two months post-injection and Hirt DNA extraction was used to purify the liver DNA. Weeks later, DNA was again obtained after the livers had time to regenerate. Polymerase chain

reactions (PCR) of the DNA were done on Dpn1 digested and on undigested samples to estimate the level of transcription of the episomal hFIX gene. The persistence of bands appearing in subsequent gel runs for digested samples indicated that small amounts of the plasmid had replicated in the mice. Human liver cells (HepG2) were cultured and transfected with identical plasmids; PCR revealed the same result in which a small amount of the episomal plasmid had replicated. Western blots using plasma samples from hemophilia B mice revealed a higher than normal expression of hFIX. Due to the low efficiency of replication in tissue culture experiments, a new replication sequence originating from African green monkey kidney will be used in place of the PBILB-Rep sequences.

### **Analyzing Data Sets using Spectral Clustering**

*David Hiller, Senior, Mathematics, Statistics*

*Mary Gates Scholar, Space Grant Scholar*

*Mentor: Marina Meila, Statistics*

The problem addressed by this research is to find the optimal way to cluster a large set of data. Clustering could be used in many different applications. For instance, clustering could help to identify groups of web sites which are commonly linked to each other. Or, in the medical world, clustering could be applied to determine variants of a disease. An optimal clustering simultaneously ensures that pairs of elements in the same cluster have relatively high similarity to each other, while pairs of elements in different clusters have relatively low similarity to each other. The clustering problem can be attacked by a variety of methods. Among these, spectral methods cluster a set of data by examining the eigenvectors of the matrix expressing the similarities of each pair of elements. It has been shown that a similarity matrix representing strongly clustered data will possess eigenvectors whose numerical elements are clustered into the same number and sizes of clusters as the original data. My role in the project has been to write algorithms which recognize these indicator vectors, as well as find the best way to cluster them. Then, light will be shed on the optimal clustering of the original set of data. The algorithms were tested on computer-generated data, and were found to generally identify the “correct” clustering of a well-clustered data set.

### **Search for Hydrogen Regulatory Systems in the Methanogenic Archeon *Methanococcus Mariprofundis***

*Andrew Hill, Senior, Microbiology, Biochemistry*

*Mary Gates Scholar*

*Mentor: John Leigh, Microbiology*

The Archaea are a recently discovered domain of life (1977) which consists of single-celled organisms that resemble traditional bacteria in their general structure, but many of their internal systems resemble those of eukaryotes. The purpose of our study is to learn more about the regulatory

mechanisms of this new domain of life. *Methanococcus maripaludis* derives its energy entirely from hydrogen. It has been shown that *Methanococcus maripaludis* has a regulatory response to different levels of hydrogen in its environment. We have deleted three genes from the chromosome in order to study their effects on gene regulation. Two are similar to traditional transcriptional regulators found in bacteria, while the third may directly sense hydrogen. We expect that the mutant organisms will show aberrant regulation of their metabolism genes.

### **Putative Identification of Rubisco Activase in Stramenopiles and Alveolates**

*Amanda Hoyt, Junior, Biochemistry*

*Mentor: Rose Ann Cattolico, Biology*

Rising levels of carbon dioxide in the atmosphere are contributing to global warming. Autotrophic organisms convert carbon dioxide into carbohydrates, potentially decreasing carbon dioxide levels in the atmosphere. Over half of carbon fixation is performed by phototrophic algae, but carbon fixation studies have focused primarily on terrestrial plants. Understanding the impact on algal productivity will help in the development of realistic models for predicting changes in the oceans biochemical cycle. In terrestrial plants, carbon dioxide entrance in the Calvin Cycle is driven by the catalytic enzyme Rubisco 1,5 biphosphate carboxylase, know simply as Rubisco. Historically, Rubisco has been thought to be the rate-limiting enzyme that drives Calvin Cycle function, but it is now known that Rubisco is non-functional without the cooperative enzyme Rubisco activase. Rubisco activase, thus, greatly affects the rate of carbon fixation in terrestrial plants. Algae also contain the enzyme Rubisco, but it is unknown whether Rubisco activase is present, or how the enzyme functions in these organisms. Using molecular techniques we have amplified and sequenced a segment of Rubisco activase in the chloroplast DNA of the diatom *Cylindrotheca*, the dinoflagellate *Pyrocystis*, and in the chromophyte *Heterosigma akashiwo*. We are in the process of obtaining the full-length gene in the previously mentioned organisms and expanding our data set to include *Ectocarpus*, *Sphacelaia* and *Nereocystis*. These data will be analyzed using phylogenetic methods to determine the relatedness of Rubisco activase among this diverse group of algae. In the future, our lab will characterize the putatively identified Rubisco activase to determine whether it plays an integral role in the Calvin Cycle within these algae.

### **Phenotypic Analysis of SNPs in Human DNA Polymerase Epsilon**

*Jessica Hsu, Senior, Biochemistry*

*Mary Gates Scholar*

*Mentor: Lawrence Loeb, Pathology*

*Mentor: Ranga Venkatesan, Pathology*

The completion of the human genome project allows contemporary geneticists to examine the genome on the most basic nucleotide level. Single nucleotide polymorphisms (SNPs) are single base pair differences in alleles found throughout the human population. These differences, involving only single nucleotide substitutions in DNA, could have significant effects on human health. The presence or absence of particular SNPs has the potential to alter an individual's predisposition to a certain disease or even change their response to drug treatment. The precise roles and effects of the majority of SNPs in the genome remain unknown. The objective of our research project is to study and characterize the role of SNPs in the human DNA polymerase epsilon (hPol $\epsilon$ ) gene. The gene product of hPol $\epsilon$  functions in concert with DNA polymerase delta to replicate chromosomal DNA. We have characterized the effect of single point mutations in the active site of *Saccharomyces cerevisiae* DNA polymerase delta and have found that changing the leucine at residue 612 to asparagine has significant effects on mutation rate *in vivo* and on cell cycle behavior. The results from studying DNA polymerase delta lead us to believe that Pol $\epsilon$  SNPs have the potential to alter polymerase function during DNA replication. From database searches, we know that Pol $\epsilon$  is a polymorphic gene and contains twenty known SNPs in its coding region. Upon sequence alignment, we found that six of these SNPs are conserved between humans and the yeast species *S. cerevisiae*, making *S. cerevisiae* an ideal model organism to study the function of these SNPs. We have now cloned the homologous yeast DNA polymerase epsilon gene and have introduced the six conserved SNPs. From there, we will determine the function and effect of these mutations on the catalytic activity of polymerase epsilon. We hypothesize that these SNPs will alter polymerase epsilon function, which can be detected in several ways. Because polymerase epsilon is essential for chromosomal replication, defects in the enzyme activity will produce cell cycle phenotypes, which are easily detectable by microscopy and flow cytometry. If our hypothesis is verified, detection of these SNPs in Pol $\epsilon$  can have implications for diseases involving alterations in DNA replication, the prime example being cancer.

### **Single Nucleotide Polymorphisms in Human Olfactory Receptor Genes**

*Jessie Hsu, Senior, Cellular and Molecular Biology*

*Howard Hughes Scholar*

*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 approximately 1000 OR genes, a majority of which are pseudogenes. We are interested in quantifying allelic diversity in human ORs across several different ancestral and modern populations. We first

selected five mouse ORs that bind to known ligands and identified the orthologous human receptors. For each of these five 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 27/35 SNPs identified in this study are non-synonymous, i.e., they change the amino acid sequence of the OR. Such a large fraction of non-synonymous changes suggests that these ORs have been subject to relaxed purifying or weak positive selection. Residue changes found in highly conserved regions of the receptor protein and sites critical for receptor function are of particular interest because changes in these areas are more likely to alter the binding properties of the OR. The data collected from our sequence variation studies allow us to identify various combinations of SNPs in individuals for a particular OR and provides a basis for functional studies to determine the effect of sequence variation on the ability of polymorphic ORs to recognize and distinguish between various odorants.

### **Spreading of Embryological Distinct Urothelial Cells is Inhibited by SPARC**

*Amber Hudson, Junior, Bioengineering*

*Mary Gates Scholar*

*Mentor: James Bassuk, Urology*

The AON-epitope of SPARC is a conserved motif expressed by human SPARC in a variety of human cell types. Through the use of a monoclonal antibody that recognizes this epitope, transitional epithelium was found to restrict expression of SPARC to the suprabasal and intermediate layer. Such intracellular expression was defined by immunoreactive signals that localized to the apical plasma membranes of suprabasal and intermediate cells. Polarization of SPARC to apical plasma membranes of suprabasal cells was retained *in vitro* by a subpopulation of cells that exhibited characteristics of suprabasal cells – cell cycle quiescence, large cell volumes, and multiple nuclei. In contrast, the basal layer of transitional epithelium *in vivo* and cycling cells *in vitro* did not exhibit this apical staining pattern, but instead sequestered the SPARC polypeptide within urothelial cytoplasm and/or nuclei, as revealed by immunohistochemical analysis. Elution of soluble proteins and DNA from urothelial cells revealed the presence of SPARC within the nuclear matrix – and that SPARC colocalized with the nuclear matrix Ki-67 antigen. rSPARC activity was demonstrated and quantified with a Rounding Assay whereby the spreading of freshly-plated cells were inhibited by recombinant SPARC in a concentration- and time-dependent manner. Inhibition of spreading was observed in urothelial cells derived from endoderm (bladder) and mesoderm (ureter) germ layers. Statistically significant differences were seen between urothelial cells from these 2 layers. Mesodermal cells recovered more slowly from the inhibitory effects of

rSPARC, such that at hour 6 endodermal cells underwent significantly more spreading, as shown by a Rounding Index. These experiments provide new insights about the matricellular trafficking of SPARC and suggest that intra- and extra- cellular localization patterns influence the development, homeostasis, and differentiation of transitional epithelium.

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

*Marc Eric Hungerford, Junior, Electrical Engineering*

*Mary Gates Scholar, Space Grant Scholar*

*Alexei Zyuzin, Senior, Electrical Engineering*

*Mentor: Alexander Mamishev, Electrical Engineering*

Fringing electric field sensor arrays are currently under development by many research groups. Their potential for three-dimensional imaging of dielectric spectra is already benefiting research and manufacturing fields including medical, material study, and even process control for food preparation. However, fringing electric field sensors have electrical characteristics that are hard to measure with standard laboratory and field equipment. The common capacitance between the electrodes is on the order of 0.1 pF and the resistance is up to 1 TΩ!. Thus, research in this field is severely limited by the cost and size of equipment capable of acquiring accurate measurements from the individual sensor cells. We developed a small, modular, and cost-effective sensor interface. A single device will cost an estimated \$200 - a fraction of the price of the equipment already in use. It will interface up to eight sensor cells to a computer's USB port. Multiple interfaces can be instantaneously connected to a single computer or embedded device. Modular design will allow measurements acquisition from a virtually unlimited number of fringing field sensor cells grouped into an array. The miniaturization and modularization of the interface equipment into a single cost effective device will facilitate the expansion of research and interest in three-dimensional, one-sided and non-destructive dielectric sensing to a wider audience, including more research laboratories, students, and anyone else interested in this field.

### **The Characterization of Inherent Amino Acid Conformational Propensities**

*Daigo Inoyama, Senior, Biochemistry*

*Mentor: Valerie Daggett, Medicinal Chemistry*

Most of what we know about protein structure relates to their native or folded conformation. Less is understood about the unfolded state because of limitations in experimental studies. Although residual secondary structure is known to exist in unfolded proteins, the underlying structure of this 'random coil' state is unknown. Previous spectroscopic studies suggest that random coil has a tendency to adopt polyproline II conformation in aqueous solution. This raises the question of whether the random coil is really random or assumes a range of preferred structures. The

pentapeptide GGXGG has been identified as a model to study unfolded proteins because of its inherent conformational flexibility. The glycines flanking the middle residue impose the least steric effect of all naturally occurring amino acids and the peptide is small enough to minimize the number of possible intra-molecular interactions. This unconstrained environment is ideal for studying the full range of conformational flexibility available to the center residue. A previous GGAGG spectroscopic study has been conducted [Ding et al]. However, theoretical studies are required to elucidate at atomic detail the behavior of the peptide. This work employed molecular dynamics (MD) simulations to study the GGXGG motif with all twenty L-amino acids substituted for X. Two separate temperature simulations have been performed for each amino acid(s) to observe the temperature effect on conformations. Ramachandran plots, residual  $J_{\text{HN}\alpha\text{O}}$  spin-spin coupling constants, and chemical shifts that are obtained from MD can be used to characterize the conformation and, in the case of GGAGG, benchmarked against experimentally available values. By finding the set of Phi and Psi angles that are available to each of the 20 amino acids, it may be possible to improve protein structure prediction and begin to predict the unfolded states of proteins.

### **Regeneration and Tissue Engineering of Human Fetal Digits**

*Jennifer L. James, Junior, Bioengineering*

*Mary Gates Scholar*

*Mentor: Christopher Allan, Orthopedics*

Human digit tips, especially in children, can regrow after distal amputation. It is plausible that amputated human digits might one day be induced to regrow. Through combining cellular and molecular events in the digit tip regeneration process with principles of tissue engineering we may develop better solutions for digit and limb loss. The cells, matrix and signaling pathways involved in this regenerative response are unknown. We describe an in vitro model for study of this phenomenon that offers opportunities for investigation not previously possible. Control and tip-amputated digits from 31 human fetal specimens between 56 and 117 days estimated gestational age were cultured in serum-free medium at 37° Centigrade with 40% oxygen for 48 hours to four weeks and processed for light and electron microscopy, immunohistochemistry, or scaffold attachment studies. Staining for collagen types II and I accurately characterized the ossification of digits to assess the response to tip amputation. The anti-mouse Msx-1 antibody, involved in tip regeneration in mice, was found to bind to epidermis and tissue beneath the nail field of human specimens. The distal tip amputation site of younger digits demonstrated intense cell proliferation, with multiple layers of stratified cells covering the amputated bone or cartilage of the distal phalanx. Such coverage correlated statistically with age. At the proximal cut end,

skin retraction occurred and no cell proliferation took place. Therefore the regenerative response appears to be isolated to amputations through the nail bed. A preliminary seeding experiment showed adhesion of small numbers of cells to scaffolds. In conclusion, cultured human fetal digits regenerate amputated tip tissues in an age-dependent fashion. More research must be conducted to determine the cells, genes and signals involved in this response. This model may further the study of human digit regeneration, leading to the development of cell or scaffold-based tissue-engineering therapies.

### **Water movement across the sill at Dabob Bay, Puget Sound, Washington**

*Kathryn Jenks, Senior, Oceanography, Math*

*Mentor: Eric D'Asaro, Oceanography, Applied Physics Laboratory*

The goal of my project is to understand how the water exchange across the sill at Dabob Bay, Puget Sound, Washington, varies throughout the tidal cycle. It is generally assumed that Dabob Bay can be considered a closed system—that is, there is no significant water exchange across the sill at Dabob Bay. However, no direct measurements of the exchange have been made. I will measure velocity sections across the sill using an Acoustic Doppler Current Profiler (ADCP) on four cruises in March and April. Temperature, salinity, and density data will be collected by a Conductivity, Temperature, and Depth sensor (CTD) on some of the cruises at four locations. Since each section will be taken on a different phase of the tide, I will then examine the water transport and properties as a function of the derivative of tidal height for the different flow regimes. Based on the previous work done in Dabob Bay, I hypothesize that there are multiple layers of flow vertically, anywhere from two to four. I am not sure what I expect to find across the channel, but probably a bimodal system. If I find significant water exchange across the sill at different parts of the tidal cycle, it would be worthwhile to implement longer-term continuous measurements to get a more accurate understanding of the water exchange across the sill.

### **Use of Phagemids for Pol I Random Mutagenesis in *E. coli***

*Ben P. Johnson, Senior, Biological Oceanography*

*Mentor: Manuel Camps, Pathology*

*Mentor: Lawrence A. Loeb, Pathology*

Random mutagenesis is a powerful approach for generating genetic diversity. We have developed a system for random mutagenesis of a DNA target. This system is based on expression of a highly error-prone DNA polymerase I. The sequence of interest is encoded in a Pol I-dependent plasmid. Random mutations are introduced during replication of this plasmid by Pol I. The frequency of mutagenesis is increased by 5 orders of magnitude and is

largely restricted to the target plasmid. Mutations are generated during growth in culture, facilitating the simultaneous application of a positive genetic selection. Sequential iteration of mutagenesis and selection allows the accumulation of beneficial mutations, which increases the effective complexity of the mutant libraries. As proof of principle, we generated extended-spectrum mutants of  $\beta$ -lactamase (PNAS 100, 17:9727-9732). Here, we placed the target sequence in a phagemid, a vector containing two origins of replication, which allows switching between the plasmid and the phage modes of replication. The advantages of this approach relative to the plasmid system include an additional mutagenic step (replication of the negative strand of the phagemid), a larger library size, easy iteration, and possible use in phage display. As a target for mutagenesis we chose ABH2, a human homologue of the *E. coli* demethylating enzyme AlkB. A library was generated by replication of a phagemid encoding ABH2 in cells expressing error-prone Pol I. We used repair of MMS lesions introduced into an M13 helper phage as a selection for mutants with improved performance. The phagemid system of random mutagenesis should be a powerful tool for modification of enzymatic activity, for altering regulatory sequences, and for genetic and structure-function analysis.

### **The BEACONS Project: Positive Behavioral Supports in Washington's Public Schools**

*Charlyn Johnson, Senior, Speech Communication, Spanish*

*Zesbaugh Scholar*

*Mentor: Douglas Cheney, Education*

The purpose of the BEACONS Outreach Project (Behavioral, Emotional and Academic Curriculum for the Ongoing Needs of Students with or at risk of developing emotional/behavioral disabilities) is to establish positive behavioral supports in school districts throughout the state of Washington. Through the use of school wide and individualized approaches, positive behavioral supports (PBS) address significant social and educational outcomes while also precluding students' problem behaviors. This session will summarize findings from the project in the areas of school wide assessment and progress, as well as student level assessment and progress. Each participating school chronicles the nature and incidence of office discipline referrals (ODR) to verify the efficacy of their school wide PBS program; and this measurement is used to calculate administrative and instructional time gained as a result of any decreases in ODR. Students are also annually evaluated on their academic, social, and emotional performance through assessments such as the Social Skills Rating Scale (SSRS), and students identified as being at high risk of emotional/behavioral disorders (EBD) receive evidence-based interventions. Leadership teams at each school ensure the effective implementation of PBS programs and assess the school's overall performance with

students, staff, and families on a yearly basis. Currently, 13 elementary schools from six school districts across the state are participating in the BEACONS Outreach Project, and results from their efforts in the project will be presented in this session.

### **3-Dimensional Organization of Telomeres: A Recombination Based Genetic Assay**

*Elizabeth Johnson, Senior, Biochemistry*

*Mary Gates Scholar*

*Mentor: Daniel Gottschling, Genome Sciences*

The eukaryotic nucleus is thought to be organized into chromosomal domains. For instance, by microscopic methods, the 64 telomeres of *Saccharomyces cerevisiae* are visualized to be in 6 – 8 clusters at the nuclear periphery. Another surprising indication of nuclear organization is the finding that while telomeres may replicate at any time of the cell cycle, the telomeres on any given chromosome replicate simultaneously. In order to begin to understand the mechanism by which this organization occurs, we have developed a genetic assay that can determine whether or not the ends of each chromosome are in close proximity. Two nonfunctional alleles of LYS2, an auxotrophic marker, have been inserted at strategic locations near the telomeres of chromosomes V and VI. Each allele has a frame shift mutation caused by insertion of a few nucleotides, one near the 3' end, and the other near the 5' end. Recombination between the mutations yields a selectable phenotype (lys<sup>-</sup> to LYS<sup>+</sup>.) Rates of recombination are predicted to increase if the insertion sites are in close physical proximity to one another. Preliminary data indicates that both position and orientation influence rates of recombination. Strains containing only one allele convert to LYS<sup>+</sup> on the order of one event per 10<sup>7</sup> cells. Strains containing both alleles range from one to 200 events per 10<sup>7</sup> cells, depending on chromosomal location of the alleles. This suggests that the assay may indeed reflect chromosomal organization and be useful for ultimately dissecting how this organization occurs.

### **Expression of Human Nucleoside Transporters in Transgenic *Xenopus laevis***

*Lisa Johnson, Senior, Cellular and Molecular Biology, Philosophy*

*Mentor: Aimee H. Bakken, Biology*

The major aim of this project has been to create a non-human model system for studying the localization, and mechanisms of action of wild type vs. mutant human nucleoside transporter proteins. Human intestinal cells have a very poor ability for *de novo* nucleoside biosynthesis. Thus, they depend on uptake of nucleosides from the intestinal lumen as food passes through it. Two classes of nucleoside transporters are known to carry out this uptake in the human small intestine – equilibrative transporters (ENTs) which are found in all cells, and concentrative (Na+

dependent CNT) transporters which are thought to be found in the brush border membranes of tissues that are specialized for uptake. We have used the mature eggs from *Xenopus laevis* to generate transgenic frogs, which carry GFP-labeled cloned human nucleoside transporters of both classes (through microinjection of sperm nuclei, plus the cloned-GFP-tagged genes, which then fertilize the eggs). A rat promoter has been used to successfully activate the human nucleoside transporter genes in our transgenic *Xenopus* embryos and tadpoles. The expression of hENT-1 has been detected at days 4-12 of tadpole development. Immunohistochemical staining of control tadpole intestinal sections with an antibody against hENT-1 shows positive staining in the enterocytes suggesting that the antibody cross-reacts with a previously unidentified *Xenopus* ENT-1 transporter. Further studies will ask: 1) are nucleoside transporters expressed ONLY in the small intestine of *Xenopus* or also in other highly absorptive tissues (kidney and liver) 2) comparison of the cellular localization of ENT-1 vs. CNT-1 transporters – are they polarized as in humans? and 3) characterization of RNA transcription and translation along the length of the intestine and over time in development.

### **Culture Codes in the Christian Ritual of “Holy Communion”**

*Ingrid Johnston, Senior, Speech Communication*  
*Mentor: Lisa Coutu, Communication*

Communicating with people who hold different beliefs can be a challenge, one often filled with anxiety or uncertainty. However, if one understands another person’s beliefs, uncertainty and anxiety can be reduced. For this reason I ask the question: How does the specific American Catholic Church, the Newman Center, enact the ritual of “Holy Communion” and what does “Holy Communion” mean to the people of that specific church? This question reduces anxiety by helping one know a community’s beliefs and practices. Therefore, this study is important because being aware of how the Newman Center talks about and enacts “Holy Communion” and knowing what “Holy Communion” means to them promotes understanding of how one religious group practices a part of its faith. This understanding has the potential to lead to more open dialogue between different religious groups, benefiting the larger religious community’s knowledge of the Catholic Church. This study focuses on finding the speech code (a distinct way a community talks about a certain subject) and its meaning (the significance that group attaches to the speech code or talk) of the Newman Center’s communication about and of “Holy Communion” or “communion.” I intend to discover the significance and importance that “communion” plays in the life of participants of the Newman Center by using Ethnography of Communication. This method will entail conducting 12 participant observations of mass services held at the Newman Center, along with 8 interviews discussing

“communion” with 5 participants of mass and 3 staff at the Newman Center. With careful, meticulous observations and in-depth interviews this study will provide a thorough analysis of “communion” and it’s meaning at the Newman Center.

### **LiquidBrowse: Using Interface Continuity to Improve Web Browsing**

*Ethan John, Senior, Computer Science*  
*Mentor: David Hendry, Information School*

When browsing the Web, users are often confronted with the issue of interface discontinuity. Clicking on a link or requesting a new web page is often done blind – users have very foreknowledge of what they will see after committing to the new page. To make matters worse, the Internet changes constantly, and users are often presented with new locations that contain new content. What a user remembers from yesterday is not necessarily what they will see today. Similarly, users often seem to have a difficult time navigating browser history based only upon page titles and a vague sense of chronology. It would be extremely desirable to give surfers a chance to preview new content while removing the sense of committal that comes with loading a new page or following a link. Previews could take many forms, though our current ideas involve overlaying semi-transparent versions of past or future pages in order to give users a clear view of what’s coming, without completely removing them from the scope of their starting page. To investigate how previewing pages would improve web browsing, we will be building a browser that attempts to alleviate these problems through the judicious use of transparency and animation using the OpenGL graphics technology. After completing this prototype, we will be conducting user tests in an effort to better understand how these methods might actually impact everyday users. Through this research, we would like to better understand how users browse the web, whether certain types of browsing are preferred for certain tasks, and whether the principles of continuity are worth investing in other forms of interface design.

### **Prenatal Syphilis Screenings In Mozambique Africa**

*Andrea Jones, Junior, Cellular and Molecular Biology*  
*Mary Gates Scholar, Space Grant Scholar*  
*Mentor: Steve Gloyd, School of Public Health and Community Medicine, Health Alliance International*  
*Mentor: Tom Martin, School of Public Health and Community Medicine, Health Alliance International*

Health Alliance International is a nonprofit 501(c)(3) organization incorporated in the State of Washington, USA, and registered with the U.S. Agency for International Development. HAI provides technical and material assistance to government and community institutions to evaluate, strengthen, and sustain effective health services, as well as focus on changing the inequitable conditions

that contribute to poor health. Syphilis is a sexually transmitted disease that can negatively affect the health of women and their unborn children. If detected early and treated, mothers can give birth to healthy babies and remain healthy themselves. In Mozambique, Africa, as women come in for their first prenatal screenings they are administered a syphilis test. It is important for women to come to the prenatal clinics and be screened for syphilis as early as possible because the infection gains access to the fetus very early on in untreated syphilis pregnancy and can result in severe birth defects and stillbirths. It is also important once a woman has tested positive for syphilis to have her sexual partner(s) notified so that they can receive treatment and stop the spread of the infection. HAI has been collecting data on syphilis testing and treatment from many prenatal clinics in Mozambique for almost 10 years. This data contains a wealth of information that can enable HAI to better understand the effectiveness of screening efforts at the different health care facilities in Sofala and Manica provinces, as well as the overall prevalence of the disease in the two provinces. My research goals were to organize the data in a fashion that enables more efficient analysis and easier interpretation for a variety of audiences.

#### **Is Temporomandibular Disorder Genetic?: A Twin Study Using the University of Washington Twin Registry**

*Merri Jones, Senior, Dental Hygiene*

*Mentor: Jack Goldberg, Epidemiology*

Temporomandibular disorder (TMD) is a complex condition of unknown origin. The role of genetic factors in this disorder is poorly understood. This study examined the genetic influence of TMD by studying a population-based sample of monozygotic (MZ) and dizygotic (DZ) twins in Washington state. Data come from a mail survey of adult twin pairs in the University of Washington Twin Registry. In the survey, twins are asked if they had a physician-diagnosis of TMD. The MZ and DZ twin concordance rates for TMD are compared to determine the genetic influence on TMD. MZ twins share 100% of their genes, while DZ twins share on average 50% of their genes. A difference in concordance rates, with MZ twins being more concordant for TMD than DZ twins, is an indication of genetic influence. In total, 641 MZ and 446 DZ twin pairs participated in the study. The overall prevalence of self-reported physician-diagnosed TMD is 4%. The concordance rate for TMD is 28% in MZ twins and 9% in DZ twins; this study is statistically significant ( $p=0.05$ ), suggesting a genetic influence on TMD. This study is one of the first to identify genetic factors contributing to TMD. Further twin studies with larger and more precisely defined phenotypes might examine the genetic influence on subtypes of TMD, such as myofascial pain, internal derangement of the joint from injury, and degenerative joint disease as the result of osteoarthritis and rheumatoid arthritis.

#### **The Expression of Six3-Cre and its Degree of Colocalization with Tyrosine Hydroxylase in the Developing and Adult Mouse Brain**

*Jenny Kam, Senior, Biology and Zoology*

*Mentor: Claire Cannon, Biochemistry*

Expression of the homeobox gene *Six3* is necessary for the formation of the eyes and ventral forebrain. Here, we crossed genetically modified *Six3-Cre* mice that express the bacterial enzyme Cre-recombinase under the direction of the *Six3* promoter to mice that carry the Rosa26 reporter. In those progeny with both modifications (*Six3-Cre X Rosa26R*), a loxP-site-flanked *lacZ* gene was transcribed to produce the enzyme  $\beta$ -galactosidase ( $\beta$ -gal) only in cells in which Cre-mediated recombination had occurred. In other words,  $\beta$ -gal was a marker for *Six3* gene expression that may have occurred at any time during the life of the mouse. Using double immunohistofluorescence, we colocalized  $\beta$ -gal with the enzyme tyrosine hydroxylase (TH), a marker of catecholaminergic neurons. Specific staining for  $\beta$ -gal was observed in predicted areas such as in the hypothalamus, cortical layers II/III and V and hippocampus. In addition, we observed specific  $\beta$ -galactosidase in midbrain and brainstem areas, particularly the locus coeruleus (A6), where TH and  $\beta$ -gal were highly colocalized. The consistent, regionally specific expression pattern of *Six3*, demonstrated here for the first time in adult mice, suggests that the *Six3-Cre* mouse could be a useful tool for site-specific genetic manipulation of certain catecholaminergic and non-catecholaminergic cell groups in the mouse brain.

#### **Chromosome Segregation in the Nematode *C. elegans***

*Alexia J. Katzaroff, Senior, Biology, Spanish*

*Mary Gates Scholar*

*Mentor: Mark Roth, Biochemistry*

Chromosome segregation is a process essential for life. Improper segregation of the chromosomes during mitosis can cause drastic problems, including cell lethality and cancer. To better understand this fundamental process, we are using the nematode *C. elegans* as a model organism for examining genes required for chromosome segregation. *C. elegans* has very large centromeres that run the entire length of the chromosome, allowing for easy viewing under a microscope. In addition, *C. elegans* permits RNA-mediated interference (RNAi) which can be used to reduce expression from any gene. Using RNAi, we have identified several genes required for successful chromosome segregation. These mutants show a missegregation phenotype that includes severe anaphase bridging, which results in nuclei of irregular and random sizes within embryonic cells. To further characterize these genes, we are using antibodies against previously characterized centromeric proteins to examine how these components are affected by the RNAi. In addition, we are attempting to raise antibodies against the proteins encoded by these

genes in order to study the localization of these proteins in cells. Such antibodies will also be used to examine other chromosome segregation mutants and to identify relationships amongst the genes required for proper chromosome segregation, expanding our understanding of this essential process.

### **Effects of Erythropoietin on Neonatal Hypoxic Ischemic Brain Injury**

*Brian Kellert, Junior, Cellular and Molecular Biology, Biochemistry*

*Mary Gates Scholar*

*Mentor: Sandra E. Juul, Pediatrics*

Erythropoietin (Epo), a hormone that promotes red blood cell proliferation, has been shown to decrease brain damage in adult models of brain injury. Little is known about its effects in neonates. We hypothesized that Epo would reduce brain injury in a neonatal model of hypoxia-ischemia (HI). Our objective was to determine whether Epo treatment preserves brain size and neuron count following unilateral brain injury in a neonatal rat model of HI. Under anesthesia, the right carotid arteries of seven day-old rat pups were tied off. Animals were then exposed to 8% oxygen (room air is 21%) for 90 minutes, followed by daily injections of Epo (2,500U/kg) or placebo for three days. Animals were euthanized on day thirty, and the brains fixed for later study. Whole brain hemispheres were compared and scored (0=no injury, 4=severe atrophy with cavities > 3mm wide). Coronal sections were analyzed using Soft Imaging analySIS software. Right and left hemisphere areas were measured at two levels (anterior and posterior), and a ratio was determined, creating a metric for the degree of injury on the side of carotid artery ligation. Dopaminergic neurons were stained using tyrosine hydroxylase (TH). Count per area was then determined for each hemisphere. The mean whole brain hemisphere score for was for Epo-treated animals was  $0.8 \pm 0.6$ , compared to  $2.4 \pm 0.8$  for the placebo group. The area ratio was 0.78 vs. 0.68 in Epo vs. placebo-treated animals, respectively. TH neuron<sup>2</sup> of Epo animals were  $1.72 \pm 0.90$  vs.  $0.65 \pm 0.30$  in placebo animals, ( $p < 0.06$ ). The lower overall injury score for Epo-treated animals suggests a reduction of brain injury. The higher ratio of injured to control hemispheres shows decreased injury in the Epo group. The preserved dopaminergic neuron density in Epo treated animals shows specific protective effects in these neurons. This preliminary data suggests that Epo reduces HI brain damage.

### **Trauma Narratives, Emotional Processing, and PTSD**

*Zena Jihyun Kim, Senior, Psychology*

*Mary Gates Scholar*

*Mentor: Lori A. Zoellner, Psychology*

Characteristics of the organizational structure of traumatic events has been closely associated with the development and maintenance of posttraumatic stress disorder (PTSD,

Amir et al., 1998, Foa et al., 1995). Specifically, disorganized and fragmented trauma narratives recounted by individuals with PTSD may indicate disturbed emotional processing and memory encoding, and further may contribute to the maintenance of PTSD. Yet, studies to date have not employed important methodological controls, such as including trauma exposed individuals without PTSD and non-traumatic narratives. In this study, female assault survivors with and without PTSD recounted both neutral and traumatic events. The structure of both neutral and trauma narratives were analyzed through an objective text analysis program (LIWC; Pennebaker and Francis, 1999), which allows for exploring both thematic content and narrative grammatical structure. We will present data comparing trauma narratives with neutral narratives and comparing narratives of individuals with PTSD to those without PTSD. The findings may suggest that the organizational structure of trauma narratives, or how the traumatic event is laid down in memory, may be important for the development and maintenance of PTSD. Further, the focus on organizing and integrating the trauma memory may have important implications in the treatment of chronic PTSD.

### **Responses of Hippocampal Interneurons to Changing Visual Environments**

*Michael King, Senior, Psychology*

*Mentor: Sheri Mizumori, Psychology*

The hippocampus is widely believed to be important for spatial learning and memory. Hippocampal pyramidal cells ("place cells") tend to increase their firing rates as rats move through specific environmental locations ("place fields"). Place cells most likely form a representation of context that rats use to guide their behavior. The firing rate of most interneurons is correlated with a rat's movement velocity and acceleration, and most of those ("theta cells") fire synchronously with a 4-12 Hz oscillation of the hippocampal EEG. Theta cells may help to define place fields by gating place cell activity. We previously reported that the firing patterns of place cells become less spatially specific when rats perform a spatial memory task in darkness, and that this change correlates with task performance. We predicted that changes in interneuron firing might accompany changes in place cell firing. To test this hypothesis, we recorded the extracellular signals of 104 theta cells and 26 non-theta interneurons from 13 rats performing a spatial working memory task on a radial maze. Rats performed 5 baseline trials, followed by 5 trials in one of three conditions: no visual cue manipulation, lights out, or rotated cues. Each cell's firing rate was correlated with the rat's velocity and acceleration for each block of 5 trials. Changes in these correlations across blocks were tested for significance with a Wilcoxon sign-rank test. Chi square tests indicated that a greater proportion of theta cells changed their velocity and acceleration correlations during dark trials than after no

manipulation or cue rotations. There were no significant changes in the proportions of non-theta interneurons that changed their correlations. These data support the idea that place cells and theta cells cooperate to define context, and that non-theta cells have a more general role in representing movement information that stays constant across contexts.

### **HIV/AIDS and the Contagion of Liberal Interiority: Rethinking the Politics of Intimacy**

*Preetma Kooner, Junior, Microbiology, Comparative History of Ideas*

*Mary Gates Scholar*

*Mentor: Chandan Reddy, English*

In this study, the main goals were to use different types of discourses on HIV and AIDS to understand how infection and disease are connected to liberal ideas in creating the liberal citizen-subject. The findings indicate that health and medicine, through normalization, liberal intimacy, and creation of the Other (in this case, the HIV subject) work to define how an individual must function to be a liberal citizen-subject and therefore function through the collective. Different types of discourses were chosen that would reflect how three significant components of the HIV and AIDS discourse operate. The popular discourse was represented by the New York Times' coverage of the Nushawn Williams' case, the medical and social science narrative was taken up by "AIDS in the HAART Era", and finally The Deal: A 'Zine to Live By served as example of prevention and awareness discourses. The examination these discourses proved that HIV infection functions as a means of reflecting the teetering balance one stands on as a liberal subject. HIV and AIDS act as opposition to liberal ideals. HIV lies as the border-zone of what constitutes a person and what does not. As HIV and AIDS developed significance to the US public in the late 1980's, being infected or dying of AIDS became a marker for marginalized people who would otherwise not be visible. Thus HIV and AIDS do not serve to simply create a marginal group but separate them from the greater community. The significance of understanding how HIV and AIDS narratives work is that they illuminate the racialized categorization and division that liberalism is predicated upon. HIV and AIDS have created a new form of race that uses science and medicine to justify its labeling, yet ultimate goal of inclusion through the construct of the liberal citizen-subject.

### **An Extensive Study of the Rapid Trap Movements of *Dionaea muscipula*.**

*Shane O. Krolkowski, Senior, Botany*

*Mentor: Rainer Stahlberg, Biology*

*Mentor: Elizabeth Van Volkenburgh, Biology*

The Venus' flytrap, *Dionaea muscipula*, has been studied extensively by various researchers. Among the suggested

mechanisms for trap closure are rapid shrinking of the upper (inner) or rapid expansion of the lower (outer) epidermal cells. Here we report new results that may contribute to a better understanding of the mechanics of trap closure. Touching one of the 'trigger hairs,' located on the upper side of the traps, twice consecutively causes the trap to close. However, if a hair is touched two times with an interval of approximately 45 seconds, the trap will have no response. This allows us to suggest that there is a build up of either chemical or electrical signals that contribute to the cause of trap closure. After removing these hairs, touching of the trap is no longer sufficient to close it. Closure can only be brought on by the wounding of trap leaves or the offering of proteins in solid or liquid form. On a microscopic level we studied thin epidermal sections made from the lower side of a trap. We found small green vacuoles that change size and color when the trap closes and also when exposed to HNO<sub>2</sub> acid. It is known that low pH concentrations induce cell expansion. These vacuoles do not fluoresce red when excited by ultraviolet light (like chloroplasts would) and do not disappear after freezing (like normal vacuoles would). We believe that rapid trap closure is much more complicated than suggested before. More studies are needed to figure out what causes the cells to expand in the first place, the purpose of the 'trigger hairs' in this process, and what the role of the small green vacuoles is in the whole scheme of trap closure.

### **Molecular Phylogenetic Studies of Section *Pentathera* and Subgenus *Hymenanthes* in Genus *Rhododendron* Using the RNA Polymerase II Subunit Genes**

*Jiro Kusunose, Senior, Bioengineering*

*Junyuan Hu, Junior, Biology, UW World Wide Program*

*Mentor: Benjamin Hall, Biology and Genome Science*

The *Rhododendron* is a flowering woody plant, with over 800 known species worldwide. These species are categorized into 8 subgenera, according to their flower and foliage traits. In the past, phylogenetic trees (similar to family trees) describing species relatedness have been constructed based strictly upon physical characteristics. However, advances in DNA sequencing technology make it possible to amplify genes, sequence them and use the sequence to infer a phylogeny. Recent studies conducted in Japan, China and here at UW, using this method, have revealed that section *Pentanthera* and subgenus *Hymenanthes*, two groups with very different appearances, are in fact very closely related. Both groups share unique features in their genes that none of the other *Rhododendrons* carry, suggesting a close common ancestor. By sequencing and aligning their RNA polymerase subunit II (RPB2) genes, and by constructing a phylogenetic tree based upon this data, we hope to determine which species of *Hymenanthes* and *Pentanthera* are least diverged from that common ancestor. We are currently studying 19 *Hymenanthes* and 6 *Pentanthera* species for this project.

Initial results suggest that the *Hymenantes* and *Pentanthera* species of Japan, Taiwan and South-Eastern China are the ones most closely related to the common ancestor. At the symposium, we hope to identify those species least diverged from this ancestor, and to indicate the geographical area where this occurred.

### **Tissue Engineering of the Esophagus: Epithelial Interactions with a Cell-Extracted Esophagus**

*Tess C. Lang, Junior, Neurobiology*

*Howard Hughes Scholar, McNair Scholar*

*Mentor: Cecilia M. Giachelli, Bioengineering*

The stomach, jejunum, or colon are often used as replacements for the esophagus. However, complications associated with these substitutes necessitate the need for a tissue-engineered esophagus. Previous research in our group has focused on developing a cell-extracted esophagus as a potential replacement scaffold. The purpose of the current study was to evaluate epithelial interactions with this acellular matrix towards the eventual goal of a complete replacement esophagus. Rat esophageal epithelial cells (REEC) were seeded onto the acellular esophagus and raised to the air-water interface on day 4. The samples were fixed on day 11 and analyzed by staining with Hematoxylin and Eosin (H&E). The cells showed excellent morphology, with both stratification and keratinization. Characterization of the cell constructs was done by analyzing protein expression using immunocytochemistry. All cells stained positive for the general cytokeratin marker (AE1/AE3). Expression of the basal cell marker, cytokeratin 14 (CK14), seemed to be limited to lower cell layers, but was not distinctly confined to the basal layer. A proliferation marker, Ki67, demonstrated that the basal cells were proliferating. In conclusion, our results show that the acellular esophagus supported REEC proliferation and differentiation similar to that seen in the native esophagus. (Supported by the Singapore-University of Washington Alliance and the UWEB USIRP program)

### **Cooling Micro Electronics using Corona Propulsion**

*Sam Larson, Senior, Electrical Engineering*

*Mary Gates Scholar*

*Mentor: Nels Jewell-Larsen, Electrical Engineering*

The design and fabrication of a corona air propulsion micropump for enhanced cooling of microelectronics is presented. A novel MEMS-scale design is introduced to minimize operating voltage. Finite element electrostatic simulations suggest corona onset to occur two orders of magnitude below that of classical electrostatic blowers. The device is comprised of parallel traces, in a blade to plane configuration, producing entrained airflow across the substrate. Several variations of the design are constructed, employing a basic photolithography process. The ongoing phase of research involves evaluating anemometric,

current-voltage, and thermal transfer characteristics of the first prototypes.

### **The Effects of Light of Various Wavelengths and the Presence of Oxygen on Lactone Synthesis**

*Christal Lee, Senior, Chemistry*

*Mary Gates Scholar*

*Mentor: Gamal Khalil, Chemistry*

The Gouterman and Khalil research group synthesizes porphyrin complexes for incorporation into sensors such as pressure sensitive paints. These sensors detect changes in pressure or temperature using the porphyrin's ability to absorb and emit visible and near infrared (NIR) light. The motivation behind this current project is to synthesize stable porphyrin derivatives, known as monolactone and dilactone, which will have the ability to absorb and emit at higher NIR wavelengths. This property is desired because it increases sensor sensitivity. It is also valuable to the development of sensors that require an effective synthesis procedure in which product yield is maximized. The reaction of tetra(pentafluorophenyl)porphyrin (H<sub>2</sub>TFPP) with certain reagents produces monolactone and dilactone as well as various other porphyrin derivatives, which have demonstrated emission in the NIR. Understanding of this reaction mechanism will assist in determining ideal experimental conditions to efficiently synthesize lactone products. To determine possible reaction mechanisms, the reaction conditions are varied to test the effects of light and oxygen on reaction progression. The light experiments will consist of exposing the reaction vessel to various wavelengths of light. It has been observed that the presence of specific wavelengths of light appears to hinder the reaction by slowing the reaction rate. The presence of atmospheric oxygen may also affect the reaction rate. If oxygen participates as a reactant, it is hypothesized that the reaction may not proceed in its absence. Nitrogen gas will be used to eliminate oxygen from the reaction vessel. In each experiment, reaction progression is determined by spectroscopic identification of derivatives in the product mixture. Current efforts are directed at purifying and positively identifying reaction products. The results of this research will facilitate the development of photosensitive dyes that will be incorporated into photovoltaic cells and NIR sensors for oxygen, ammonia, carbon dioxide and temperature.

### **Rebooting Youth Political Engagement: The Potential of the Internet**

*Christine Lee, Political Science, Communication*

*Mentor: W Lance Bennett, Political Science*

Participation in traditional politics such as voting has declined among all age groups since the 1970s, yet the decline is most prominent among current youth (18-25 years old). Some attribute this political disengagement to the nature and tendencies of young people, but this claim

is inaccurate as studies show today's youth is more significantly disengaged than the youth of previous generations. A step towards a potential solution to the youth political engagement crisis may lie within the Internet, as young people tend to gravitate towards the Internet and view the World Wide Web as a highly valuable source of information. However, it is unlikely that traditional political websites such as election campaign sites personalize and direct messages to the youth. If this is the case, the potential for the Internet to increase youth political engagement appears to be vastly underused. This project will first investigate the 2002 Youth Political Web Sphere (archival collection of prominent youth-oriented political websites) to identify discourse, content, and features that appeal to youth. The study will then examine the 2002 Election Web Sphere (archival collection of the U.S. congressional and gubernatorial election campaign websites) for the existence of such youth-friendly content and features and analyze whether these campaign sites possess characteristics that appeal to young people. Additionally, the project will also examine the 2004 Youth Political Web Sphere (personally archived collection of the same prominent youth-oriented political websites) for discourse, content, and features and will analyze whether this web sphere has maximized the Internet's potential since 2002. These results combined with an overall analysis of the project will then be used to discuss prospective patterns (for example, the 2004 election campaign websites) and further implications for the Internet's potential role in increasing youth political engagement.

### **Supporting Floating Point Signal Processing Applications on FPGAs**

*Henry Lee, Senior, Electrical Engineering*

*Mary Gates Scholar*

*Aaron Wood, Junior, Electrical Engineering*

*Mentor: Scott Hauck, Electrical Engineering*

We live in a world of cell phones, PDAs, iPods, and myriads of other personal electronic devices. All of these devices claim to be ultra light and ultra portable, but what we end up carrying around is pocketfuls of disparate items. Through the emerging design paradigm of reconfigurable computing, it will be possible to create sophisticated composite devices with all of the capabilities of the different personal electronic devices available today. Reconfigurable computing is becoming feasible through chips known as field programmable gate arrays (FPGAs). These chips contain millions of gates, logic units and interconnecting wires that can be reconfigured (or reprogrammed) to perform any kind of computation. Before FPGAs are capable of fulfilling their potential in reconfigurable computing, however, there are certain issues that must first be resolved. To support computationally complex applications such as multimedia, FPGAs must be able to perform fast floating-point operations. Unfortunately, floating-point operations in FPGAs involve

complex algorithms built from simpler integer arithmetic units and additional supporting logic. To overcome this weakness in FPGAs, we investigate efficient implementations of floating point operations onto these devices, including rounding schemes to meet existing floating-point standards. With the foundation of optimized adder and multiplier hardware specifically for FPGAs, we strive to contribute to the foundation of reconfigurable computing and realize its full potential for a variety of applications.

### **Cellular Mechanisms of Ascidian Endoderm Invagination**

*James Lee, Senior, Cellular and Molecular Biology*

*Mary Gates Scholar*

*Maria-Jose Bravo, Junior, Cellular and Molecular Biology*

*Howard Hughes Scholar*

*Tammie Robinson, Senior, Cellular and Molecular Biology*

*Howard Hughes Scholar, Mary Gates Scholar*

*Ryan Gile, Post-baccalaureate, Center for Cell Dynamics*

*Howard Hughes Scholar*

*Mentor: Garrett Odell, Biology*

*Mentor: Edwin Munro, Biology*

*Mentor: George von Dassow, Biology*

*Mentor: Kristin Sherrard, Biology*

Invagination is a dynamic process in which a sheet of cells bends inward, moving its component cells into the interior of the embryo. Despite considerable experimental and theoretical attention, the cellular and mechanical basis for invagination is still not known. We have studied ascidian endoderm invagination, the first step of gastrulation, which leads to the formation of the gut. We used time-lapse microscopy to document the pattern of cell shape changes that accompany endoderm invagination within intact embryos. In particular, we observed a pattern of nuclear descent within endoderm cells (from the apical surface to the basal interior) during invagination that has not been described previously. We also examined the behavior of isolated vegetal plates (that contain mostly endoderm) and individual isolated endoderm cells. We found that vegetal plates invaginate normally, while isolated endoderm cells displayed patterns of cell shape change and nuclear movement reminiscent of endoderm cells during invagination in whole embryos, suggesting that the forces driving invagination are intrinsic to these cells. To explore the cytoskeletal basis for these changes, we used confocal microscopy to examine embryos that were fixed during invagination and stained for filamentous actin and microtubules. Our observations contradict, rather than support, existing theories of invagination. However, we did observe prominent clouds of cytoplasmic F-actin associated with the microtubule organizing centers that flank nuclei. These clouds appear to connect to one another

through points of contact between neighboring cells to form a meshwork that spans the endoderm plate. We speculate that this meshwork could generate components of the forces that contribute to invagination. Finally, we used a computer model to explore how various hypothesized interactions among different cellular components could account for the invagination of a sheet of cells. Future studies will incorporate our observations of ascidian endoderm cells into this model.

### **Study of SirT1 Function in Regulating Senescence and Longevity in Mice**

*Jennifer M. Lee, Sophomore, Neurobiology*

*Mary Gates Scholar*

*Mentor: Yansong Gu, Radiation Oncology, Immunology*

SIRT1 is the mammalian homologue of the yeast *Saccharomyces cerevisiae* gene Sir2. The Sir2 family genes play important roles in gene silencing and have been implicated in cell cycle regulation and DNA repair. Perhaps the most intriguing discovery thus far is that overexpression of the SirT1 gene significantly extends the lifespan in both yeast and the worm *C. elegans*. Consequently, study of the mammalian homologues of the Sir2 family genes has become the focus of our research. We have generated SirT1-deficient mice, which display abnormalities including elongation of atrioventricular valves in the heart and abnormal closure of the optic fissure. We suspect that these phenotypes represent the effects of early aging due to the loss of SirT1 function. To further explore the role of SirT1, we have developed a model that allows us to analyze the phenotypic effects of SirT1 gene expression in spatial and temporal manners. A crucial component of our research depends on accurate detection of a combination of deletion events. To accomplish this, our method employs a common 5' primer and two strategically located 3' primers that amplify pre-determined regions of the SirT1 gene, thus revealing whether the mice possess wild-type, conditional, or knock-out alleles. Our preliminary results demonstrate that we can successfully identify each allele separately. Once this new genotyping method has been refined to distinguish all three alleles in a single reaction mixture, we will be able to more efficiently identify which mice have deletions and begin organ-specific deletions. Knowledge of the genotypes will enable us to study the resultant phenotypic effects of organ-specific deletions and eventually correlate how the aging of vital organs contributes to the lifespan. This work sets the stage for exciting future research into the exact function of SirT1 in individual organs at specific stages of the adult life.

### **Spirituality, Mindfulness and Substance Abuse**

*Janis Leigh, Senior, Psychology*

*Sarah Bowen, Graduate Student, Psychology*

*Mentor: G. Alan Marlatt, Psychology, Addictive Behaviors Research Center*

Recent studies suggest that mindfulness-based therapies may be effective in treating several disorders. However, mindfulness methods are applied somewhat differently by therapy making the task of interpreting results and comparing findings difficult. In addition, mindfulness as a construct has not yet been operationalized, although efforts to do so are currently under way. It is hoped that the present study will contribute to efforts aimed at operationalizing mindfulness by: 1) testing the reliability and validity of a new mindfulness measure called the Freiburg Mindfulness Inventory (FMI); 2) including spirituality measures to explore the relationship between mindfulness and spirituality (e.g., Spirituality Assessment Scale), and 3) determining whether mindfulness and/or spirituality serve to buffer or mediate cigarette smoking and alcohol use. Undergraduate students currently enrolled in an Introductory Psychology course at the University of Washington (N=196) completed the FMI and spirituality measures, and provided information on their tobacco and alcohol use. It is hypothesized that higher levels of mindfulness and/or spirituality will correlate with low levels of tobacco and alcohol use, and associated problems. Analysis of the data is currently in process.

### **Listening to Another's Distress: Responses and Consequences**

*Tiffany Lewis, Senior, Speech Communication*

*Mentor: Valerie Manusov, Communication*

It has been shown that when a distressed person talks about his or her distress, it may improve his or her physical and/or mental health. Though this may be healthy for the people who are talking, it may be unhealthy for those who listen to their distress. There are some characteristics of listening that may be linked to this burden on listeners, such as the listener's empathy, responses, and goals. The purpose of this project is to understand what characteristics of listening should be encouraged or avoided to protect the health of the listener, especially in everyday relationships. I am discovering this by surveying people about their experience listening to others talk about distressing events. The survey asks participants to take two weeks to be aware of when they listen to people who are distressed. Then they will complete a survey that asks them to describe the way that they listened and responded, how they approached the interaction, how responsible they felt for the distressed person, and how they felt about listening to the distressed person. The survey also has the participants answer questions that measure their empathy level.

### **Comparing Variation in DNA Sequences to Ascertain Species Boundaries in *Rhododendron* Subsection *Moupinensia***

*Shermi Y. Liang, Senior, Cellular and Molecular Biology*

*Xi Li, Junior, UW-Sichuan University Exchange Program Student, Arts and Sciences*

*Mentor: Benjamin Hall, Biology, Genome Sciences*

*Rhododendron moupinense* and the related species *R.dendrocharis* and *R.petrocharis* are native to China. Small, isolated populations of all three occur at numerous locations in central and western regions of Sichuan. Based upon their morphological similarities, these three species were placed in subsection *Moupinensia* of subgenus *Rhododendron*. In order to determine whether further subdivision (i.e. additional species) is warranted, we will measure genetic distances within and between species for multiple isolated populations of these *Rhododendrons*. For this analysis, one of the gene sequences used will be 1500 base pairs of an intron in *RPB2*, a gene that codes for the second-largest subunit of RNA polymerase II. While exons are highly conserved because of their important functions, non-coding introns are rapidly evolving and exhibit a high rate of nucleotide change. This characteristic of large introns makes them well-suited for achieving species-level resolution. Initial results on *RPB2* sequences from established clonal isolates available as nursery plants in the U.S. indicate that *R.dendrocharis* and *R.petrocharis* may be more closely related to each other than they are to *R.moupinense*.

### **Transcriptional Expression of Putative Iron Transport Genes in Group B Streptococcus**

*Robert M. Linville, Senior, Microbiology*

*Mentor: Craig E. Rubens, Pediatrics*

Group B Streptococcus (GBS) is the leading cause of neonatal sepsis and meningitis in the U. S. For other human pathogens, iron has been found to be very important for bacterial virulence in the human host. Within the GBS genome, three possible iron-transport systems have been identified and are currently under investigation for their role in iron uptake: ferric-hydroxamate uptake or *fhu*, ferric iron transport or *fit* and iron binding protein or *ibp*. We hypothesize that these genes may serve a role in the virulence of these bacteria. The goals of this work were to characterize and compare the expression of these groups of genes under iron-rich and iron-limited conditions, as limited environmental iron has been shown to induce iron-uptake mechanisms in other bacteria. Part of this investigation examined the transcriptional organization of the *fit* and *ibp* genes to determine whether each system's genes were transcribed as an operon. To do this, GBS cells were grown in iron-rich and iron-limited media and RNA was isolated from each sample at different stages of growth (early, middle and late logarithmic phase). This RNA was used in reverse-transcriptase polymerase chain reactions (RT-PCR), which demonstrated that all four genes of the *fit* system were co-transcribed on a single RNA

strand. At least two of the *ibp* genes were also co-transcribed. The RNA is also being used to perform qualitative Northern blot and Dot blot analysis, using DNA gene probes for *ibp*, *fhu*, and *fit* genes with a constitutive *rpsL* gene for a control, to identify differences in gene expression. Characterization of gene regulation in response to environmental iron will clarify their roles in iron-uptake and contribute to our understanding of iron utilization by this pathogen.

### **Telomere Length Measurement and Analysis by Quantitative PCR**

*Kenneth Liu, Senior, Bioengineering, Applied and Computational Mathematical Sciences*

*Howard Hughes Scholar*

*Mentor: Peter Rabinovitch, Pathology*

Telomeres are repeated DNA sequences located at the ends of eukaryotic chromosomes. These sequences are non-coding, yet they are crucial in maintaining the stability of the chromosome. It has been previously shown that telomere shortening is directly related to the process of aging and is a critical factor involved in the initiation of some tumors. Because telomere length is a good indicator of chromosomal stability, various techniques have been developed to measure the length of telomeres. Here, we present the use of Quantitative Polymerase Chain Reaction (Q-PCR) to measure telomere length. In Q-PCR, DNA amplification is monitored by the fluorescence of a reporter molecule. The amount of DNA produced during each PCR cycle is directly related to the increase in fluorescence of the reporter molecule. By using primers that specifically amplify the telomeric region and a second set of primers to amplify a single copy gene, the relative telomere length of each DNA sample can be approximated by taking the ratio of telomere length to single copy gene amplification. Because telomeres are hexanucleotide repeat sequences, the telomere primers are specially constructed so as to not be self-priming. Results from Q-PCR are not only reproducible and sensitive, but also closely resemble those from telomere restriction fragment (TRF) assays, a well-developed but more time-consuming technique for measuring telomere length, thus confirming the accuracy of telomere length measurement by Q-PCR. Application of this technique is not only limited to DNA samples; it can also be used directly on cells after sorting and Proteinase K treatment. The effectiveness of telomere length measurement by Q-PCR suggests the possibility of using Q-PCR in cancer research and medical diagnosis.

### **Electronic Placemat: A Sketching Application for Pen-and-Paper Games**

*Ian Li, Senior, Computer Science*

*Mary Gates Scholar*

*Mentor: Richard Anderson, Computer Science and Engineering*

Most research with pen-based computer applications have focused on informal work-oriented activities such as prototyping web sites and user interfaces, early design in architecture, and whiteboard tasks. I present a project to support a different informal activity, playing pen-and-paper games, to widen the target audience to include children. This project is called the Electronic Placemat (EP) and it is a Tablet PC application that allows two people to play games such as hangman and tic-tac-toe. I will discuss the issues in building EP to naturally support game play, such as creating a paper-like user interface, determining user intentions through their strokes, and supporting the interaction of two people playing on one Tablet PC. I will also address my observations of people playing pen-and-paper games both on paper and the Tablet PC and how it guided my development of EP.

### **Evaluation of Impact Potential of Wind Energy Conversion in the U.S.**

*Ben Long, Junior, Electrical Engineering*  
*Mentor: Kai Strunz, Electrical Engineering*

Wind energy conversion systems are increasingly of interest as a form of renewable energy because they are environmentally benign and do not require fossil fuel. Specifically, wind energy conversion feasibility is expanding. In order to determine the impact of wind generation on the future energy market, the average annual energy output of a wind turbine as a function of wind speed distribution and the wind turbine's characteristics is investigated. Then, for a common wind turbine design with an output power rating above 1 MW, the technical capabilities, efficiency, and predicted evolution are analyzed and results are normalized with respect to the output power rating of the wind turbine. With these results and research into future energy demands, an estimate for the quantity of, and feasibility for wind generation in the U.S. is predicted.

### **Design and Construction of a Langmuir Trough**

*Matthew Loo, Senior, Physics*  
*Mentor: Sarah Keller, Chemistry*

Lipids are amphiphilic molecules found in cell membranes. In the presence of water, lipids self-assemble into bilayer and monolayer structures. Studying the connection between lipid monolayer and bilayer behavior has a long history in the membrane community, and can provide useful information about lateral organization in both systems. For example tighter packing of lipids in a monolayer results in a lower area per molecule. To observe an area condensation in lipid monolayers at the air-water interface, a Langmuir trough is used to control and measure the surface pressure of the lipids. Isotherms measured with this common research tool help us create a thermodynamic model of lipid behavior in a monolayer. This poster documents my work building an automated Langmuir trough. My design

is based on a similar trough in the Vogel lab at the University of Washington. Using the CAD program Solidworks I created a digital prototype and blueprints of each part prior to construction. Costs for the materials and parts were estimated. Parts were assembled in the Physics department machine shop. Testing and calibration can be done using known pressure/area isotherms. Data acquisition and control are achieved with LabView software. Additionally, we will be able to use this trough to evenly coat cover slips with lipids or other amphiphilic substances using the Langmuir-Blodgett technique. Development of this apparatus will provide our lab with measurements of surface pressure and molecular area allowing us to probe lateral organization in lipid monolayers.

### **Chagas Disease and Leishmaniasis: Targeting Sterol Biosynthesis for New Drugs**

*Ashley Lundgren, Junior, Neurobiology, Germanic Language and Literature*  
*Mary Gates Scholar*

*Mentor: Frederick Buckner, Allergy and Infectious Diseases*

Leishmaniasis and Chagas disease are important causes of mortality in tropical regions of the world. The ultimate goal of this project is to identify new drugs that can be used to treat infections caused by *Leishmania* and *Trypanosoma cruzi*, the respective protozoan pathogens responsible for these diseases. The goal of this project is to study one of the enzymes involved in the sterol biosynthesis of these pathogens. Specifically, I cloned and expressed the lanosterol demethylase enzyme that is essential in the sterol biosynthesis pathway. This enzyme will now be inserted in a vector for expression in *E. coli*. The recombinant enzyme will then be available for enzymatic analysis and for screening of a compound library for inhibitors. I hope to identify inhibitors that are selectively active against the parasite lanosterol demethylase and that are minimally active against the corresponding mammalian enzyme.

### **Identification and Characterization of Wavelength-Shifted Variants of *Photinus Pyralis* Luciferase**

*Yi-Ching Lu, Senior, Bioengineering, Biochemistry*  
*Mentor: Francois Baneyx, Chemical Engineering*  
*Mentor: Elyse Shapiro, Chemical Engineering*

*P. pyralis* (firefly) luciferase catalyzes the oxidation of substrate luciferin that leads to the emission of yellow-green light (559 nm). Mutations were randomly introduced in the wild-type luciferase gene (*luc*) by using error-prone PCR. The mutated *luc* genes were placed under transcriptional control of the *trc* promoter. Plasmids were transformed into Top10 *E. coli* cells. After induction by IPTG and addition of luciferin, colonies of *E. coli* cells were screened for color variations. More than 50,000 colonies were screened for luminescence wavelength shifts. Four

mutants, with emission peaks occurring at 604 nm (orange-red), 605 nm (orange-red), 549 nm (green), and 540 nm (green), were identified and isolated. DNA sequencing of the wavelength-shifted variants revealed the mutations to be either single or double amino acid changes. Gene fusions between stress promoters and the luciferase gene can be used to detect and characterize antibacterial compounds. Efforts are underway to develop an integrated biosensing strain that is capable of detecting multiple cellular events.

### **Effects of Salinity on Survival and Reproduction of Phytoplankton and Copepods in Marine Closed Ecological Systems**

*Megan Mach, Senior, Biology: Conservation Biology, Ecology and Evolution*

*Mentor: Frieda Taub, Aquatic and Fishery Sciences*

Populations tend to increase until resources are exhausted, or some factor becomes limiting. For example, our human population is growing at an incredible rate, and may become limited soon. To test how organisms respond to these conditions, simulations can be developed in small, model systems. In this study, I established Closed Ecological Systems consisting of mixed phytoplankton, detritus, a salt water mix called "Instant Ocean," and the copepod, *Tigriopus californius*. The animals are tide pool copepods; in nature they must survive over a wide range of salinities because tide pools are subject to concentration by evaporation and dilution by rain. The salinities tested ranged from 32 ppt (normal sea water) to 128 ppt, and a set of variable bottles (starting at 32 ppt and slowly increased over time); each treatment has 3 replicates. At the highest two salinities, 96 and 128 ppt, the phytoplankton and *T. californius* were unable to survive and grow, showing the limit of their adaptation levels. At a salinity of 80 ppt the algae was undetectable but the animals were able to survive for a longer amount of time; unable to reproduce and eventually dying off. The lowest two salinities, at 32 and 64 ppt had algae and *T. californius* able to survive and reproduce normally during the length of the experiment. The bottles with varying salinities started out at 32 ppt and every week went up 15 ppt to see if a gradual increase would allow the *T. californius* to adapt and live at higher salinities. This experiment is just one of the first steps in developing systems which are optimal for sustained survival.

### **Double-to-Single Photoionization Ratio of Li at Medium Energies**

*Marleen M. Martinez, Junior, Pre-Engineering  
Space Grant Scholar*

*Mentors: Ralf Wehlitz, Physics, University of Wisconsin*

The double-to-single photoionization ratio of atomic lithium has been measured for photon energies ranging from 120 eV to 910 eV. Through the extensive use of various filters, we were able to significantly extend the previous range of measurements [M.-T. Huang et al., Phys.

Rev. A 59, 3397 (1999)]. We find that our data are in agreement with the predicted high-energy limit of 3.4%. By applying simple model curves to our data, we can also corroborate the idea that sequential processes contribute substantially to the double-photoionization cross-section ratio as predicted by theory.

### **Encouraging Children's Ecological Literacy through Informal Education: Developing Understanding and Care for Nature Outside of School Through Community-Based Programs and Places**

*Erika Anne Matthias, Senior, Landscape Architecture,  
Mary Gates Scholar*

*Mentor: Julie Johnson, Landscape Architecture*

Experts stress the importance of integrating ecological literacy (EL) into education systems, and that understanding of and care for one's environment is key to the development of the individual. While schools focus on formal education mostly inside classrooms, children need settings for informal environmental learning. I sought to identify approaches for the encouragement of EL through children's informal education. I present the idea that community centers and local park systems may serve as forums for such place-based learning and the development of attachment to place. This project began with a literature review of works relating to EL and nature education (including David Orr, *Ecological Literacy*; David Sobel, *Beyond Ecophobia*; Roger Hart, *Children's Participation*) and a paper synthesizing key findings. Findings included the importance of the following: early experience of and relation to nature, the care and guidance of a mentor, age/developmental appropriateness, and that of children's participation in community development and environmental care. With the idea that local parks systems and community centers may provide an appropriate setting for these approaches to community- and place-based learning, I proposed that fields of planning and design work to create programs and places to support this goal. I then focused on working with Seattle Parks Environmental Stewardship representatives to develop an understanding of their approach to EL and discuss my findings with them. We will spend the remainder of my project working together to create a program that works with the city's community centers to identify places and activities that incorporate learning and stewardship in their day camp and child care programs. We are aiming to create resources for each community center to use in the development of and programming for outside-of-school programs.

### **Maintaining Vision: An Investigation of Caspases and their Role in Lens Cells**

*Julia Mattson, Sophomore, Pre-Neurobiology  
Mary Gates Scholar*

*Mentor: John I. Clark, Biological Structure*

In humans, the leading cause of blindness worldwide is cataracts, the loss of transparency in the lens of the eye. The structure of the mouse lens is very similar to that of the human lens, and therefore can be used as a model to study lens transparency. Normal lens cell differentiation is associated with “modified” apoptosis, or cell death. In the lens, the nuclei are programmed to degenerate and to disappear from the lens cells but programmed cell death does not continue. The cells survive for decades without nuclei and maintain active metabolism, anaerobic glycolysis, without dying. Certain apoptotic enzymes, including caspases and calpains, in the normal lens have a natural function in development of lens transparency. Caspases, short for cysteinyl **asp**artate-specific **proteases**, are enzymes that cleave proteins at their aspartate residues and have cysteine in their active sites. Fourteen different caspases, as of now, have been discovered and placed into three broad categories: initiator caspases, effector caspases, and inflammatory caspases. Initiator caspases, which include Caspase-8 and -9, cleave effector caspases, such as Caspase-3, which in turn activate a series of proteins, ultimately leading to cell death. In my research, I have used Western blotting techniques to detect the presence of Caspase-8 in lens cortical cells where nuclei are degenerating. Caspase-3, -6, and -9 are under investigation, since they are all involved in the activation of Caspase-8. While caspases have been studied in the epithelial cells on the surface of the lens, this is the first study that will, define the function of caspases and modified apoptosis in development of lens transparency. My hypothesis is that caspase activity is necessary for differentiation of transparent cellular structure. Biomedical implications for this system include possible cataract inhibition by controlling caspase activity.

**Women’s Rights as Human Rights Realized?:  
Implications of the International Criminal Tribunal  
for Former Yugoslavia’s Conviction of Rape as a  
Crime Against Humanity**

*Meghan DuPuis Maurus, Recent Graduate, Political  
Science, Philosophy*

*Mary Gates Scholar*

*Mentor: Gillian Harkins, English*

This paper examines the effects of the International Criminal Tribunal for the Former Yugoslavia’s recent convictions of rape as a crime against humanity. The convictions represented the first time that anyone has been charged, tried, and convicted of rape in wartime. Advocates for the rights of “women” called the ruling a sweeping victory for the advancement of “women’s” rights. This study investigates the ruling and its effects for “women’s” rights. Central to the case is the effectiveness of the liberal subject. To what extent does liberalism’s notion of abstract personhood actually help “women” in wartime? Central to this research was an examination of the effectiveness of an abstract idea of rights, which this paper calls into

question, versus the material condition of people’s lives. Secondly, when the project of liberalism is flawed do you abandon liberalism? Is liberalism a step toward inclusion, or a means to neutralize oppressed peoples into appearing included while actually remaining excluded? The worry is that if liberalism is considered the only way to further enable people and improve peoples’ lives, then many will remain unprotected or empowered. Although the case was not without flaw, it was considered a victory for liberal notions of “women’s” rights. However, it did little to materially change the lives of women in war. The freedom from fear of sexual violence, which is a central tenet of human rights, remains unachieved for civilians in war or peace. In order to end this kind of violence the cultural aspects which make the act seem a viable tactic must be fought. After examinations of the effects of the cases as well as studying the discourse around notions of liberal rights I feel that although not worthless activists should not see this achievement as a total victory for women. Systems of power that condone or allow genocide via the female body, including liberalism, need to be deconstructed and changed.

**The Near-Bottom Current Regime and the Influence  
of the Benthic Nepheloid Layer on Transport and  
Accumulation of Particulate Matter in Puget Sound,  
WA**

*Shannon K. Maynor, Senior, Physical Oceanography*

*Mentor: Mark L. Holmes, Oceanography*

Historical physical oceanographic data reveal the presence of a 60-80 meter thick, turbid benthic nepheloid layer (BNL) in the near-bottom waters of Puget Sound. The BNL is likely formed during neap (weak) tides when intrusions of Pacific Ocean waters are able to move southward into Puget Sound through Admiralty Inlet. Where shoreline headlands constrict water moving through the Sound, the estuary floor is characterized by pairs of depressions separated by a shallower axial ridge. The formation of this W-shape has never been investigated. A restricted passage tends to accelerate tidal flow, resulting in faster flood currents on the western side of the basin, and faster ebb currents on the eastern side. The anticipated relationship between tidal currents, development of the BNL, and the W-shaped bottom morphology will be investigated using an array of measurements over a transect crossing the most striking example of these depressions. In March 2004, an acoustic Doppler current profiler (ADCP) will be used during a spring (strong) and a neap tide to obtain the full range of tidal currents, in addition to using a conductivity, temperature, and depth (CTD) profiler to record salinity, temperature, and light transmission throughout the water column. Sediment grain size, age, and distribution will also be incorporated into the analysis. Understanding how particulate matter is transported and deposited throughout the Main Basin may provide key

insights into the sources and distribution of pollutant levels in Puget Sound.

### **Cellular Basis of Excitability in Embryonic Mouse Hindbrain Motor Neurons**

*Shannon McArdel, Senior, Neurobiology*

*Mary Gates Scholar*

*Mentor: Martha M. Bosma, Biology*

It is known that for a brief period during the embryonic development of mice, the motor neurons in the animal's hindbrain exhibit highly synchronized spontaneous electrical activity. During the 19-day gestation period, this synchronicity is most prominent at embryonic day 11.5. While the patterns of activity and the degree of synchronization have been determined by intracellular calcium imaging methods, the cellular mechanisms responsible for the observed activity are not yet known. Our goal is to characterize the mechanisms of spontaneous activity observed in the embryonic mouse hindbrain, using voltage-sensitive intracellular recording techniques. Electrophysiology provides a means of measuring the synaptic inputs on a neuron from other neurons, the sources of these inputs, the cell's threshold for firing action potentials, and a means for identifying the specific ion channels responsible for the cell's inward and outward currents. We have seen a range of electrical properties during the course of development, strongly suggesting a time course for insertion or activation of specific ion channels, as well as for modifications to the electrical coupling of motor neurons in the hindbrain. The action potentials we record are much slower and longer than those in mature neurons, and are primarily  $\text{Ca}^{++}$  dependent rather than  $\text{Na}^{+}$  dependent as in their mature counterparts. Additionally, the magnitude of synaptic input from neighboring neurons suggests a high degree of direct electrical coupling which may be responsible for the synchronized activity. As we continue to acquire data, we hope to characterize the neurons' changing ion channel composition, the population of neurons contributing to the synaptic activity observed in individual neurons, and a mechanism for the observed synchronized activity.

### **Relational Maintenance Strategies Versus Avoidance of Negative Behaviors in Intimate Relationships**

*Lindsey McCallum, Junior, Communication*

*Mentor: Valerie Manusov, Communication*

My research looks at relational maintenance in intimate relationships. There are two areas of research in relational maintenance—using maintenance strategies and avoiding negative behaviors—that researchers have found to be important in the continuity of relationships. Although these two areas are closely related, they have never been compared to see which, if either, is more important in maintaining relationships. Maintenance strategies include such intentional behaviors as sharing tasks and/or networks and using positivity. Research says that if couples make a

conscious effort to use these strategies with their partner, the relationship will maintain a suitable level of satisfaction. If the strategies are not carried out, the satisfaction level may decline. The other area of research focusing on relational maintenance focuses on avoiding negative behaviors. Researchers say that, in relationships, negative behaviors begin a cascade of negative behaviors that predict dissolution of relationships. The negative behavior cascade starts with complaining and criticizing, which leads to contempt, then to defensiveness, and eventually to listener withdrawal from interaction. My research attempts to integrate the two areas of research. I am using a survey to measure what set of practices appears to be more important: using strategies to improve the relationship or avoiding negative behaviors to prevent it from coming apart. I will also look at whether certain strategies are related to certain negative behaviors or avoidance of certain negative behaviors. I will offer extra credit to students in an undergraduate class in the communication department who have been in an intimate heterosexual relationship for six months or longer. I will have them fill out a weekly log for six weeks, where they will rate their behaviors on a scale of one through seven. This data collection will occur in the spring of 2004.

### **Educational Use of Cooperatively-Controlled Drawing Games**

*Kyle McClellan, Senior, Computer Science*

*Mentor: Steven L. Tanimoto, Computer Science and Engineering*

The Department of Computer Science and Engineering at the University of Washington has developed a system called INFACT that makes it easy to log the activities of computer users who engage in various collaborative activities. One of the many applications of this is in the field of education. Educational programs written for the system record data about the actions the user takes while interacting with the program. This information can be analyzed and examined for trends. The results can be used for assessment of the strengths and weaknesses of the user's understanding in the given field. The main drive of my research is to augment the sparse library of cooperatively- controlled games based around the INFACT system. I have developed a drawing game that could be used as a tool to teach coordinate systems. In it, groups of users are required to draw something specific, usually a geometric shape. Each member of the group controls a single axis, so all must cooperate to produce the final result. Each member is then given a score based on time, the accuracy of their drawing, and other indicators of their understanding of coordinate systems, such as actions they may make to compensate for mistakes previously made by other group members.

### **The Cost of Quorum Sensing Signals**

*Megan L. McCloskey, Senior, Zoology*

*Mary Gates Scholar*

*Mentor: Carl T. Bergstrom, Biology*

Many species of Gram-negative bacteria use quorum sensing signals to coordinate gene expression according to local cell density. Previous work has drawn on mathematical models of communication to suggest that quorum sensing signals must be expensive to produce if they are to convey reliable information. Here, we develop several lines of evidence that indicate otherwise. We extend recent mathematical results in costly signaling theory to show that quorum sensing signals can be honest without being costly, if production costs increase non-linearly with production rate. We review the biosynthetic pathway responsible for producing the acyl-homoserine lactone quorum sensing signal used by many Gram-negative bacteria, and argue that for this pathway, the requirements for low-cost signaling are indeed met. Finally drawing from both biochemical and phylogenetic evidence we develop a novel hypothesis for the evolution of quorum sensing from an ancestral waste removal pathway.

### **Effects of a Diatom Diet on Egg Production and Hatching Success of *Pseudocalanus newmani***

*Melissa McKay, Senior, Oceanography*

*Mentor: Claudia Halsband-Lenk, Oceanography*

Diatoms represent a major planktonic food source in coastal marine ecosystems, and usually dominate the phytoplankton community during blooms. Copepods, crustacean zooplanktonic organisms, are the primary consumers of phytoplankton and transfer energy and organic material to higher trophic levels, such as fish larvae. Some diatoms release certain aldehydes upon wounding that have deleterious effects on copepod reproduction in the form of reduced egg production, reduced hatching success, and/or development and survival of the copepod young, the nauplii. An experiment was carried out to measure egg production, hatching success and naupliar survival of *Pseudocalanus newmani* after adult females were fed *Thalassiosira pacifica*, a diatom known to produce toxic aldehydes. Of the eight females tested, two produced eggs regularly and also had the highest hatching success. All other females had low production rates (averaging 0.45 eggs female<sup>-1</sup> day<sup>-1</sup>) and variable hatching success ranging from 100% to 0%. Naupliar survival was low (37% - 0%) for all females tested. Most of the females produced fecal pellets initially, but few if any pellets by the end of the experiment. The decline in fecal pellet production suggests that the females stopped feeding on *Thalassiosira pacifica* in the course of the experiment. Methodological issues are discussed that may have contributed to the results of low survival rates. Difficulties occurred during transfer of the fast small swimming female between jars, quantifying egg production within an egg sac, and due to the small size and motility of nauplii. However, the data suggest a negative effect on reproductive success related to the toxicity of the food source.

### **Competition Between *Brachionus calyciflorus* and *Daphnia magna* in a Closed Ecological System**

*Amy McMahon, Senior, Cellular and Molecular Biology*

*Howard Hughes Scholar, Mary Gates Scholar*

*Mentor: Frieda Taub, Aquatic and Fishery Sciences*

Closed ecological systems can be useful in studying ecological processes because they eliminate the complexities of open systems, such as gas or nutrient exchange. By definition, closed ecological systems exchange energy with the outside environment, but do not exchange matter. This reduced complexity makes studying interactions between organisms and their environment easier. Using this tool, I studied the extent of competition between two zooplankton, *Brachionus calyciflorus* and *Daphnia magna*, which both feed on the same food source, and the effect of this interaction on the longevity of closed ecological systems. Competition is the interaction between species that use a common resource. Usually, this negatively affects one or more of the competing groups. To study this interaction, I combined populations of rotifers, *Brachionus calyciflorus*, and cladocera, *Daphnia magna*, along with a mixture of green algae, in 60 ml glass closed systems. Over time, I recorded population size and the abundance of algae. The experimental design consisted of 4 treatment groups: (a) rotifers only, (b) daphnids only, (c) rotifers and daphnids, and (4) no grazers. After 3 weeks of interaction, I concluded that the presence of *D. magna* negatively affected the population growth of *B. calyciflorus* when they competed for resources. *D. magna* populations seemed to be positively affected by competition with *B. calyciflorus*. This suggests that there may be some benefit for *Daphnia magna* to be with rotifers or to consume small traces of rotifer medium. In future studies, adding rotifer medium, without rotifers, would control for this. Algal abundance within each experimental group decreased rapidly and leveled off, indicating that it was similarly reduced by the presence of one or both grazers. These findings could be used to sustain *Daphnia magna* populations for longer amounts of time, increasing the longevity of closed ecological systems containing this grazer.

### **A Revolution in Salinity Measurement**

*Alexander J. Mendez, Freshman, Physics and Math*

*Gates Millennium Scholar, Space Grant*

*Scholar*

*Mentor: Matthew Alford, Applied Physics Laboratory*

My research during the 2003 Summer Quarter, under the mentoring of Dr. Matthew Alford, was directed upon an investigation of his Refractometer Salinity Measurement System (RSMS). It was shown that the RSMS is capable of functioning as an optical refractometer for extended recording deployment in an ocean environment. In the past salinity measurements were calculated using a standard conductivity, temperature, and density (CTD) device, which

calculated. This method has inherent errors, requires frequent calibration, and its frequency response to spatial and time based changes of salinity on the micro scale was lacking high frequency response. The one key research objective was to verify that a single sensor could be tested under laboratory conditions to replace the CTD method of salinity measurement. I developed a testing system that in order to record and examine the characteristics of the RSMS. A clear set of test requirements were developed and an operational test system was fabricated to measure and record salinity under laboratory-controlled conditions. Special techniques were developed, which provided for a linear boundary between two carefully controlled salinity solutions. Orthogonal to the salinity boundary the RSMS was permitted to transit the boundary under controlled velocities so as to minimize any induced turbulence. A multipurpose software program that controls the system data acquisition and post processing functions was developed using MATLAB. The testing provided backing to show that the RSMS accurately performed without frequent calibration; had higher detectability of salinity changes; provided improved stability over the CTD method; and had a stable time base. These characteristics were repeatedly proven so that an opportunity now exists to better understand the mixing associated with one kind of wave, the so-called near-inertial wave, is now possible in the ocean environment.

### **Olfactory Preferences in Infant Pigtailed Macaques (*M.nemestrina*)**

*Caroline Kenney, Recent Graduate, Psychology, Anthropology*

*Mary Gates Scholar*

*Claudette Meyer, Senior, Psychology*

*Mentor: Gene Sackett, Psychology*

Olfactory conditioning in human infants can enhance ingestion of new and aversive solutions, thereby aiding medicine consumption and diet transitions. Olfactory conditioning is also useful for studying long-term memory. Preliminary to a study of olfactory conditioning, we assessed scent preference/aversion in 5 nursery-raised infant pigtailed macaques, ranging in age from 5-10 months. 10-cm diameter circles with a .5-in center hole, cut from coffee filters, were soaked for 60-sec in pure extracts of lemon, almond, or vanilla. Two bottles containing 500 ml of water were attached to the left and right rear cage wall, at "lixit" height (turned off) 1-ft from the cage floor. The circles were randomly placed on the bottles, 2-in from the spout end, from 11:00-14:45 hours on each of 21 test days. Baseline sessions used unscented bottles. Test sessions paired each scent against water, as well as each against the other two scents. Amount of water consumed from each bottle was recorded. Repeated measure ANOVAs indicated that infants consumed more water paired with almond and vanilla than at baseline, demonstrating that these scents enhanced ingestion. Water

paired with lemon was at or below baseline, suggesting a relative aversion to this scent. Some scents can enhance the intake of water by infant macaques. These may be useful in olfactory conditioning to study memory and enhancing substance palatability. Supported by NIH HD12913-21, RR00166, HD02274.

### **Ion Trapping and Why It's Cool**

*Edmund Meyer, Senior, Physics, Astronomy*

*Mentor: Norval Fortson, Department of Physics*

This poster presentation will aim to shed light on one particular technique used for ion trapping. We use a radio frequency voltage applied to a conducting ring in order to create an AC electric field. A significant portion of the poster will focus on the main experimental methods employed to trap our ion (Barium+ 138). I will present the relevant atomic structure of Barium+ and then show how these attributes tell us something about nature. A section of the poster will be devoted to explaining how to use ion trapping for parity violation and the possibility of quantum computation.

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

*Andrew Miller, Senior, Mechanical Engineering*

*Mentor: Mark R. Holl, Electrical Engineering*

Manual preparation of Barrett's Esophagus biopsies to create a suspension of cell nuclei for cancer research currently takes a significant amount of time by a trained technician. This time used by the technician is expensive, and can be better put to use in other areas. By automating the process, we hope 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 dropping a rotating disk with tiny protrusions onto it into a well containing the biopsy. The tissue clings to both the upper and lower surfaces, and rotational motion teases and slices the tissue biopsy apart. A reagent with mechanical shear is also used to break small clumps of tissue apart into individual cells. After the cells have been dissociated a microliter-volume pump draws them out and into a test tube for storage. This process is performed on an inverted fluorescence microscope, to observe the process as it occurs in order to guide design improvements. A literature review was conducted to determine the state of the field in both clinical practice (scalpels and pipettes) and commercially available mechanical devices (gratings and meshes). Preparation methods for very small biopsies were found to be lacking. The research presented here is being conducted in collaboration with the Reid Lab at the Fred Hutchinson Cancer Research Center. An automated prototype was fabricated, and we are working to optimize its output. Testing with the prototype has yielded encouraging results,

in the form of a uniform suspension of cells collected after operation, although it contains a significant debris fraction. We are currently investigating laser microfabricated and etched surfaces produced by photolithography to reduce debris and increase yield.

### **Engagement in Scientific Discourse Among Underachieving Girls**

*Solmaz Mohadjer, Senior, Earth and Space Sciences*

*Mary Gates Scholar, Zesbaugh Scholar*

*Mentor: Mark Windschitl, Education*

*Mentor: Jessica Thompson, Education*

‘Science’ is a verb. It describes a set of action, namely the acts of discovery and inquiry. However, for many students the word ‘Science’ is a noun. It is a thing not to be done, but to be looked at from afar, through the secondary eyes of their instructors. Much research has been carried out in order to understand why so many students fail in their science classes. However, comparatively little effort has been spent on trying to create an atmosphere of engagement in science classrooms whereby underachieving students encounter science as a verb through experimentations and inquiry. Our research study focuses on how twenty underachieving students engage in science when efforts are made to create an inquiry-based environment in conjunction with relevance to students’ lives and meaningful interactions between students and their instructors. My research specifically focuses on the interactive behavior and scientific discourse of three underachieving ethnic minority girls in a lunchtime science-learning environment. This research is important because often researchers and educators do not have an opportunity to understand how underachieving students *do* engage in scientific conversation. The data collection includes classroom observations, interviews, and ten lunchtime science sessions in which these three individuals discuss scientific ideas together and with their instructor. My primary findings have been that students participate in the lunchtime sessions differently in comparison to their participation in a science classroom. Students ask more content-related questions in comparison to procedural questions, especially when working in small groups. In addition, students emphasize the importance of personal relevance and interpersonal relationships in learning science. The research findings can be used by science teachers to create a classroom environment that engages *all* students in learning.

### **Special Interest Politics: Boeing as a Case Study**

*Evan Morrissey, Senior, International Studies, Political Science*

*Mentor: John Wilkerson, Political Science*

*Mentor: Bryan Jones, Political Science*

The role of special interests in the political decision-making process is becoming increasingly important. Yet how much

influence do special interest actors have over the national political process? This project examines this question using the Boeing company as a case study. Analyzing Boeing’s positions on congressional bills over time and the pass/fail or success rate of these bills will help to determine the company’s influence over congressional decision-makers. I expect the Boeing company to have a fairly high (above 60%) success rate on bills it supports vocally, i.e., testifies on behalf of before Congress. If this hypothesis is true, Boeing is a strong special interest group with a great deal of political power and maintains heavy influence over lawmakers. I also expect that Boeing’s political activity and influence will have increased over time, meaning that I will find Boeing is increasing its time spent with Congressional testimony and also achieving higher success rate in terms of bill passage. Therefore, I expect to use the Boeing company’s political activity history as a case study to explain the increased activity and success of special interest political actors on the Congressional decision-making process.

### **Toxicity Effects of *Heterosigma akashiwo* on the Development of the Sheepshead Minnow (*Cyprinodon variegatus*)**

*Claire Muerdter, Sophomore, Pre-Major*

*Howard Hughes Scholar, Mary Gates Scholar,*

*Space Grant Scholar*

*Mentor: Rose Ann Cattolico, Biology*

The alga *Heterosigma akashiwo* is a toxic alga, causes numerous fatalities in adult finfish worldwide including industrially important fish like salmon. While *Heterosigma*’s ability to kill adult finfish is documented, its effect on developing fish is unclear. To examine this effect, this study exposed Sheepshead Minnow (*Cyprinodon variegatus*) eggs to *Heterosigma* and then monitored their embryonic development. Minnow eggs were collected within twenty-four hours of being laid and exposed to a set concentration of *Heterosigma* cells. Two different *Heterosigma* strains were used: one from North America, CCMP 452, and one from Japan, NIES 293. Two different growth phases of *Heterosigma* were used: the logarithmic phase (which occurs soon after culture inoculation and is characterized by rapid cell division) and the stationary phase (in which cell division is slowed). The eggs were divided into three groups, with one group being exposed to logarithmic *Heterosigma*, a second group to stationary *Heterosigma*, and a third control group to no *Heterosigma*. Each of these groups was divided into two subgroups and exposed to the alga for either three hours or twenty and a half hours. Following exposure, the eggs were thoroughly rinsed to remove all *Heterosigma*. The development of the embryos was then monitored until hatching or obvious cessation of development, and the successful hatching rate of the different group of eggs compared. While further repetition of these experiments is necessary to verify the conclusions, my data suggest that

the CCMP 452 strain was more toxic than the NIES 293 strain. I also found that *Heterosigma* cells in the stationary growth phase appear to have a more detrimental effect upon minnow development than those in the logarithmic phase. Finally, the embryos exposed for a longer amount of time to *Heterosigma* exhibit a greater occurrence of developmental problems.

### **The Role of Retinoic Acid Degradation in the Patterning of the Zebrafish Hindbrain**

*Jonathan P. Myers, Senior, Biochemistry, Neurobiology  
Mary Gates Scholar*

*Mentor: Rafael E. Hernandez, Molecular and Cellular  
Biology, Fred Hutchinson Cancer Research Center*

*Mentor: Bruce W. Draper, Fred Hutchinson Cancer  
Research Center*

*Mentor: Cecilia B. Moens, Fred Hutchinson Cancer  
Research Center*

The developing vertebrate hindbrain transiently shows a characteristic series of segments, or rhombomeres. The hindbrain gives rise to parts of the brainstem that are responsible for visceral function, muscle coordination, and other functions. The neurons that arise in the rhombomeres show a surprising degree of conservation in organization across species. The pattern of neuronal differentiation is determined by the segmental expression of selector genes. Expression of these genes is established in response to extracellular signals, including retinoic acid (RA). Retinoic acid is synthesized in the paraxial mesoderm and acts as a posteriorizing signal required for the expression of target genes in the posterior hindbrain including Hox group-1 genes posterior to rhombomere 3. The activity of RA is limited to the posterior hindbrain by enzymes that degrade RA, such as Cyp26a1. Other RA-degrading enzymes, such as Cyp26b1, may serve other functions beyond initial patterning events. Our overall aim is to better understand the role of these two Cyp26 genes in zebrafish development. To this end we have identified 15 alleles of Cyp26a1 in a novel reverse genetic screen. We have designed an over-expression assay in order to determine the severity of these alleles by measuring their efficacy in repressing RA signaling in the hindbrain through their ability to repress *hoxb1b* expression. The first allele we have assessed has been unable to repress *hoxb1b* expression in this assay, suggesting a loss of function. Surprisingly, fish that are homozygous for this allele are viable, suggesting that *cyp26a1* may be a non-essential gene. We are testing whether maternally provided Cyp26a1 rescues embryos lacking the zygotic gene product. Additionally we are isolating two other mutant alleles that are predicted based on amino acid conservation to be more deleterious, and we will begin analyzing the homozygotes of all three alleles for more subtle embryonic or adult phenotypes.

### **Species Inventory and Conservation Implications for the Near-Shore Coral Reefs of Gandoca-Manzanillo**

### **Wildlife Refuge, Costa Rica**

*Sarah Myhre, Senior, Marine Biology, Western  
Washington University*

*Space Grant Scholar*

*Mentor: Alejandro Acevedo, Biology, Western  
Washington University*

I conducted a 3-month survey along the shore of Gandoca-Manzanillo Wildlife Refuge, Caribbean Costa Rica, in 2003. The goal was to identify the marine species in the refuge to suggest conservation and research priorities. The study site was a 600-m stretch of coast that harbors coral reefs, which are visited by tourists and in which protection is a refuge mandate. Surveys were carried out along random transects running perpendicular to the shore with a width of one m. Transects started from mean high tide level mark and had a length of 4-15m. I tallied the presence of organisms visible to the naked eye, identifying them to species, or the next highest taxon. Forty-seven transects were conducted and 338 species in 12 phyla were identified: Rodophyta (22 spp.), Chlorophyta (18 spp.), Phaeophyta (20 spp.), Anthophyta (3 spp.), Porifera (15 spp.), Cnidaria (52 spp.), Ctenophora (3 spp.), Annelida (10 spp.), Mollusca (24 spp.), Echinodermata (17 spp.), Ectoprocta (2 spp.), Arthropoda (17 spp.), Urochordata (10 spp.), Chordata (125 spp.). I identified 30 species of coral, 9 species of macroalgae, which compete for space with corals, and the long-spined sea urchin (*Diadema antillarum*), a macroalgae grazer observed in 12 of the transects. The hatching of ca. 150 green turtles (*Chelonia mydas*) was also recorded, a rare event in that part of the refuge. Results indicate that the study site is diverse and includes endangered species (sea turtles), species that provide habitat (corals), and species that can alter communities (long-spined sea urchin). Suggested priorities include: 1) monitoring density and potential impact on macroalgae and coral cover of *Diadema antillarum*, 2) assessing the establishment of a turtle nesting ground, 3) educating local people and visitors on the damage created by walking on the coral or harvesting organisms, and 4) raising community awareness about the richness of the area.

### **Till-Fabric Analyses of NE-SW Trending Flutes on Northern Whidbey Island: Evidence of Readvance of the Cordilleran Ice Sheet During the Latest Vashon Stage of the Fraser Glaciation**

*Justin Nelson, Recent Graduate, Anthropology, Political  
Science*

*Michelle Mullen, Senior, Earth and Space Sciences*

*Ryan Mano, Senior, Earth and Space Sciences*

*Mentor: Terry Swanson, Earth and Space Sciences*

Northeast trending flutes were first recognized by R.A. Hagerud using LIDAR (Light Detection And Ranging) topography and inferred to represent a directional change of ice flow late during the last glaciation. Till-fabric and stratigraphic analyses of these NE trending flutes, as well

as stratigraphically lower Vashon till units indicate that the Cordilleran Ice Sheet (CIS) likely readvanced over north Whidbey Island following its initial retreat. Two hypotheses have been proposed to explain the change in ice flow direction from predominantly north-south during the early to late stages of the Vashon advance, to the NE flow direction during the latest episode of re-advance of Vashon ice over northern Whidbey Island. The first suggests that the ice front in the Strait of Juan de Fuca retreated earlier (through rapid calving) than that in the Puget Lowland, inducing a change in ice divide and local flow direction over northern Whidbey Island as originally proposed by R.M. Thorson in 1980. The second suggests that during the retreat and readvance of the CIS over northern Whidbey Island ice flow direction in this region was controlled by extensive alpine glaciation from the North Cascades similar to that suggested by D. Easterbrook and D. Kovenan for the Nooksak drainage further to north. Though more research is required, preliminary evidence indicates that rapid calving in the Strait of Juan de Fuca caused the major source of change in ice flow direction.

#### **Active Dendritic Conductances and Persistent Inward Currents in Rat Hypoglossal Motoneurons**

*Greg Newkirk, Senior, Neurobiology, Zoology*

*Mary Gates Scholar*

*Mentor: Marc Binder, Physiology, Biophysics*

Previous research on unanesthetized animal preparations of brainstem and spinal cord motoneurons demonstrate the presence of active dendritic conductances that modify the transfer of synaptic currents to the soma and affect repetitive discharge. Motoneurons also manifest large, voltage dependent, persistent inward currents that are mediated largely by the influx of  $Ca^{2+}$  ions. The goal of our study is to demonstrate that the membrane channels responsible for these persistent inward currents are located primarily on the dendrites of motoneurons. We study the properties of rat hypoglossal motoneurons *in vitro* from 250  $\mu m$  slices of young rat brainstem tissue. The extremely small size of motoneuron dendrites makes direct electrical recordings exceedingly difficult and thus, we must make inferences about their behavior from indirect measurements. In one project, are combining somatic voltage-clamp recordings with fluorescent imaging using a  $Ca^{2+}$ -sensitive fluophore to simultaneously compare  $Ca^{2+}$  influx in the soma and in the dendrites, which will allow us to identify the source of the current. We are also using focal iontophoresis to activate glutamatergic dendritic synapses and measure the transfer of current from the dendrites to the soma. If the source of these currents is indeed in the dendrites, then we will attempt to identify the types of dendritic ion channels that contribute to the amplification of the glutamate-evoked current transmitted from the dendrites to the soma using pharmacological techniques to block specific groups of membrane channels. We have also included neurobiotin in our recording

electrodes so that we can study the morphology of the dendritic trees and compare this with the physiological properties of the cell. Our working hypothesis is that cells with truncated dendritic trees (due to the preparation of the brainstem slices) will generate smaller persistent inward currents than those cells with intact dendritic trees.

#### **Pseudomonas Quinolone Signal-Quorum Sensing**

*Hai Nguyen, Senior, Microbiology*

*Gates Millennium Scholar*

*Mentor: Tina Guina, Microbiology, Pediatrics, and Infectious Diseases*

Cystic fibrosis (CF) is an autosomal recessive disorder that is the most common lethal genetic disease in Caucasian. Shortly after birth, the respiratory tracts of most patients with CF are infected with the opportunistic Gram-negative bacteria, *Pseudomonas aeruginosa*. Over time, this persistent infection coupled with specific adaptations *P. aeruginosa* makes to the CF airway environment results in chronic airway inflammation that leads to severe and progressive lung injury. For this reason, *P. aeruginosa* is a major cause of mortality in CF. Previous studies from our laboratory showed that clinical *P. aeruginosa* isolates from infants with CF synthesized high levels of Pseudomonas quinolone signal (PQS), one of the key quorum sensing signaling molecules. Quorum sensing is a mode of bacterial intercellular communication that is essential to regulation of *P. aeruginosa* virulence factors production and stress response. The project I'm working has been to analyze levels of PQS production in 200 clinical strains of *P. aeruginosa* isolated from infant CF patients up to three years of age. To estimate the levels of PQS production by these isolates, I used methods of organic extraction and separation of organic compounds by thin-layer chromatography. This analysis determined that over 50% isolates collected from 19 out of 24 (79%) patients produce high level of PQS. Therefore, the high-level production of PQS is one of the earliest known adaptation processes that *P. aeruginosa* undergoes upon CF patient lung colonization. The manuscript describing this work is in preparation and will be soon submitted to the *Journal of Clinical Investigation*. In future, I will further analyze *P. aeruginosa* isolates from various sources such as from patients with acute *P. aeruginosa* infections as well as those collected from the environment (water, soil, etc.).

#### **Understanding the Dynamics of Tumor Growth through Imaging and Mathematical Modeling**

*Stephanie Nissen, Junior, Bioengineering*

*Mary Gates Scholar*

*Carly Bridge, Senior, Neurobiology*

*Hana Harpold, Junior, Bioengineering*

*Mentor: Kristin Swanson, Pathology*

Mathematical modeling can be a powerful tool in understanding complex biological systems. Glioblastomas

are brain tumors characterized by aggressive diffuse invasion of surrounding tissues. Glioblastomas generally recur despite extensive treatment and are uniformly fatal. It is becoming more clear that the diffuse invasiveness of these tumors contributes most to their resistance to treatment. A mathematical model (1, 2) has been created that can be applied to patient data to calculate two factors of such tumors: proliferation and infiltrative potential. With this model of the basic mechanisms involved in tumor progression, patient data can be combined to develop a picture of a tumor's past, present, and future behavior, a potentially powerful clinical tool. Currently, one can track a tumor by means of a series of magnetic resonance imaging (MRI) scans to obtain values for the model parameters. Here we present our MRI image analysis techniques applied to three glioblastoma patients to define the temporal evolution of the three dimensional tumor volumes. We demonstrate the strong correspondence between these calculations and the mathematical model's predicted behavior. Future research will be focused on integrating results obtained from PET scans of a tumor, potentially obviating the need for multiple MRI scans over a long period of time by correlating with the net tumor growth, a current model parameter.

1. K. R. Swanson, E. C. Alvord and J. D. Murray: A Quantitative Model for Differential Motility of Gliomas in Grey and White Matter, *Cell Proliferation* 33(5): 317-330, 2000
2. K. R. Swanson, E. C. Alvord and J. D. Murray: Virtual Brain Tumors (Gliomas) Enhance the Reality of Medical Imaging and Highlights Inadequacies of Current Therapy, *British Journal of Cancer*, 86: 14-18, 2002.

#### **IceVis – Icecast Streaming Media Log Analysis Tool**

*John Oleinik, Senior, Atmospheric Sciences*

*Dan Podhola, Senior, Informatics*

*David Horm, Senior, Informatics*

*Tho To, Junior, Informatics*

*Mentor: David Hendry, Information School*

RainyDawg Radio is a new Internet radio station at the University of Washington. The station focuses on college and indie rock and is run by the Associated Students of the University of Washington. Approximately 700 people listen to the station weekly. In early 2003, the station chose to implement the streaming media technology called Icecast<sup>1</sup> for open source, reliable, and scalable streaming media. While this technology worked effectively for the station, it by itself did not enable the radio station to analyze the listening habits of its audience. As listeners tune in to the internet stream, the server records information such as the users IP address, length of connection, media player software and operating system. At the start of this project, there were two known commercial software packages that would parse the Icecast log format and both were very limited in their features. The aim for this project was to

create a visualization of Icecast log files that would help RainyDawg Radio, and stations across the world, understand the listening habits of their audiences. This application, called IceViz<sup>2</sup>, had the following requirements: a) present basic statistics of listeners and songs; and b) overlay audience usage information on playlist and artist information. The result was a prototype that let a station manager choose a weekly time slot on the station and dynamically view the listener statistics and music played during that particular show. The system also allowed for daily and weekly statistics for the overall station. Future plans are to investigate richer visualizations to support the needs of DJs and managers and to create a configurable open source distribution that can be used at any radio station using Icecast.

<sup>1</sup> Icecast Streaming Media Server. Downloaded 27 February, 2004 from <http://www.icecast.org/>

<sup>2</sup> IceVis prototype. Downloaded 27 February, 2004 from <http://oldintranet.rainydawg.org/stats/>

#### **Therapist Interpretations in Behavior Activation and Cognitive-Behavioral Therapy for Depression**

*Gareth Holman, Senior, Psychology, Comparative History of Ideas*

*Tammy McKaskle, Senior, Psychology*

*Cindra Ouellette, Senior, Psychology*

*Mentor: Robert J. Kohlenberg, Psychology*

Therapists often make explanatory statements to clarify the meaning of an action or experience for the client. These explanatory statements are known as interpretations (Keijsers, et. al 2000). Interpretations may be reflexive (R), merely restating what the client has already said, or they may be expressive (E) of the therapist's own opinions and beliefs. This exploratory study will evaluate and compare the frequency and type of interpretations used in a small sample of videotaped behavioral activation therapy (BA) and cognitive-behavioral therapy (CT) sessions performed as part of a large randomized trial of depression treatments. BA is a new type of treatment that involves motivating the client to engage in behaviors that are incompatible with and lead to subsequent change in depressive feelings (Jacobson, et al. 1996). CT is a well established treatment that involves helping the client to recognize and change the underlying thought patterns that maintain their depression (Jacobson, et al. 1996). We know little, however, about how these therapies differ in their use of interpretation. We will select four clients from each therapy condition, matched for depression, gender, and age. We will assess the frequency and type – R, E, or other - of interpretations used by therapists in each condition. The reliability of ratings will be established through interclass correlation coefficients based on independent re-rating of sessions. Findings will be discussed in light of their potential relation to treatment condition. We will provide a qualitative analysis of a selection of interpretations,

examining their role in relation to the specific treatment condition in which they occur.

### **The Design of the Command and Data Handling System on the Mars Gravity Biosatellite**

*Steven Cowell, Senior, Mathematics, Philosophy*

*Jeremy Hanni, Senior, Computer Science*

*Eric Hultman, Senior, Electrical Engineering*

*John Pang, Senior, Applied and Computational Mathematical Sciences*

*Andrew Redmond, Junior, Electrical Engineering*

*Mentor: Adam Bruckner, Aeronautics and Astronautics*

The Mars Gravity Biosatellite is a joint engineering effort by the students of the University of Washington, Massachusetts Institute of Technology, University of Queensland to send a group of 15 mice into low earth orbit for 35 days, in a simulated Martian gravity environment (0.38g). In this first ever study of the effects of Martian gravity on mammals, experimental data will be transmitted back to earth for analysis throughout the flight, as well as stored on board the satellite for analysis upon returning to Earth. Like any satellite or spacecraft, the command and data handling subsystem is the central processing unit for the spacecraft, and must collect and store data, interpret ground commands, and provide overall spacecraft control through interface electronics. In our preliminary design, we have chosen a centralized architecture, interfacing with different subsystems through a combination of digital and analog lines. The backbone of the system will be on a VME backplane, which will connect our processor, interface cards, and long-term storage devices. Some difficult challenges that we have encountered in developing our design include the scarcity of parts able to withstand the harsh radiation environment of space and electro-magnetic interference from spacecraft electronics interfering with analog interfaces. Currently, we are continuing our research in component selection, mapping the mission states throughout the mission, outlining software packages needed for each state, and performing trade studies on the effects of EMI on our current design.

### **Evolutionary Analysis of the Caribbean Group of Bignoniaceae *Tabebuia* Species**

*Chelsie Papiez, Senior, Botany*

*Mentor: R. Olmstead, Biology*

*Tabebuia* is the largest genus of the Bignoniaceae family, which is mostly comprised of large tropical trees and lianas that are distributed from Southern Mexico down to Brazil and the Caribbean. The evolutionary relationships among these Caribbean species are not well understood, most likely due to adaptive radiation that can occur within islands. To resolve the evolutionary relationships within this group and to determine where the clade fits in the bigger picture of *Tabebuia* evolution, the evolving chloroplast trnL-trnF intron and spacer region is being

sequenced and analyzed for representative members of the group. Using these data we will determine whether or not the Caribbean *Tabebuia* species are a monophyletic group.

### **Mapping a Multicultural History of Education in the Puget Sound Region: Catholic Schooling**

*Erin Peinado, Senior, History*

*Zesbaugh Scholar*

*Mentor: Nancy Beadie, Education*

In the 1920s, the Archdiocese of Seattle began a program to expand Catholic schooling to serve the growing ethnic and immigrant populations in the city. The goal of our project is to map out the diverse populations served by parish and mission schools in the Seattle area from 1920 to 1970, including schools serving Asian, European, and African-American families. We plan on doing this through archival research at the Seattle Archdiocese Archives as well as particular parish schools and the archives of major Catholic orders of nuns in the Seattle area. We will be matching this information against census information and historical maps from the University of Washington Maps and Special Collections. Eventually, we hope to contact primary sources and conduct oral interviews. Our research is still in progress so no definitive conclusions have been made.

### **Information Seeking Behavior in Recreational Planning**

*Justin Perron, Senior, Informatics*

*Ben Brigham, Senior Informatics*

*Mentor: Matthew Saxton, Information School*

The development of the Internet enables changes in the ways in which people plan recreational travel. Unfortunately, some people dread planning a vacation because of the time and work involved and the complexity of the task; planning a trip should build anticipation for the trip rather than cause frustration. The goal of our exploratory study is to characterize patterns in the information-seeking behavior of people planning recreational experiences. Specifically, we are interested in both how they use the Internet in the planning process and common barriers encountered. Barriers occur when someone is blocked from seeking information or successfully getting help. Data collection will be conducted at SeaTac Airport using two separate interview schedules. The first interview explores how participants (N=200) went about the process of planning their trip and is designed to be administered over 3-5 minutes. In the initial interview, we ask participants questions about the reservations process, if they used the Internet, and how they decided where to stay. A purposive sample of participants (N=20) from the initial interviews will be asked to take part in an in-depth interview, which focuses on their experience using the Internet to plan the trip. In this second interview, we ask participants questions about which web sites were

helpful in planning, how much time they spent planning, and what specific problems they encountered during the process. Each in-depth interview is anticipated to last 20-30 minutes. Given the size of our samples, we expect to reach saturation with regard to general patterns in information-seeking behavior and common barriers encountered among participants. The findings from our study may suggest potential improvements related to information transfer between recreational destinations and their visitors in the context of this task domain.

### **Downslope Flow Over a Mountain**

*David Peterson, Senior, Aeronautical and Astronautical Engineering*

*Mary Gates Scholar, Space Grant Scholar*

*Mentor: Peter Rhines, Oceanography*

Knowledge of the interactions topography has with the oceans and the atmosphere is important to the understanding of weather phenomenon at all scales. An experimental apparatus has been created to investigate one such interaction. The experiment is investigating the influence a mountain has on the overturning circulation of a narrow basin. This type of overturning flow is most analogous to the flow found in an estuary. One of the major questions this project hopes to answer is what the mountain's contribution to mixing is, and how this affects the stratification in the basin. This flow is particularly interesting because of the presence of a downslope jet on the lee side of the mountain. Such jets are common in nature; examples include the Chinook winds in Colorado and the Santa Ana winds in Southern California. Measurement techniques include velocity measurements with a Laser Doppler Velocimeter, velocity measurements utilizing Digital Particle Velocimetry, and Density measurements using a Conductivity-Temperature-Depth probe. The project is currently in a stage of analyzing data to get a solid understanding of the time history of the experiment. The next stage will most likely be comparison of the life cycle of the flow with and without the mountain. This will allow for quantification of the influence the mountain has on the flow. Future progress may include the introduction of multiple mountains into the flow.

### **Basal Respiratory Exchange Ratio Is Altered With Statin Use in Normals**

*Colin T. Phillips, Junior, Biochemistry*

*Mentor: B. Gregory Brown, Cardiology*

**Please note complete abstract and accompanying table printed on page 74.**

### **Probabilistic Weather Forecasting Using Bayesian Model Averaging**

*Michael Polakowski, Senior, Statistics, Applied and Computational Mathematical Sciences*

*Mentor: Adrian Raftery, Statistics*

Typical deficiencies of probabilistic weather forecasts are that they are underdispersive and exhibit bias. The forecasts examined are ensemble forecasts, which are forecasts created from several competing member forecasts. Underdispersive meaning that the range of the ensemble forecast is often smaller than desired. This project uses Bayesian model averaging (BMA) for the postprocessing of ensembles to correct these deficiencies. The BMA method is a standard method for combining different predictive probability distribution functions (PDFs). The goal is bias correction of the ensemble as well as a PDF of a weighted average of the ensemble members that results in prediction intervals as sharp as possible subject to calibration. Ensemble member weights are calculated to reflect the accuracy of each member over a specified training period. Calibration meaning that the predicted PDF accurately reflects the true PDF. Sharpness is such that prediction intervals generated from the predictive PDF are as short as possible. This method takes into account both the variation of each ensemble member as well as the variation between the forecast members. This method was applied to 48-hour forecasts of sea-level pressure in the Pacific Northwest in January- June 2000 using the University of Washington MM5 mesoscale ensemble. The predictive PDFs were much better calibrated than the raw ensemble, and the BMA forecasts were sharp in that 90% BMA prediction intervals were 62% shorter on average than those produced by sample climatology. As a byproduct, BMA yields a deterministic point forecast, and this had a RMSE 11% better than any of the ensemble members, and 6% better than the ensemble mean. Similar results were obtained for forecasts of surface temperature.

### **Developing a 3-D Model for Douglas Fir Stem and Branch Growth**

*Victoria Poling, Senior, Sustainable Resource Science*

*Mary Gates Scholar*

*Wang Xin, Junior, Ecosystem Science and Resource Management*

*Mentor: Thomas Hinckley, Forest Resources*

Extensive study and description has been done on the root growth morphology of a dominant Douglas fir tree. This work has been used to create a 3-D model of root growth. The goal of our project was to do an extensive study and description of growth morphology for the above-ground portion of the tree, i.e. stem and branches. The study will be used to further the transition from 2-D to 3-D portrayals of tree growth. We used the Duff and Nolan tree and crown dissection technique, in which the tree stem is cut into sections of yearly growth increments. We measured the extension (length) of horizontal branch growth and vertical stem growth, the girth (diameter) of the stem at yearly increments and the branches at the point of emergence from the stem, as well as the direction (angle and azimuth) of branch extension. Using this method we have been able to reconstruct the tree in terms of the measured increments.

Analysis of variation in extension, direction and girth shows regular patterns that can be accounted for based on location relative to the top of the tree, and due to the growth year or age of the tree. Additional analysis shows patterns of “good” growth and “poor” growth years due to variation in climate. These patterns will be compared with observed variation in annual root growth morphology to see if a “good” or “poor” year of root growth necessarily corresponds to a “good” or “poor” year of above-ground growth.

### **The Role of KiSS-1 and GPR54 in the Reproductive Axis**

*Simina Popa, Senior, Neurobiology, French  
Mary Gates Scholar*

*Mentor: Robert Steiner, Physiology, Biophysics, and  
Obstetrics and Gynecology*

The GPR54 gene encodes a G-protein coupled receptor that is expressed in the brain. Humans and mice with mutations in the GPR54 gene fail to undergo normal pubertal maturation. This is because they release insufficient quantities of gonadotropin releasing hormone (GnRH) to support normal gonadotropin secretion from the anterior pituitary gland. Gonadotropins such as luteinizing hormone (LH) and follicle stimulating hormone (FSH) stimulate and maintain normal gonadal function. The GPR54 receptor is activated by metastin, a 54 amino acid peptide encoded by the KiSS-1 gene. The goal of our project is to better understand how metastin and GPR54 influence the hypothalamic-pituitary-gonadal axis. We found that metastin acts on the brain to stimulate LH and FSH release. Injections of metastin into the lateral cerebral ventricles of mice caused a significant increase in gonadotropin levels in the blood plasma as compared to injections of the vehicle control. We also showed that metastin mediates its effects on the pituitary through GnRH secretion. When metastin is injected with acyline, a GnRH antagonist, gonadotropin levels no longer increase. We think metastin may act directly on GnRH neurons to stimulate GnRH release because GnRH and GPR54 mRNAs colocalize to the same cells according to preliminary data from double label *in situ* hybridization (ISH). Finally, we wanted clues about the inputs and outputs of cells expressing GPR54 and KiSS-1. We could find the first clues by mapping where in the brain these cells are located. We used single label ISH to map both mRNAs in the mouse brain and have found that KiSS-1 mRNA is expressed in the hypothalamus and in other areas of the brain that are known to be affected by steroid hormones. This could mean that KiSS-1 is subject to feedback from the gonads. The distribution of GPR54 mRNA is still to be determined.

### **Historical Black Carbon Deposition in near Shore Sediments in the Main Basin of Puget Sound, Washington**

*Andrea Pratt, Senior, Oceanography  
Mentor: Mark Holmes, Oceanography*

Black carbon (BC) is derived from fossil fuel combustion, biomass burning and runoff over exposed graphite. Sources of BC are linked to climate history and changes in land-use/industrialization. BC represents a significant sink in the global carbon cycle and is a signature of both anthropogenic and natural processes. Changes in black carbon concentrations over time reflect changes in source strength. Historic BC deposition from the atmosphere and river run off can be measured in marine or lake sediments. My hypothesis is that black carbon concentrations have increased beyond pre-industrial (prior to 1900) concentrations due to increased industrialization and land use change in the Puget Sound basin. A 3-m-long marine sediment core will be collected on 20 March 2004 from central Puget Sound aboard the *R/V Clifford A. Barnes* using a piston coring system. The core will be analyzed for sediment accumulation rates over the last 100 years using the <sup>210</sup>Pb chronology method. Absent any distinct changes in core lithology, the rate of accumulation will be extrapolated in order to correlate depth-in-core with age of the sediment. The sediment will then be analyzed for BC concentrations using thermal techniques. Temporal trends in BC concentration (pre- and post-industrial) will be identified. Industrialization trends will be quantified using historic population data for the Puget Sound region. Any correlation of temporal trends of industrialization with BC concentrations will be investigated. I expect to find increased black carbon in recently deposited sediments. The results of this study are relevant to a similar study conducted in Lake Washington where BC concentrations increased in the sediment over time due to land-use change and industrialization. No data on this topic currently exists for Puget Sound. Isotopic fractionation analysis could later be performed in attempt to quantify source strength and separate natural and anthropogenic sources.

### **Union Democracy**

*Natalie Quist, Junior, Political Science  
Adam Goodwin, Junior, Comparative History of Ideas,  
Microbiology*

*Mary Gates Scholar  
Devin Kelly, Senior, Sociology  
Mentor: Margaret Levi, Political Science  
Mentor: David Olson, Political Science*

The Union Democracy project is an ongoing undertaking by the Political Science department that addresses to what extent unions are democratic in nature. This project particularly focuses on the International Longshore and Warehouse Union (ILWU). In this investigation of union democracy, the project has already compiled and analyzed nearly all 70 years of the ILWU's voting records. The project has also examined the deliberations of the ILWU's conventions. Both are obvious demonstrations of

democracy within the Union. In this next phase of the project, the internal democracy of the ILWU will continue to be analyzed. However, this time the focus will be on certain pivotal moments that the Union experienced, such as the Pig Iron Controversy of 1938, certain Union affiliations and disaffiliations, the ILWU-PMA (Pacific Maritime Association) Mechanization and Modernization Agreement of 1960, and the setting of term limits. Documents being examined in this project include the ILWU's convention proceedings and ILWU's official newspaper, "The Dispatcher." Various texts regarding these issues and events are also being analyzed. The expected outcome is that these events were significant to the ILWU, and they will further demonstrate the Union's internal democracy.

### **Using Joint Application Development to Model Information Behavior in a Gastrointestinal Research Lab**

*Ahror Rahmedov, Senior, Computer Science and Engineering*

*Mary Gates Scholar*

*Mentor: William Lober, Biomedical and Health Informatics*

Designing accurate data models is an important step in developing successful information systems. Biomedical research labs often address this in an ad-hoc manner. We have explored the use of Joint Application Development (JAD) techniques in the design process as a way of improving on the ad-hoc design methods. By formally involving the users during the design process, we were able to design correct data models for the main entities of the system, and capture most of the system's functional requirements in a series of use cases, which were then used to develop data models and the web based application itself. We expect a significant improvement over ad-hoc designs when compared with our systematic approach to providing a solution to information management needs of one particular oncology research lab at the University of Washington. The results will be available by the end of the spring quarter and evaluated based on user feedback.

### **Small City Police Territoriality: A Comparative Case Study**

*Suzanna Ramirez, Senior, Sociology, Psychology*

*Mentor: Steven Herbert, Geography*

Past incidences of police brutality have sparked and inspired a new wave of research in law enforcement. Herbert (1997), during a case study of Los Angeles Police Department (LAPD), found six "normative orders" of policing, or elements that influence the behavior and use of discretion by police officers: Law, Bureaucracy, Safety, Adventure/Machismo, Morality, and Competence. Herbert's study was set in the Wilshire division of the LAPD, one of LA's most dangerous and busy police patrol

areas. While LA is known as a large city having large amounts of crime, high ethnic heterogeneity and a wide range of socioeconomic classes, the current case study sought to question whether these six normative orders of policing were generalizable to police departments in small cities with less crime and different community dynamics. This case study involved participant observation during Officer shifts at varying times of the day and week, and also observed community dynamics through department staff and city council meetings in a small city outside of Seattle. This patrol beat differs greatly from LA's Wilshire Division in its small size, rate and type of criminal activity, and majority Caucasian population. Observations show that Herbert's six normative orders do play out in daily operations and behavior of officers in this small city. However, the tight knit police force, close proximity of department supervisors, low crime rate, and homogenous ethnic population bring about different reasons for the existence of normative orders in this small department. The influence of small city politics has also been observed to be an additional influence on police behavior. These results show that Herbert's normative orders of policing are likely to be a consistent force of police culture and territoriality despite differing community dynamics, crimes rates, and demographics. However, these normative orders of policing may not capture all unique aspects of territoriality in police departments.

### **Sloths of the Pleistocene in Washington**

*Andrea Repetto, Junior, Zoology, Earth and Space Sciences*

*Mary Gates Scholar*

*Mentor: Elizabeth Nesbitt, Earth and Space Sciences*

Jefferson's ground sloth (*Megalonyx jeffersonii*), now extinct, was widespread in North America during the last Ice Age, 2 million – 10,000 years ago. A new specimen was excavated on Orcas Island in summer 2002 by a team from the Burke Museum. This giant sloth had a geographic distribution across all of North America but this is only the third found in Washington State. The Burke Museum holds an almost complete specimen collected from SeaTac Airport in 1961. The *Megalonyx* bones excavated from Orcas Island include a tooth, ribs, femur, tibia, fibula, astragalus, calcaneus, metatarsal and pedal claw. Many other flora and fauna were also found with the ground sloth. Other bones excavated were bison vertebrae and a frog femur. Plant fossils consist of *Pseudotsuga menziesii* (Douglas fir) and *Pinus contorta* (Lodgepole pine) cones, bark and wood fragments, and pollen analysis is in progress. Invertebrates include the marine clam *Macoma nasuta*, and three species of land snails. Carbon dates from the Orcas Island sloth bones will provide a more exact date of death, and bone samples will be analyzed in an attempt to extract specific dietary information. The data derived from the Orcas Island specimen will be compared to the SeaTac sloth fossil, as well as one from western Idaho.

This project is also being done in collaboration with Dr. G. McDonald, National Park Service in Denver, Colorado. From this, we hope to learn more about the daily life of the ground sloth, and detail a more exact ecological framework.

### **Optimization of Ionic Wind for use as a Lifting Mechanism**

*Josh Rickey, Senior, Aeronautical and Astronautical Engineering*

*Mark Baron, Senior, Aeronautical and Astronautical Engineering*

*Mentor: Dana Dabiri, Aeronautical and Astronautical Engineering*

Through our research, we have confirmed that utilizing a large voltage potential between two separated conductors can create a low velocity accelerated stream of air. The cathode side consists of a length of thin wire, while the anode side consists of a thin aluminum plate. The small surface area of the wire creates a large charge density, which leads to the rapid ionization of the air around it. However, the large plate has a small charge density, which only generates a small amount of ionization around it. The ionized air particles produced around the wire accelerate towards the oppositely charged collector plate because of the charge difference, creating the "Ionic Wind". Once the voltage potential reaches a level between 20 kV and 40 kV, the thrust produced is greater than the structural weight. It is then possible to levitate small test platforms. The goal of this project is to determine optimum configurations that maximize thrust, and minimize power consumption. We want to identify the parameters that directly correspond to changes in thrust. This will be accomplished by variations of the cell density, the collector distance, and the collector width. We expect to see a definite trend in efficiencies when looking at optimum collector distances with respect to increasing voltage potentials. We also are expecting a strong trend towards higher efficiencies with the increase of cell density. If these trends hold true, we may then attempt to build a platform with the capability of carry its own power source as well as potential stability and control devices.

### **Three-Dimensional Defocused Digital Particle Image Thermometry and Velocimetry**

*Paul Riddle, Senior, Aeronautical and Astronautical Engineering*

*Mentor: Dana Dabiri, Aeronautical and Astronautical Engineering*

The effort of this research is to further the study of turbulent flow using the principles of Particle Image Velocimetry to acquire statistical data of inherently random processes to characterize mixing within the bulk fluid for turbulent flows. The tools needed to conduct an experiment of this nature do not currently exist in a meaningful form. It is the goal of this project to develop these advanced tools,

verify the accuracy of these tools on well-documented flow configurations, and to use these tools to improve our physical understanding of turbulent flow. Current progress on research is two fold: first, the experimental apparatus, which consists of a water tunnel (akin to a wind tunnel), requires a test section that incorporates a two-dimensional backward-facing step. The purpose of the step feature is to study the effects of mixing within three-dimensional turbulent flows that develop between flow separation at the step and its eventual reattachment downstream. In the intermediate region, a constant-temperature heating element will add heat, allowing us to study the effects of mixing within the turbulent region, a matter of importance to aerothermodynamics. Second, a digital video camera, capable of acquiring temperature and velocity data needs to be designed and built. This video camera will be comprised of three CCD's, two in black and white and one in color, located at the vertices of an equilateral triangle. This arrangement will allow for the acquisition of velocity and temperature data within three-dimensional space. These cameras will be unlike any used thus far in three-dimensional data acquisition and it is the complexity of these devices that not only provides the greatest technical challenge to the design, but also the greatest scientific reward.

### **Functional Roles of Innate Immunity and the MBL-complement Pathway During Ascidian Metamorphosis**

*Brock W. Roberts, Senior, Biology*

*Howard Hughes Scholar, Mary Gates Scholar*

*Mentor: Billie J. Swalla, Biology*

Ascidian metamorphosis represents a powerful model system for investigations into chordate development and evolution. This process transforms the free-swimming larval ascidian into a sessile adult through several staged metamorphic events. First, larvae become competent to respond to settlement cues. Settlement involves attachment to a substrate, rapid resorption of the larval tail and slow differentiation of adult structures. Subtractive hybridization revealed that numerous transcripts with putative innate immune functions are discretely upregulated during metamorphosis in *Boltenia villosa*. Several of these genes have well-known roles in the MBL-complement pathway of innate immunity, including Mannose Binding Lectin (MBL) and MBL-Activated Serine Protease (MASP). MBL recognizes and binds bacterial pathogens, activating MASP. This initiates a serine protease cascade, resulting in the proteolysis of complement factors, facilitating phagocytosis and the inflammatory response. Competent larvae upregulate MBL and MASP and respond to bacterial cues to initiate settlement. MASP is expressed in the papillae-associated tissue (PAT) cells. In competent larvae, these MASP-expressing cells migrate through a tunnel in the larval tunic, suggesting a function in bacterial substrate recognition. These cells also coordinate settlement through

a separate EGF signaling pathway. Using KCl as an artificial settlement cue, we have shown that MASP expression in the PAT cells is temporally correlated with larval competency. Preliminary functional experiments have shown that serine protease inhibitors block metamorphosis, allowing tail resorption but preventing further morphological changes. To perturb this pathway with specificity, we have employed RNA interference (RNAi) and antisense oligonucleotides. We have identified MASP as a candidate for knock out studies using RNAi because of its central role in the MBL-complement pathway and its expression in the PAT cells, at the interface with the external environment. Using these techniques, we are testing functional hypotheses for the roles of specific innate immunity genes during metamorphosis.

### **Lack of Feminist Discourse and Emerging Non Governmental Organizations as it Pertains to the Women of Juárez**

*M Virginia Rodriguez, Senior, Comparative History of Ideas*

*Mary Gates Scholar*

*Mentor: Gillian Harkins, English*

This paper examines knowledge production under the umbrella of the western capitalist state, i.e. liberalism, and how feminist academic discourse created under the structure of the university, academic journals and books exists within hegemony and does not represent the voice of the subject that it wishes to 'rescue' from the hegemonic order, but in fact is partnered with the hegemony that satisfies both the hegemony and the voice of liberal feminist critique. This paper also critiques the emergence of Non Governmental Organizations and how liberal feminist ideology is connected to the development of Non Governmental Organizations (NGO). I use three primary documents to best illustrate my thesis; Melissa W. Wright's piece titled, *A Manifesto Against Femicide*, where she argues to make a connection between capitalism and violence, and Julia Monarrez Frago's *Serial Sexual Femicide in Ciudad Juárez* which offers a blunt and unapologetic critique of the hegemony as the underlying reason for the violence against the women of Juárez. Sabine Lang's piece on the NGO-ization of feminism is used to support my theory of NGOs as means to partner with feminist ideology in order to pacify critique of hegemony by the inherent distractions of structure building such as capital, communication, policy, thus 'watering down' the essence of the initial goal of a humanitarian objective. Globalization is used as the occurring theme in critiquing knowledge production and how it has cultivated and changed the way the subject and violence are viewed. Thus this process of thinking about violence has itself lent to the invisibility of the Juárez murders.

### **Predicting Type 1 Diabetes using a GAD65 Antibody Assay**

*Chad Rogers, Junior, Sociology*

*Mary Gates Scholar*

*Mentor: Ake Lernmark, Medicine*

*Mentor: Dong Luo, Medicine*

Type 1 diabetes, or insulin dependent diabetes mellitus (IDDM), is an autoimmune disease where the body attacks and destroys insulin producing beta cells. Each year 11,000 to 12,000 children are diagnosed with IDDM, making it one of the most common chronic disorders among children. Type 1 diabetes is often diagnosed only after symptoms such as frequent urination, increased thirst, and unexplained weight loss are present in a patient. Because diabetes is often diagnosed post-onset it is possible that irreversible damage may take place prior to proper diagnosis. Research has shown that glutamic acid decarboxylase 65 antibodies are present in 50-80% of recent-onset IDDM patients. It is believed that GAD65-antibodies can develop many years before the clinical onset of diabetes. By developing a method to detect the presence of GAD65-antibodies it may be possible to diagnose IDDM prior to onset. If patients are made aware of their increased risk of developing diabetes prior to its onset it would allow them to adapt to a lifestyle that would minimize the impact of diabetes. Being aware of the risk would also allow the patient to pay careful attention to early symptoms so that treatment can begin as soon as diabetes develops. By molecularly engineering the fusion protein biotin-glutamic acid decarboxylase 65, it has allowed us to design a non-isotopic assay that can detect the presence of GAD65-antibodies prior to the onset of diabetes. Our GAD65-antibody assay has great potential for future clinical application as a diagnostic tool and could aid the way that future diabetes cases are diagnosed. Earlier diagnosis would lead to a faster and more efficient treatment that would give those at risk for IDDM a greater outlook in managing their disorder.

### **Quantifying Metabolism with Nuclear Magnetic Resonance Spectroscopy**

*Joshua Rusk, Sophomore, Biochemistry*

*Mary Gates Scholar*

*Lauren Palmer, Freshman, Biology*

*Space Grant Scholar*

*Mentor: Martin J. Kushmerick, Radiology,*

*Bioengineering, Physiology, Biophysics*

With long term space flight becoming a reality, muscle atrophy caused by zero gravity is a serious concern. Although much is known about the process of muscle metabolism, quantifying the metabolic processes could lead to methods of maintaining muscle in space. Working under the direction of Martin J. Kushmerick, MD, PhD, of the University of Washington departments of Radiology, Bioengineering and Physiology and Biophysics, our

research measures phosphometabolites through a process called Nuclear Magnetic Resonance Spectroscopy (NMR). Due to the magnetic properties of nuclei in phosphometabolites such as phosphocreatine, inorganic phosphate and adenosine tri-phosphate, magnetic pulses can excite the spins of the atoms in these phosphorous containing molecules. As these spins return to their natural randomized state, we electronically measure the amounts of these three phosphometabolites. For our experiments, we use the extensor digitorum longus (EDL) muscle from the hind leg of the mouse and sustain it in a salt solution simulating the muscle's natural environment. We subject the muscle to periods of anoxia (deprivation of oxygen simulating muscle activity) to deplete the phosphometabolites and then measure the recovery time course after oxygen is restored. Results thus far look promising to find an equation that fits the rates of recovery. Our current and future work measures lactate produced by the muscle during these experiments. Lactate is a byproduct of fermentation, the process generating energy as oxygen levels are depleted in the muscle. In the long run, this work will hopefully help doctors provide treatment solutions to muscle atrophy and rehabilitation and also may be applicable to energy metabolism in other organs.

#### **PIV Data Outlier Identification**

*Adi Salehuddin, Senior, Aeronautics and Astronautics*  
*Mentor: Dana Dabiri, Aeronautics and Astronautics*

Particle Image Velocimetry (PIV) is a method of measuring velocity fields. The PIV method is achieved by acquiring two images shortly after each other and calculating the distance individual particles travel within this time. From the known time difference and the measured displacement the velocity profile is calculated. PIV data has allowed the analysis of fluid particle motion to improve significantly. However, the data acquired may contain several erroneous points that are called outliers. These outliers result in the misrepresentation of the particle motion profile. The current methods widely used today utilize a specific threshold point of cutoff for the outliers. Any change in velocity that is calculated to be higher than this constant threshold is automatically deemed an outlier. This results in a serious problem: the removal of data that is correct, for example in an area of high gradient change. The current research being conducted requires the implementation of a refined method of outlier identification. This method would enable the threshold to vary depending on the velocity profile around the node of interest. To obtain this variable threshold, the velocity profile of the local area around the node of interest is considered. This allows the threshold to better accommodate the changes in velocity profile of a specific region. This method will allow for better accuracy, especially in zones of high gradient. Any node that is determined to outside the threshold is tagged and replaced with a velocity profile that is averaged from the local area.

The end result would be a velocity profile that is more representative of the actual fluid profile.

#### **The Modern Girl around the World Project: India**

*Gazelle Samizay, Senior, International Studies, Interdisciplinary Arts*

*Mary Gates Scholar*

*Mentor: Priti Ramamurthy, Women Studies and International Studies*

Literature regarding globalization has focused on the economic effects of increased trade and cultural homogenization, ignoring the impacts of globalization on gender and racial identities. The Modern Girl Project seeks to explain how globalization is an important force in universalizing conceptions of gender, class, race, sexuality and modernity in India and around the world. Modern girls appeared worldwide in the early to mid-twentieth century, and were often seen as seeking sexual, economic and political emancipation by stepping outside of their traditional roles as daughters, wives and mothers. Because modern girls were usually identified by the cosmetics and fashion they wore, Professor Priti Ramamurthy and I are trying to trace the development of their identity in India through the commodities they purchased. I have been collecting data on the modern girl in India by examining magazines, newspapers and films from the 1920s-1960s for articles, images, and advertisements that define the modern woman in specific ways, especially racially. I have found many advertisements depicting modern Indian women using whitening creams produced by multinational companies. This illustrates how multinational companies played a role in defining the modern woman as white through the products they sold and their marketing strategies. Film was another global commodity that facilitated the creation and transmission of the image of the modern woman internationally. Certain actresses who were popular worldwide became symbols of the modern woman through the roles they played. Silent film has been particularly important to the study of the modern girl because silent films were understood regardless of language comprehension or literacy level, enabling them to reach a truly global audience. Through our research, we have found that global trade, consumption practices, mass media and culture have interacted to decompose, reinforce and recreate conceptions of femininity in India and around the world.

#### **Adaptation: Interface Modification on Dynamic Web Pages Through User Access Data-Mining**

*Lee Sam, Senior, Informatics*

*Mentor: David McDonald, Information School*

The human-computer interface has always been an actively problematic issue in the world of information science. Widely studied, the interaction is the focus of numerous research papers. Drawing upon past work from Intel

Research Labs and the University of Washington Computer Science department, this project evaluates a number of active interface adaptation techniques to find their relative effectiveness. Adaptation techniques essentially work by hiding and exposing selective information to the user, and can be classified by the basis of their operation. The first is a class of visually based adaptations, which includes techniques like color and font size modification. These techniques try to expose useful information by modifying the appearance of the interface. The other class of adaptation is based on modifying site structure, bringing relevant information “closer” to the user. This class of adaptation includes techniques like cluster linking where conceptually similar pages are grouped together, and the promotion/demotion of pages within the site hierarchy based on use. By comparing these two major types of adaptive techniques, based on visual and structural modifications, we can see the pitfalls of each. We can learn from these failures and shortfalls to eventually develop an evolutionary adaptation system for active web sites. To accomplish this, this study exposes two groups of users to one of the two classes of adaptations on a website and asks them to find information. Measuring the time and the number of page browses it takes for users to find specific information as well as their relative levels of user frustration, we can rate these adaptation strategies relative to a control group. This study will give insight into which adaptations work most effectively in an information seeking context.

### **Object Oriented Finite (OOF) Element Analysis of Computational Modeling of Real Microstructures**

*Ravi Mikkelsen, Junior, Materials Science and Engineering*

*Mary Gates Scholar*

*Joe Schmeller Junior, Materials Science and Engineering*

*Kaishi Wang, Junior, Materials Science and Engineering*  
*Mentor: Raj Bordia, Materials Science and Engineering*

Computational materials science provides an effective tool for predicting the properties of materials and designing materials with specific properties. A significant challenge in realizing this is the limitation of conventional techniques in dealing with realistic micro and nano structures. The National Institute of Standards and Technology, N.I.S.T. has recently developed a new approach to address this limitation. The process begins by taking a microstructure of the material and then importing it into the software package. A mesh is then created and each phase is assigned its respective properties. From there, different virtual experiments can be run. The current version can run both thermal and mechanical simulations but OOF2, to be released this year, will add electrical and chemical simulations. Our current experiments are run on a two-phase brass system, trying to accurately model various mechanical properties of each phase. Experiment 1:

Compare Young’s Moduli of the two phases and the composite of the two to see if predicted results can be obtained. Experiment 2: Compare thermal expansion coefficients of the two phases and the composite of the two to see if predicted results can be obtained. Experiment 3: Change the volume ratio of the phases and repeat experiments one and two. The results obtained thus far have proven the power of this software to corroborate our predictions. In this project our eventual goal is to predict the electrochemical and thermoelectric properties of porous ceramic materials. This project ties in closely with experimental projects in the group to optimize the processing and microstructures of cathodes for solid oxide fuel cells and oxide thermoelectric devices.

### **Oxidative Stress Elevates the DNA Repair Activity of Apurinic/Apyrimidinic Endonuclease in Human Gliomas**

*Allison Schmitt, Senior, Biochemistry, Chemistry*

*Howard Hughes Scholar*

*Mentor: John Silber, Neurological Surgery*

Gliomas are among the most lethal of human cancers, with less than 20% of patients surviving more than two years after diagnosis. The poor prognosis for gliomas reflects their resistance to alkylating agent-based chemotherapy. Numerous laboratory and clinical studies have implicated DNA repair as a mechanism promoting resistance to the alkylating agents commonly used to treat gliomas. Importantly, the Silber lab has demonstrated that a number of DNA repair activities are elevated in human gliomas compared to adjacent normal brain. One of these activities is apurinic/apyrimidinic endonuclease (Ap endo), an enzyme that initiates the excision of baseless sites induced by alkylating agents. *In vitro* studies have demonstrated that Ap endo can contribute to human glioma cell alkylator resistance. However, the mechanism underlying the increase in Ap endo activity occurring during tumorigenesis in the brain is unknown. Our hypothesis is that elevated oxidative stress, reflecting the greater oxygen utilization accompanying tumor cell proliferation, promotes elevation of Ap endo activity. To test this hypothesis, endogenous oxidative stress was reduced by adapting two human glioma cell lines maintained at ambient oxygen tension (21% O<sub>2</sub>) to grow at 5% O<sub>2</sub>. After four weeks, exposure to the lower oxygen tension slowed the rate of glioma cell growth. Moreover, Ap endo activity and resistance to the clinically utilized methylating agent temozolomide and chloroethylating agent BCNU were reduced nearly two-fold in both lines. These findings support our hypothesis and provide additional evidence for a role for Ap endo in glioma resistance to alkylating agents. Notably, we have observed an inverse correlation between Ap endo activity and time to tumor progression following alkylating agent chemotherapy in grade II and grade III gliomas, suggesting that reducing Ap endo may improve clinical response. Lowering endogenous oxidative stress may be one strategy

to increase the clinical effectiveness of alkylating agents in gliomas.

### **High Powered Helicon**

*Thomas Schnackenberg, Senior, Physics, Earth and Space Sciences*

*Mentor: Robert Winglee, Earth and Space Sciences*

The High Powered Helicon (HPH) is for efficient electric plasma propulsion. For a propulsion system we wanted fast-moving, high-density plasma. Using hydrogen for fuel we have seen densities of around  $10^{17}$  particles per cubic meter and particle speeds of 40 to 80 kilometers per second downstream from HPH. Those speeds are 10 to 20 times faster than what you can get with chemical propellant. Using this we can get a rough idea of how much force HPH can produce, which is approximately 0.5 to 2 newtons. HPH is doing this with 20 to 30 kilowatts of power. This is comparable to the best Hall Effect Thrusters today. Currently we are trying to better understand how HPH works and what it can do. As a thruster it looks to have the potential to be as good as other advanced propulsion methods. It also looks to have potential for the manufacture of semiconductors, which uses plasmas to etch silicon wafers.

### **Regulation of *Salmonella* Virulence by the PhoPQ System**

*Anna Schneider, Sophomore, Biochemistry*

*Mentor: Sam Miller, Microbiology*

Bacteria from the genus *Salmonella* exhibit a broad host range and infect different vertebrate animals, including mice, cattle, birds and reptiles. In humans, *Salmonella typhimurium* is associated with food poisoning and gastroenteritis, while *Salmonella typhi* causes a severe systemic disease in humans called typhoid fever. During its life cycle, *Salmonella* resides in different host tissues, such as the intestine and—in the case of systemic infections—in the liver and spleen. For *Salmonella* to cause disease, it is crucial to sense signals specific to a particular host environment and to adapt to each environment accordingly. This project studies PhoQ, which is a central regulator of *Salmonella* virulence, by both *in vitro* and *in vivo* techniques. The PhoQ protein is involved in signal sensing, and activates the transcription factor PhoP. The expression of PhoP-dependent genes ultimately results in the survival of *Salmonella* in the hostile environment of the infected organism. The goal of the project is to discover what signals are relevant *in vivo* and what regions of the PhoQ protein are important for signal sensing. PhoQ is known to respond to metal ions such as magnesium and calcium. We have shown that PhoQ activity is also regulated by antimicrobial peptides—important antimicrobial molecules produced by the immune system. We are studying these responses by engineering PhoQ mutant proteins. We use quantitative expression analysis

to determine whether these proteins respond to magnesium or to antimicrobial peptides. Utilizing a mouse model, we are also testing the virulence of *Salmonella* strains expressing these mutant proteins. This approach will shed light on how PhoQ senses various environmental signals, which has important implications for host–pathogen interactions.

### **The President, Volunteerism, and Social Services**

*Lindsay Scola, Junior, Political Science*

*Mentor: Bryan Jones, Political Science, Center for American Politics and Public Policy*

*Mentor: John Wilkerson, Political Science, Center for American Politics and Public Policy*

In his 1989 inaugural address President George Bush stated that he was launching a national program to encourage citizens to do voluntary activities previously covered by government funding. Following this occurrence was one of the largest cut in the social services budget. This begs the question: when Presidents focus their attention on volunteerism, does this result in the reduction of social services spending? Also, do administrations believe that by encouraging citizens to take a more active role in volunteerism that there is no longer a need for many of the services that government invests in? When there is an effort by the executive body to encourage citizens to become more active in issues such as volunteering in food banks, homeless shelters, etc. is there a direct reduction in social services? I will be looking at every Executive order, Congressional Bill, document, or hearing that in some way defines volunteerism or is directly related to volunteerism. This data will be my independent variable and I will be using the budget cuts in this area as my dependent variable. All data used in this research will span from 1973 to present. I predict that there is a direct correlation between the emphasis that an administration places on volunteerism and the amount of money given to the services citizens are volunteering for. I also expect to find that President Bush's "Thousand Points of Light" was not a one-time occurrence and that there has been a trend showing similar behavior of other presidential agendas and initiatives.

### **Measurement of Moisture Distribution in Organic Materials**

*David Seater, Junior, Electrical Engineering*

*Mary Gates Scholar, Space Grant Scholar*

*Mentor: Alexander Mamishev, Electrical Engineering*

Real-time non-invasive moisture content sensing techniques are needed for online moisture measurement and control in food products. In this investigation, a dielectric spectroscopy based system is used to detect moisture loss in store-bought, pre-baked cookies. Experiments were conducted with a planar dielectric sensor in the frequency range from 10 Hz to 30 kHz over a period of several hours.

## **Using Sensor Fusion to Create a Real Time Action Tracking System**

*Matthew Nevitt, Senior, Informatics*

*Kabir Shahani, Senior, Informatics*

*Brandon Tengan, Junior, Informatics*

*Geoffrey Velasco, Senior, Informatics*

*Mentor: David McDonald, Information School*

The lack of 'real-time' quantitative feedback of individual performance has plagued participants of skateboarding (and other extreme sports/action sports) since its inception. The absence of accurate, objective, real-time statistical information for judging and evaluating the performance of extreme athletes is a severe information problem. Through a careful needs analysis and work with a number of experts in various technical fields (both hardware and software), our team has successfully designed and implemented a system to solve this information problem. In the initial prototype, sensors have been embedded into a skateboard. Using the instrumented, skateboard telemetry was collected for a few basic skateboarding maneuvers. This sample telemetry was used to facilitate the development of the presentation software which uses the data to calculate the height the skateboard travels off a half-pipe. Both a Human-Centered dimension and a Technical dimension are equally represented in the design, an aspect which is crucial to its success. While this particular proof of concept has been implemented for a skateboard, it is important to note that this project is only indicative of a much larger application in providing 'real-time' statistics for other objects in such an environment. While the proof of concept has been established through the system's current state, more rigorous field testing is in progress to determine exactly how well the sensor fusion can accurately determine the desired data points. We are confident that little variation to the current design will be required to complete the prototype's fully desired functionality. The successful implementation of this project is critical to a number of emerging fields. The ability to fuse existing technologies to extract information from real world problems shows great promise for both the field of sensory perception and action sports.

## **Temporal Change in Barrett's Esophagus Segment Length (BESL) During Prospective Surveillance**

*Leilani Sharpe, Senior, Biochemistry*

*Mary Gates Scholar*

*Mentor: Brian J. Reid, Medicine*

Barrett's Esophagus (BE) is a condition in which the normal lining of the esophagus is replaced with metaplastic epithelium as a consequence of chronic reflux of gastric acid into the esophagus. Traditionally, patients with BE have been treated with medications to decrease acid reflux, including antacids initially, followed by H<sub>2</sub> receptor antagonists (H<sub>2</sub>RAs) and, more recently, proton-pump inhibitors (PPIs). Although not all studies have reached statistical significance, retrospective case-control studies

and prospective cohort studies have shown trends towards increased risk of progression to cancer with increasing Barrett's esophagus segment length (BESL) when segment length is measured as a continuous variable. However, relatively little is known about prospective changes in Barrett's esophagus segment length. The aim of this study was to investigate BESL changes during prospective surveillance and factors contributing to BESL change. Endoscopic landmarks were followed prospectively in 467 patients for an average of 5 years and changes in BESL were monitored at well-defined endoscopic intervals and recorded in a database. Individuals with BESL change outside of the expected statistical variation during follow-up were further analyzed for contributing patient and environmental factors. Analysis of the collected data suggests that: (1) Most BESLs remain stable during prospective follow-up, (2) Patient gender and the length of follow-up do not seem to affect the rate of change of a Barrett's segment length, (3) Extended treatment with PPIs appears to contribute to decreased BESL, (4) Smaller hiatal hernia and shorter baseline BESL increase a patient's likelihood of complete regression of BE.

## **Human Toll-like Receptor 4 Polymorphisms in Caucasian Periodontal Patients**

*Yang-Luen Shih, Senior, Biochemistry, Chemistry*

*Mentor: Frank Roberts, Periodontics*

*Mentor: Beth Hacker, Periodontics*

Periodontitis is an inflammatory disease caused by chronic activation of the host response to oral bacteria resulting in alveolar bone loss. One of the characteristics of gram negative bacteria is that the lipopolysaccharides (LPS) can be recognized as foreign by the innate immune system. LPS binds to the surface of the host cell through the human toll-like receptor 4 (hTLR4). A single nucleotide polymorphism (SNP) in hTLR4 (Asp299Gly) was found which might correlate to a difference in the innate immune systems response to LPS. The objective of this investigation was to examine whether SNPs in hTLR4 are associated with periodontitis by studying both periodontitis affected and healthy Caucasian patients. Human genomic DNA samples were collected from cheek swabs and the DNA was isolated, amplified through PCR. The DNA was then purified, concentrated, and sequenced. The result of the study was that the Asp299Gly substitution was found in 8 of 51 healthy subjects and in 3 of the 46 periodontitis subjects sampled. This data was not significant, possibly due to low SNP prevalence in the population.

## **Measurement Improvements of a Two-Chord Interferometer**

*Ted Shreve, Junior, Aeronautical and Astronautical Engineering*

*Mary Gates Scholar*

*Mentor: Uri Shumlak, Aeronautical and Astronautical Engineering*

The objective of this research is to improve the performance and data analysis of a two-chord interferometer—a diagnostic implemented to characterize the behavior of plasma generated in the ZaP Flow Z-Pinch Experiment. The ZaP Experiment investigates the stabilizing effects of sheared flow in plasma, a highly ionized gas. In plasma, the electrons are free of the nuclei of the gas atoms. The two-chord interferometer measures the chord-integrated electron density, the number of electrons per area integrated along the chord length of a laser beam through the plasma, through two locations. Chord-integrated electron density measurements taken by the interferometer are improved by techniques implemented to decrease unintentional reflections, diffraction, and misalignment of the laser beam. Cleaning and remounting the steering mirrors and beamsplitters decreases the deleterious effects and improves the quality of the data. Aiming the beams to a far wall with an extra mirror permits more accurate alignment, which leads directly to improved data quality. The data analysis can also be improved by using a more robust algorithm to analyze the data. When the signal from the interferometer drops to or near zero, small errors in the measurement cause large discontinuities in the data, which produced errors with the previous data analysis algorithm. A new algorithm has been implemented which analyzes the data moving both forward and backward in time to assure the initial and final densities are zero. The new algorithm significantly reduces the errors associated with low signal level and, thereby, increases the quality of the measurements. Such improvements to the data and analysis method permit better characterization of the behavior of the plasma and make the interferometer a more accurate and versatile diagnostic. The capability of the interferometer can be further improved by adding additional chords for more complete and higher quality measurements, such as density profile information.

### **Investigation of the Hearing Mechanism via Absolute Pitch**

*Samuel Skinner, Senior, Physics, Astronomy*

*Mary Gates Scholar*

*Mentor: Vladimir Chaloupka, Physics*

Absolute pitch is a rare ability that enables an individual to determine frequencies of musical tones very precisely and accurately. Most people have relative pitch, the ability to determine the ratio of two frequencies. Professor Vladimir Chaloupka has tested the identification of random-frequency tones with individuals that have varying degrees of accuracy. The goal of the research is to examine these experiments and gain a greater understanding of the parameters of pitch determination. The piano, having quantized output tones, can lead subjects to categorize random frequencies into standard musical tones. We are investigating how the associations with different musical tones affect accuracy and precision of the response. This

research is an example of non-invasive approach to the study of the hearing mechanism.

### **Local Political Information Recommender**

*Diane Slota, Senior, Informatics*

*Mentor: David McDonald, Information School*

At election time, many voters take seriously their responsibility to cast an informed vote. However, becoming informed about local political issues and candidates often presents a challenge, despite the flood of mass mailings. There is a need for Web-based, current information on local politics, including opinion articles, editorials, news articles, cartoons, and the like. Such a system might handle local political information in three ways: (1) search for and browse relevant published information regarding local issues and candidates, (2) participate in discussion forums, and (3) assign ratings to articles as a way to collaboratively filter information that is of particular value to the people doing the ratings. My implementation focuses on the third part: the system recommends articles and other content items to users based on their own prior ratings and other people's ratings of the items being recommended. In assessing user needs, I interviewed voters of different political leanings about how they become informed about local political issues and candidates, and how they recommend political information to others; I also analyzed how they rated two sample articles. Based on the user needs assessment, I collected recent articles published in local newspapers and asked my users to rate some of them using the revised rating scales. I used an open-source recommender tool that operates a database to hold the ratings and calculate recommendations based on the ratings. To evaluate the user interface, I created Web pages containing the actual recommendations, and observed my users interacting with the Web pages. Commercially, recommender systems are often used to help people make buying decisions. Deciding which candidate or issue will receive one's vote can be equally wrenching. My project sheds some light on how people might rate and collaboratively recommend political information in a local context.

### **Piloting a Fast-Response Survey System for Washington's Teachers**

*Cable Smith, Senior, English*

*Mentor: Margaret Plecki, Education*

The focus of our study is to collect information about the teacher workforce in Washington State that is not contained in existing state databases. My primary focus working with the research team has been to pilot and assess the feasibility of a fast-response survey system using a standing sample of Washington teachers. This fall and winter, our UW team administered two of three surveys to a standing sample of slightly more than 400 classroom teachers. Our goal has been to create and test the structure of such a system, while yielding useful findings about pertinent

issues on the teaching quality agenda. In order to create a statistically representative sample of the state's teachers, the teachers have been stratified by region, experience-level and school poverty-level. We used the state's personnel database (S-275) for 2002-03 to generate the population sampling grid. The personnel database includes all teachers in the State of Washington. The database contains information such as the number of years of teaching experience, the district, and school in which the teacher works. The fast-response surveys will also be employed to explore the design and conduct of a system with a larger sample, in the future. Our research shows that a fast-response survey system is feasible for the state. It illustrates that efficient returns from a willing sample of teachers will yield good data on issues relevant to the conditions faced by Washington's teacher workforce.

### **Office Window of the Future? Two Case Studies of an Augmented Window**

*Robin Sodeman, Senior, Informatics*

*Mentor: Batya Friedman, Information School*

Millions of people in the United States work everyday in inside offices. Could a large screen plasma display acting as a window make a positive difference? Using HDTV technology, we experimented with this possibility. We mounted an HDTV camera on a university building overlooking a public plaza and streamed real-time images to a large 50" plasma display in the participants' interior offices. Data was collected over a 17-week period: 6 weeks with the interior office "as is", 6 weeks with the plasma display, and 4 weeks following the removal of the plasma display. Throughout the study, participants completed seven 30-45 minute interviews, 10 work satisfaction, mood, and office perception surveys, as well as journal entries, and responses to email queries. Seven case studies were conducted; this poster reports on two, Nina and Daniel. Nina is a 45-50 year old female lecturer at the university; Daniel is a 30-35 year old male staff member. In their windowless offices, both Nina and Daniel used their plasma displays to view live video of the plaza. In addition, Nina displayed personal images and integrated the display into her work activities. Nina's overall experience with the display was positive, citing satisfaction with the connection to nature it afforded and the benefit to her work practice. In contrast, Daniel reported a mixed experience with the display. He enjoyed the display's aesthetics and the connection it provided to the outside. However, Daniel could not get past thoughts that this technology was violating people's privacy and that passers-by might be uncomfortable if they knew their images were being displayed in nearby offices. Analysis of the remaining case studies is under way. Taken together, the results will position us to better understand the harms and benefits of reinventing the office window with plasma display technology.

### **Metallothionein Concentrations in Commencement Bay Mussels as Bioindicators of Metal Stress**

*Shannon K. Soto, Senior, Environmental Science*

*Mentor: James E. Gawel, Interdisciplinary Arts and Sciences*

The impact of industrial and urban land use on surface water quality have led to environmental concerns regarding trace metals in aquatic systems. Because of the sessile nature of mussels and their ubiquitous distribution in estuarine systems, they have been identified as suitable biological indicators of aquatic pollution. Mussels respond to intracellular metal stress by producing metallothioneins, low molecular weight, cysteine-rich, metal binding proteins. Therefore, metallothionein concentrations in mussels may serve as a molecular indicator of metal toxicity in estuarine waters. Three study sites along a suspected metal pollution gradient in Puget Sound were selected. Digestive glands, gills, and gonad tissues from *Mytilus trossulus* and a hybrid species collected from these sites were analyzed for metallothionein and cadmium concentrations. Correlations between metal levels, metallothionein production, and other physiological factors are explored.

### **Washington Kids Count**

*Diana Spence, Senior, Geography*

*Mary Gates Scholar*

*Mentor: Sheri Hill, School of Social Work*

The Northwest Rural Communities project is a collaborative effort by Children First of Oregon and Washington Kids Count that was made possible by a grant from the Annie E. Casey Foundation. The goal was to increase public understanding of the challenges facing northwest rural communities in order to better inform public policy makers, investors, and community leaders. Families living in rural communities often face different challenges than those in urban centers, but limited research has been done to address their specific needs. The project conducted focus groups with parents, educators, and community leaders in eight rural communities. To reflect the diversity of the region, some of the focus groups were conducted in Spanish and with the input of Native American leaders. "Rural" was defined as those counties that are considered "non-metropolitan" by the U.S. Office of Management and Budget (OMB), which are those with highly densely populated urban centers or at least one large city. Qualitative data gathered from the focus groups was then paired with quantitative data indicators. During this analysis some common themes emerged. Families consistently pointed to the need for reliable employment. Others cited the need for affordable, high quality childcare, primary and secondary education for children, continued education and job training for adults, affordable healthcare, better transportation, and activities for youth. Policy recommendations were broad and long range to reflect

diverse needs. Communities can build on existing strengths while addressing weaknesses by gathering better data, strengthening education systems, expanding economic opportunities, reviewing existing childcare programs, increasing the availability of transportation, and maintaining rural health initiatives. Residents of rural communities often pointed to the many positive aspects of rural living. By sharing their stories, the Rural Communities Project hopes to strengthen the well being of Northwest's rural families and to help secure their brighter future.

### **Characterizing and Mitigating Protein Adsorption Under Pressure-Driven Flow in a Microfluidic Device**

*Mark Steedman, Senior, Bioengineering*

*Space Grant Scholar*

*Mentor: Paul Yager, Bioengineering*

Proteins are a critical ingredient in most bioassays, but their tendency to adsorb (stick) to channel walls can be problematic. The goal of my research project is to determine efficient ways to reduce or eliminate protein adsorption in microfluidic channels. These channels are characterized by having at least one dimension less than one millimeter in length. The physical properties of such small channels allow for assays and diagnostic tests that are impractical or impossible on a larger scale. The Yager lab's mission is to develop medical diagnostic tools made of plastic laminates that utilize microfluidic channels. The advantages of these tools are that they are inexpensive, disposable, require only microliters of reagents, and are simple to design and easy to construct. Microfluidics is an emerging discipline that will form an integral part of Distributed Diagnosis and Home Healthcare (D<sub>2</sub>H<sub>2</sub>), a paradigm the University of Washington's Bioengineering Department has developed that aims to decentralize certain aspects of health care through the application of modern technologies. Contemporary healthcare has evolved into a centralized system that is normally very efficient and regulated. However, the necessity of a centralized healthcare system has at times resulted in overcrowded hospitals where patients are forced to wait hours for diagnosis and treatment. D<sub>2</sub>H<sub>2</sub> would eliminate the need for frequent hospital visits by relocating diagnostic tools and treatment methods from a hospital into a patient's home. Microfluidics shows promise to play a large role in D<sub>2</sub>H<sub>2</sub>, and mitigating protein adsorption in microfluidic channels will expedite the process of turning the advantages of Microfluidics into practical health care diagnostic solutions.

### **Effects of Gene Regulation on the Ability of Embryonic Chicken Pigment Epithelium to Develop into Retina**

*Christina Stratis, Senior, Neurobiology*

*Mary Gates Scholar*

*Mentor: Tom Reh, Biological Structure*

*Mentor: Branden Nelson, Biological Structure*

Did you know that some types of amphibians are able to regenerate their eyes if they are damaged, allowing them to see again? Unfortunately, humans do not possess the capability to re-grow eye tissue, but if we did, modern medicine could help many who are blind. Chickens are also able to regenerate the sensory part of the eye—the retina—from a surrounding layer of non-sensory tissue – the pigment epithelium—but only early in their embryonic development. Studies have shown that if a gene called “Pax6” is upregulated experimentally in frogs, they are able to grow extra eyes on the surface of their bodies. I hypothesized that if Pax6 was upregulated experimentally in the pigment epithelium of chick embryos without the presence of the retina, regeneration of the retina might be able to occur later in development. I began my experiments by first dissecting the pigment epithelium from the eyes of embryonic chickens. The tissue was then immediately transfected with DNA, coding for Pax6 and green fluorescent protein (GFP), using an electroporator. I was able to confirm the effectiveness of the transfection by looking for a green fluorescence emerging from the pigment cells under a fluorescing microscope. At first, the results of my research appeared to show that the upregulation of Pax6 allows the growth of retinal tissue from pigment epithelium in slightly later stages of embryonic development. However, several of the control pieces of tissue—those transfected with GFP alone—have also been able to generate new retina. It is possible that the electrical surge sent through the tissue during transfection polarizes the cells to encourage retinal growth from pigment epithelium. Future studies will investigate the ability of electricity to stimulate retinal growth.

### **Using Tablet PC Based Systems to Support Active Learning in the Classroom**

*Jonathan Su, Sophomore, Computer Engineering*

*Space Grant Scholar*

*Mentor: Richard Anderson, Computer Science and Engineering*

Traditional methods of classroom instruction via whiteboards or overhead projectors often restrict classroom interaction to the one-way activity of an instructor lecturing to the students. There has been much research on the benefits of active and collaborative learning and its use in the classroom environment. The emergence of new mobile technologies, like Personal Data Assistants (PDAs) and TabletPCs, that can be seamlessly integrated into the classroom environment leads naturally to the investigation of how these technologies can be used to support active learning in the classroom. We have developed a system extending Classroom Presenter – an application for using TabletPC “digital ink” with PowerPoint style slide presentations – that integrates both instructor and student devices to promote two-way active learning in the

classroom. Our system allows for student devices to connect to and follow along with an instructor's presentation. A unique feature of our system is that students can digitally ink on their devices, and when prompted by the instructor, can submit their inking to the instructor's device. This system allows the instructor to quickly gather and compile students' responses to in-class exercises and activities without interrupting the lecture or putting shy students on the spot. Initially, our system has been deployed to a number of Computer Science courses. In general, response to the system has been positive; students have been eager to submit their work to the instructor, encouraging a larger amount of more diverse classroom discussion as instructors can quickly display several different student-proposed solutions. Though in its early stages, the deployment of our system has shown that new technologies like the TabletPC can greatly benefit active learning in the classroom environment, and encourages further research in this area.

### **Place Lab: A Prototype for Designing Ubiquitous Location-Aware Wireless Services**

*Jason Tabert, Senior, Informatics*

*Eithon Cadag, Senior, Informatics, Business*

*Administration: Information Systems*

*Mentor: David W. McDonald, Information School*

Place Lab is an architecture platform to make location-enhanced web services valuable and readily accessible to a very large number of people in daily, real world, situations. Our approach is to create an open software base and build a user-developer community. By using standard wireless computing equipment, the Place Lab software listens for known wireless access points and attempts to triangulate a user's location. Once a location is determined, location-sensitive material can be presented to the user. A prototype for Place Lab was demonstrated at the 2003 UbiComp conference in Seattle, Washington. It acted as a type of conference and city guide. Data was collected from downtown Seattle by "war-driving"—collecting information about wireless access points and their GPS coordinates. A set of data including photos, locations, and descriptions of various places of interest at the conference and around Seattle was also created. The data then was organized into appropriate categories. As users moved throughout the conference and downtown Seattle, the software would dynamically present content that reflected items of interest nearby the user through a user-friendly Web-browser interface. The prototype proves that location-enhanced computing can be developed with minimal data collection and off-the-shelf wireless equipment. The success of the prototype spurs further research and development of location-aware computing, including the development of a website for community data collection, and the exploration of new location-enhanced services and applications. The Place Lab project is a joint research effort between Intel Research Seattle, the University of

Washington, UC San Diego, UC Berkeley, and Starhill Networks.

### **Sensitive Skin**

*Jason Tan, Junior, Computer Engineering*

*Mentor: Alexander Mamishev, Electrical Engineering*

Sensitive skin is a highly desired device for biomechanical devices, wearable computing, human-computer interfaces, exoskeletons, and, most pertinent to this paper, for lower limb prosthetics. The measurement of shear stress is very important because shear effects are key factors in developing surface abrasions and pressure sores in paraplegics and users of prosthetic/orthotic devices. A single element of a sensitive skin is simulated and characterized in this paper. Conventional tactile sensors are designed for measurement of the normal stress only, which is inadequate for comprehensive assessment of surface contact conditions. The sensitive skin discussed here is a flexible array capable of sensing shear and normal forces, as well as humidity and temperature on each element.

### **Cytotoxicity of 3-MAG in Human Glioma Cells**

*Bahareh Tavana, Senior, Biology*

*Mary Gates Scholar*

*Mentor: John Silber, Neurological Surgery*

The main focus of the Silber Lab is to study the resistance to chemotherapy in human brain tumors, due to DNA repair mechanisms, and to find methods of combating drug resistance, one of the major challenges facing chemotherapy. Our current hypothesis is that recurring tumors treated with alkylating agents will have elevated levels of 3-MAG relative to neoplasms that have not been treated with alkylators. For my individual project, I have been examining the role of 3-methyladenine-DNA glycosylase (3-MAG) enzyme in human gliomas treated with alkylating agent-based chemotherapy. Studies have shown that 3-MAG is involved in altering the chemical nature of alkylating agents used in chemotherapy, rendering them less cytotoxic. Over the past year and a half I have been able to show that the function of 3-MAG is repressed by treatment with alkylating chemotherapeutic agents. Cytotoxicity was determined by standard colony-forming assay. Briefly 500 to 1000 cells were plated and allowed to attach overnight at which point cells were treated with different concentrations of the drug for 1 hour, washed, fed with drug free medium and colonies enumerated following 2 weeks. The next phase of the project involved measuring the activity of 3-MAG in extracts of treated cells using radioactive precursors. The rate of release of Tritium 3 is quantitated in the presence and absence of antisense oligonucleotides (ASOs). My research for the remainder of my time at UW will be to continue to examine 3-MAG activity in human tumor cell lines. Thus far, my findings suggest that 3-MAG is a leading candidate for investigation

of glioma alkylator resistance. If the results of this study show that 3-MAG is in fact responsible for human glioma resistance to specific chemotherapeutic strategies this would provide sufficient justification to proceed to animal and clinical studies.

**Detecting the Little Ice Age on the Kodiak Archipelago: An Isotopic Analysis of *Saxidomus giganteus***

*James W. Taylor, Senior, Anthropology*

*Mary Gates Scholar*

*Mentor: Ben Fitzhugh, Anthropology*

Climate change is frequently credited with affecting significant changes in prehistoric culture. Proxy paleoclimatic records are often inadequate for substantiating such arguments and falsifying competing propositions. In this study, I use isotopic analyses of archaeological shells to infer Gulf of Alaska water temperatures throughout the past 800 years. Using shells of *Saxidomus giganteus* from the stratified New Karluk (KAR-1) site on the Kodiak Archipelago, I test the argument that Little Ice Age cooling coincided with a time of significant subsistence and technological change (an increased focus on fishing) in the AD 1400 levels of the site. The complex relationship between temperature and salinity of the water in which this aragonitic bivalve grows and the incorporation of oxygen into the carbonate shell of this specimen based on these two variables is also investigated through minor elemental composition. ICP-MS analysis of Sr/Ca and Mg/Ca ratios in modern and ancient specimens are correlated with  $O_{18}$  records in order to determine if these ratios approximate the influence of salinity on the isotopic record. This study investigates the potential effects of global climate fluctuations on past societies. I emphasize the role of environmental instability in affecting changes in subsistence lifestyles and how this may have influenced cultural trajectories along the Kodiak Archipelago. Other non-archaeological records seem to indicate Little Ice Age effects during this period. This is the first attempt to tie climate proxies directly to Gulf of Alaska archaeological Assemblages.

**Characterization of Sensor Error for use in the Control of Formation Flying Satellites**

*Garrett Teahan, Senior, Aeronautics and Astronautics*

*Mary Gates Scholar, Space Grant Scholar*

*Mentor: Mehran Mesbahi, Aeronautics and Astronautics*

Formation flying satellites utilizing cooperative control is an enabling technology that will bring about breakthroughs in earth and space sciences. The goal of the Distributed Space Systems Lab, as a part of the Department of Aeronautics and Astronautics, is to develop this technology to a point of maturation that will allow any space systems designer to take advantage of the benefits that may be received from using this technology. My role, through

this project, has been to develop a simulation environment for a sensor that is both accurate and efficient. The sensor I designed used methods derived from carrier phase GPS to compute the relative position between the receiving and transmitting satellites. The majority of this simulation was completed over the summer and fall quarters and work since then has been to increase the efficiency of the simulation. After increasing the efficiency by reducing the runtime by an order of magnitude I proceeded to characterize the amount of measurement error so that it may be implemented in designing and simulating the control laws developed by graduate students in the Distributed Space Systems Lab.

**Penguin Survival**

*Diana Thayer, Sophomore, Biology, Applied and Computational Mathematics*

*Space Grant Scholar*

*Mentor: P. Dee Boersma, Biology*

Several life history traits are crucial for understanding population dynamics. These include age structure of the population, reproductive success, sex ratio, and survival. How environmental change may impact recruitment into the breeding population can be assessed by using a 21 year data base. Reproductive success is variable between years, but is this variation reflected in recruitment into the breeding population and age of first reproduction? Are males or females more likely to recruit at a younger age? I will use 21 years' worth of data on the breeding Magellanic penguins of Punta Tombo, Argentina to examine these questions.

**Erosion Rates of Oregon and California Coast Ranges Measured by Cosmogenic Nuclides**

*Nathaniel Thompson, Senior, Music Education*

*Mentor: John Stone, Earth and Space Sciences*

The coast ranges of Oregon and California on the west coast of the United States are tectonically active and subject to erosion. As these are interrelated forces affecting uplift, and as they are not completely understood, we seek to find the long-term erosion rate, and how it may or may not relate to the rate of tectonic uplift. To this end, we collected fifteen samples of sand from coastal rivers in Oregon and California. The samples span an area of differing uplift rates, slower in Oregon, and faster in California. We intend to determine an average long-term erosion rate within each river basin by measuring the accumulation of the nuclide beryllium-10 in quartz crystals. Be-10 is a rare nuclide produced by cosmic-ray bombardment of O and Si atoms within quartz crystals. As the cosmic-ray flux decreases rapidly with depth below the surface, sediment shed from rapidly eroding surfaces has lower Be-10 concentrations than sediment shed from slowly eroding surfaces. Thus, we can use measurements of Be-10 in river-

borne quartz to determine the erosion rate in the drainage basin of the river.

### **X-Linked Spasticity and Parkinson's Disease**

*Lisa Tisch, Senior, Cellular and Molecular Biology*

*Mentor: Wendy Raskind, Medical Genetics*

Spasticity is a neurological condition that causes continuous muscle contraction, resulting in hypertonicity, muscle spasms, and fixed joints that often interfere with movement and speech. The condition may develop as a neurological disorder or as a side-effect of many other diseases or cerebrospinal injuries that cause damage to nerve pathways involved in the regulation of muscle function. Parkinson's disease is also a neurological disease resulting from damage to the central nervous system, but is localized to the dopaminergic nerve cells in a region of the midbrain called the substantia nigra. The disease is characterized by a resting tremor, muscle rigidity, masked face, and stooped posture. Parkinson's is a degenerative disease, with symptoms increasing over time and manifesting from an increasing shortage of dopamine in the brain. A family was identified in which five males are affected with either spasticity or parkinsonian symptoms, or with both. The combination of symptoms indicates a new, previously undefined neurological disease. The disease transmission is consistent with X-linkage, resulting in affected males related through unaffected females. The goal of this project was to verify X-linkage through statistical analysis of chromosomal markers, and to potentially locate a promising region in which to look for the mutation causing the disease.

### **F.I.R.S.T. Robotics**

*Anna Tonkonogui, Senior, Philosophy, Pre-Engineering*

*Mary Gates Scholar*

*Mentor: Alexander Mamishev, Electrical Engineering*

FIRST (For Inspiration and Recognition of Science and Technology) is a nationwide nonprofit organization founded to increase student interest in science and technology. High school students, with mentors from businesses and universities, take part in an intense six-week robotics project. These students learn a wide range of skills consisting of mechanical engineering, electrical engineering, computer engineering, business, graphics design, web development, team work, programming, and computer animation. Participation in FIRST Robotics gives the students a realistic perspective on large-scale engineering projects, and exposes them to professional facilities and experts in the field.

### **Good Vibrations: the Physics of Music**

*Victor Tseng, Freshman, Bioengineering*

*Mentor: Vladimir Chaloupka, Physics*

In this project, I am addressing the question which has

preoccupied my mentor and I for a long time: what is the role of imperfection in sound in the creation of the perception of perfection? To tackle this question, I am using "soundfonts" (libraries of recorded samples of sounds of musical instruments, especially of the pipe organ). These samples are massaged, detuned slightly, and added together in an attempt to craft intricate and lifelike sounds. I am also probing the function of transients such as "chiffing" (the split-second fuzzy noise that, say, a flute makes before the steady tone) – chiefly, how does the chiff rework or bias our perception of the subsequent steady tone? The marvel of computers allows me to actually run algorithms that convolute the tuning, layering, splicing and dicing of soundfonts in an orderly way. Even a "failure" of this study would be very interesting – maybe the recreation of real musical sound is beyond the power of machines. It might drive home what music intuitively is: not a bunch of digitally fused imperfections, but a flower to the ear ... a trembling.

### **Control of Molecular Shuttles by Localized Fuel Delivery**

*Robert Tucker, Junior, 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 molecular 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.

### **A Possible Mechanism for Representing Contextual Information in the Brain.**

*T. N. Turner, Senior, Psychology*

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

Learned information is linked to the context where the learning occurred with memory retrieval being best when testing happens in the original context. Although much is known about the brain mechanisms of learning and memory, little is known about how the brain encodes contextual information. Past research has suggested that specialized brain circuitry, including the hippocampus, anterior thalamus and retrosplenial cortex plays a critical role in learning, spatial navigation and context processing. For example, animals with hippocampal damage are unable to use contextual information to guide their behavior. The goal of the present study was to look for patterns of brain activity that could serve to identify a learning context. We recorded brain activity, in the form of neuronal action potentials, while rats learned to approach one reward location during the first half of a training session and a different location during the second half. Since the environment remained unchanged during training, the context was defined by the subjects' knowledge of the reward locations. Consistent with previous studies, many neurons exhibited location-specific firing and many responded to task relevant events (e.g. reward). Remarkably, many neurons exhibited completely different response patterns in the two contexts. For example, a neuron that responded to the reward in one context could become non-responsive in the other context. Since many neurons exhibited context-specific responses, the overall brain activity exhibited by many thousands of neurons would be unique to a given context and could therefore serve as a neural code that would allow subjects to distinguish between similar contexts and produce the appropriate behavior.

### **The Geographical Scope and Limits of the World Social Forum: A Network Analysis**

*Kirsten Varg, Sophomore, Geography*

*Mary Gates Scholar*

*Matthew Sparke, Geography and International Studies*

Created four years ago as a counterweight to the World Economic Forum in Davos, Switzerland, the World Social Forum is an annual meeting of civil society representatives (i.e. those acting on behalf of organizations such as labor unions, human rights National Government Organization (NGO), environmental NGOs, etc.). United against neoliberalism, and under the banner of "another world is possible", delegates representing geographically far-flung NGOs are brought together with the purpose of envisioning alternatives to the current world system. One of the political ideals of the Forum is inclusiveness. However, as a result of global inequality and the high cost of travel, participation is uneven: overwhelming numbers of delegates come from

Europe and North America, and have been joined thus far only by delegates from around the general vicinity of the Forum's host country (Brazil and India to date) Representation from elsewhere in the Global South is minimal. This imbalance in attendance, in conjunction with the meeting and networking of NGO actors at the Forum, has resulted in the emergence of intricate sponsoring networks through which western NGOs contribute financially to the cost of travel to the Forum for NGOs from lesser developed nations. With this research, I examine the scope of these efforts and the degree to which they have had an effect on participation from the Global South at the World Social Forum. This research contributes to a larger NSF sponsored research project being conducted by Dr. Matthew Sparke and five graduate students in the Department of Geography. This project has already led to a paper 'The World Social Forum and the Lessons for Economic Geography,' that is currently in review at the journal *Economic Geography*.

### **Solute-Exclusion Dynamics of Polyacrylamide Gel**

*Chenyang Wang, Senior, Bioengineering*

*Mary Gates Scholar*

*Mentor: Gerald Pollack, Bioengineering*

Previous experiments have shown the internal surface of a polyacrylamide gel channel to repel microspheres (dia. = 1~10  $\frac{1}{4}$ m) suspended in water. This phenomenon is characterized by an aqueous zone adjacent to the gel surface that excludes all microspheres. The exclusion zone is theorized to be caused by the surface charge of the polyacrylamide gel, which organizes the neighboring water molecules according to the dipole moment. As a result, the densely packed water molecules act as a physical barrier to microspheres, preventing them from reaching the gel surface. The goal of our study is to further characterize the solute-exclusion phenomenon with parameters such as flow velocity, solute charge, and solute size. Preliminary studies have shown that the solute exclusion zone develops over time when the solution remains stationary within the channel. Under a non-zero flow condition, we hypothesize that the thickness of the solute-exclusion zone will increase as the microspheres flow from the inlet to the outlet. Furthermore, the overall thickness of the solute-exclusion zone is hypothesized to decrease with increasing flow rate. The thickness of the solute-exclusion zone will be measured with a variety of microspheres carrying neutral, positive, and negative charges. We hypothesize that the solute-exclusion zone will develop regardless of the charge of the microspheres. In contrast, solute size (dia. = 1~10  $\frac{1}{4}$ m) is hypothesized to affect the formation of the solute-exclusion zone. An apparatus is currently being developed to extract the water from the solute-exclusion zone of the channel. If successful, the apparatus could be further refined into a water purification system.

## **Development and Optimization of Protein Microarrays**

*Feiya Wang, Sophomore, Technical Communication  
Space Grant Scholar*

*Mentor: Richard Zangar, Pacific Northwest National  
Laboratory*

Protein microarrays allow simultaneous measurement of several proteins in small sample volumes, thus this procedure is an appealing alternative for quantitative measurements of proteins in biological fluids that are not readily available. The purpose of these experiments was to optimize a non-contact method of printing protein, and develop a technique to store printed slides for future use. The SynQuad, a non-contact fluid dispensing machine produced by the Cartesian Dispensing Systems company, was used to print the protein microarrays. It uses a high-speed microsolenoid valve which delivers volumes from 20 nL to 20  $\mu$ L. Several experiments with varying conditions were performed to test spot quality and spot diameter. A few of the conditions that were adjusted include the open time of the valve, the distance from the printing tip to the slide, and the humidity of the environment. In the storage experiment, slides were stored in air-tight containers in dry or wet conditions. The experiments on the non-contact protein dispensing method revealed that there are eleven factors that affect the size and quality of spots. Based on these results, additional optimization of the SynQuad will be necessary before it can be accurately compared with pin contact methods of protein dispensing. The storage experiments strongly suggest that slides that were treated and then stored for 2 weeks under dry conditions produce a fluorescence of comparable or greater than slides which were processed immediately. However, further experimentation should be done to confirm these results and to determine the maximum amount of time slides can be stored. These experiments are part of a larger project that is developing a sensitive, high-density microarray to process hundreds of proteins. This allows testing for proteins like hepatocyte growth factor, a protein that is found in high levels in breast cancer.

## **A Forcemeter Array Assembled from Microtubules and the Motor Protein Kinesin**

*James Wang, Sophomore, Bioengineering  
Antje Hanisch, Graduate Student, Materials Science and  
Engineering*

*Mentor: Viola Vogel, Bioengineering  
Mentor: Henry Hess, Bioengineering*

Nanotechnology, the revolutionary science field that has been rapidly developing in many laboratories, focuses on manipulating molecules or atoms in the range of nanometers (10<sup>-9</sup> meters). Our research centers on utilizing biological molecules, such as microtubules and kinesins, as components of hybrid nanodevices. Microtubules are composed of proteins (tubulins) that assemble into a tube-

like structure with a diameter of 30 nm (nanometers). Kinesins are motor proteins that “walk” on microtubules and act as transporters inside the cell. We try to utilize microtubules and kinesins in various synthetic devices. We are constructing a forcemeter array, which can measure the extremely small bonding forces between biological molecules. In our forcemeter array, microtubules with known rigidity are attached to a surface and act as a cantilever while a second set of microtubules transported by kinesin motor proteins pre-coated on the surface approach the cantilevered microtubule and connect through particular receptor/ligand molecules. The strain on the link between the receptor/ligand molecules (e.g. streptavidin/biotin) can be determined by monitoring the bending motion of the cantilever. The loading rate of the forcemeters mimics in-cell (in vivo) environments and is ideally suited for studying binding between biological receptor/ligand pairs. Critical parameters in the design of the forcemeter array are the distance between the cantilevered microtubules and the surface, and the concentration of the receptor/ligand molecules connecting the moving and cantilevered microtubules. My experiments are designed to systematically vary these parameters and determine the optimal values.

## **The Opportunity Knocks Project: Using Computer Software and Hardware to Benefit the Cognitively Disabled.**

*Kai Z. Wang, Sophomore, Computer Science  
Mentor: Donald J. Patterson III, Computer Science and  
Engineering*

There is a concern for the future of American citizens dealing with aging. The generations of baby-boomers are going to become the senior citizens of the near future. With the growth in the aging population, diseases associated with aging, such as Alzheimer’s disease (estimates approaching 16 million by 2050), becomes a huge issue. The Opportunity Knocks project is a system consisting of a mobile phone, Global Positioning System (GPS) Receiver, and remote web server. The program takes in GPS data about the current location of the user, processes it, and predicts where they will go next. If the person forgets how to get home, or misses a bus stop, the phone can act as a personal navigation assistant providing directional assistance and possibly alerting them. When the user uses Opportunity Knocks the phone will display the top few choices of where they might be going based on previous behavior. Upon choosing one of these locations, directions are given as to how to get there. Information about the user can also be sent to trusted caregivers if the user strays too far from their typical path. The purpose of the system is to give these individuals greater independence in their daily activities. The fundamental breakthrough of this system is that it requires no input from the user. The system receives current location from GPS and learns to predict future destinations from stored records of their past daily

activities. With initial development nearing an end, our next phase will be running a series of user-centered design studies first on students, then moving to individuals with cognitive disorders, while making necessary adjustments to the software. The hope is that this system will allow the elderly to be more independent in their daily lives, and relieve the stress on caregivers, without sacrificing safety.

### **Public v. Private: Addressing the Issue of Academic Disparities**

*Derek White, Senior, American Ethnic Studies, English McNair Scholar*

*Mentor: Rick Bonus, American Ethnic Studies*

Recent research reveals that there are disparities in the academic achievement levels between public school and private school students. The research reveals that many public school students are not being prepared to take advantage of higher educational opportunities after high school, while their counterparts at private schools or suburban public schools are prepared for and encouraged to pursue higher education. This study examines what factors contribute to the academic disparities between public and private school students. The research focuses on the student teacher relationship as the focus of change and offers three areas that teachers can address in order to better serve the needs of “at risk” public school youth and prepare them to take advantage of opportunities in higher education. Public as well as private school teachers underwent a series of interviews and self reflective papers designed to uncover both successful and unsuccessful strategies employed by teachers to motivate and prepare students for high education. The research revealed three critical areas of focus: curriculum diversity, extra-curricular activities and teacher caring, and concludes that these areas must be addressed by teachers in order to raise the achievement levels for public school students and better prepare them to enter into and compete in high educational environments.

### **Development of an Optimal Method for Exploring the Spatial Variability and Characterizing the Basic Microbial Ecology of Deep-sea Hydrothermal Chimneys**

*Jacqueline M. White, Junior, Environmental Studies, Biology*

*Mentor: John A. Baross, Oceanography*

*Mentor: Matthew O. Schrenk, Oceanography*

Deep-sea hydrothermal vents are a system of striking contrasts, where high-temperature, highly-reduced, metal-rich fluids mix with cold, oxygenated seawater. Hydrothermal chimneys, conduits to hot fluids venting from the seafloor, contain compressed gradients between extremes. However, relatively little is known about the abundance and distributions of the microbial communities contained within chimneys. We sought to apply a standard protocol, optimized for hydrothermal chimney samples,

to characterize the microbial communities within rocks obtained from a range of different deep-sea hydrothermal environments. The protocol involved extraction of fixed microbial cells from the porous rock matrices, purification from contaminating mineral particles, and enumeration by epifluorescence microscopy. Physical and chemical parameters of the chimney ecosystem were determined from parallel sub-samples. Additionally, microbial communities were observed directly on mineral surfaces, and their distributions were documented. Initial results of this study indicate that the size and venting temperature of hydrothermal chimneys are the primary factors controlling microbial population densities. Statistical analysis shows that large, high-temperature (>250°C) chimneys harbored the highest and most heterogeneous local population densities (<10<sup>5</sup> to >10<sup>8</sup> cells g<sup>-1</sup>). Large, moderate temperature, diffuse chimneys harbored the highest overall populations, due to their extensive habitable volumes. The lowest biomass was detected in interior zones of hot sulfide chimneys, in thin spires, and in porous beehive chimneys. Attached microbial communities were most pervasive and diverse in regions interior to chimney structures, where mineralogy indicated mixing of hydrothermal fluids and seawater. The technique developed in this study is also being applied to newly discovered carbonate hydrothermal chimneys from the Lost City Field, and indicates similar microhabitat variability. Application of a standardized technique at appropriate scales will help in elucidating the relevance of isolated observations from deep-sea vents and in beginning to understand the basic microbial ecology of this extensive environment.

### **Genetic Selection in the Identification of Mitochondrial DNA Replication and Repair Proteins**

*Lisa White, Senior, Biochemistry, Political Science*

*Mentor: Eitan Glick, Pathology*

*Mentor: Lawrence Loeb, Pathology*

Mitochondria play a significant role in cellular metabolism, generating the bulk of cellular energy as well as participating in key metabolic pathways. Other than the nucleus, the mitochondria are the only organelles containing their own genome. But unlike the nucleus, mitochondrial DNA (mtDNA) have only limited means of protecting its genome from DNA-damaging insults, potentially detrimental to the health of the cell. Further, a great majority of mitochondrial proteins, including DNA repair and replication enzymes, are encoded in the nucleus. Specificity of nuclear-encoded protein localization to the mitochondria is primarily dictated by distinct ~30 amino acid sequences located at the N-terminus of a protein. These sequences, or Mitochondrial Targeting Sequences (MTS), act as keys; with the correct key, the protein is allowed entry into the mitochondria. Receptor proteins located on the mitochondrial membrane differentially recognize the MTS before facilitating the passage of protein. MTS provide a distinctive marker, differentiating a protein

destined for the mitochondria from a protein targeted elsewhere in the cell. Utilizing this unique MTS and genetic selection as a means of classification, I plan to identify proteins involved in mtDNA replication and repair. Based on sequences homologous to proteins known to localize to the mitochondria, the first 30 amino acids of DNA replication and repair proteins will be fused to a reporter protein. If the reporter protein is successfully targeted to the mitochondria, via an appropriate MTS, the protein will convey a selective advantage to deficient cells. We will infer the targeting property of the first 30 amino acids by the survival of transformed tissue culture cell, thereby identifying potential repair and replication proteins localized to the mitochondria. Identification of mtDNA maintenance proteins will expand our understanding of the mechanisms of mtDNA integrity and enhance our ability to develop treatment for mitochondrial dysfunction.

### **Carbon Nanotube Reinforced Silicon Carbide: Effects of Size and Orientation of Nanotubes on Composite Properties**

*James D. Whitt, Senior, Materials Science and Engineering*

*Rajendra K. Bordia, Materials Science and Engineering*

Carbon nanotubes are considered to be the ultimate reinforcement agent in composite systems due to their exceptional mechanical, electrical, and thermal properties. In this work SiC matrices were reinforced with 1-5  $\mu$  m and 5-20  $\mu$  m multi-walled nanotubes (MWNTs) to study the effects of nanotube size and orientation on mechanical properties. The SiC matrix was derived from both powders and preceramic polymers to evaluate the influence of matrix microstructure on properties. To take advantage of the possible anisotropic nature of mechanical properties in these systems, the axial orientation of the MWNTs was controlled in the composites using tape casting. In all cases, the elastic modulus, hardness and fracture toughness showed significant improvements over SiC alone and show a directional dependence on the MWNTs alignment. For example, in polycarbosilane-derived systems a fracture toughness of 10.84 MPa\*m<sup>1/2</sup> was achieved with aligned 1-5  $\mu$  m reinforcement. This is in excess of a three-fold increase in the fracture toughness of monolithic SiC (3.2 MPa\*m<sup>1/2</sup>)

### **Searching for the Genetic Cause of Hereditary Breast Cancer in a Large Irish American Family.**

*Kirstin J. Wiederholt, Senior, Cellular and Molecular Biology*

*Mary Gates Scholar*

*Mentor: Mary-Claire King, Genome Sciences*

Much of familial breast cancer remains unexplained by mutations in the known breast cancer causing genes BRCA1 and BRCA2. The goal of my project is to identify the gene responsible for hereditary breast cancer in a large

family with 10 cases of female breast cancer. This family is one of hundreds of “mystery families” that have a high incidence of breast cancer, but have no mutations in BRCA1 and BRCA2. Before my involvement in the project a genome-wide scan of genomic makers found an area at the end of chromosome 2 to be consistently co-segregating with breast cancer in this family. I am using more genomic markers to narrow down this linked region. Next I sequence genes in that region that are likely candidates based on biological criteria, such as genes that are involved in cell cycle control, apoptosis or DNA repair. If I find a mutation, I will do further characterization to prove that this gene is indeed the one causing the inherited breast cancer, such as proving that the tumor cells have lost both functioning copies of this gene. I will also sequence this gene in other mystery families to see if it may be causing breast cancer in them and to identify other mutations. To date, I have reduced the linked region to 5 Mb and sequenced 3 promising genes and found no mutations. Discovery of a new cancer-causing gene would provide new insight into the genetic mechanisms of breast cancer. Finding a new breast cancer gene would also open up preventative treatment options for this family, and for other families who may carry the same gene, such as earlier screening, chemoprevention or risk-reducing surgeries.

### **The Function of Clb6p in *Sacchomyces cerevisiae* Chromosomal DNA Replication**

*Christina Wilson, Senior, Biology*

*Mary Gates Scholar*

*Laura Danielson, Senior, Biology*

*Mentor: M. K. Raghuraman, Genome Sciences*

*Mentor: Heather McCune, Genome Sciences*

*Mentor: Bonny Brewer, Genome Sciences*

The process of eukaryotic chromosomal DNA replication begins at multiple, specific locations called origins. Different origins initiate synthesis (fire) at different, but reproducible times in S-phase; however, the reason for this timing difference is unknown. In *Sacchomyces cerevisiae*, two B-type cyclin proteins, Clb5p and Clb6p, can each activate origin firing, but they have been found to function differently: Clb5p has been shown to activate both early-S and late-S origins efficiently, whereas Clb6p is inefficient in late origin activation. This difference may be due to qualitative differences between early and late origins, or it may be due to reduced levels of Clb6p late in S-phase. We favor the latter hypothesis, because late origins do show some low activity in the absence of Clb5p. Furthermore, current research has shown that most of Clb6p is degraded part way through S-phase. To test this hypothesis, we have created a longer lasting version of Clb6p and will test whether late origins are then able to fire efficiently in the absence of Clb5p. If our hypothesis is correct, we will see a rescue of wild type S-phase length (by FACS) and efficient firing of late origins (by 2D gel analysis). These results would show that one of the differences in origin

firing between Clb5p and Clb6p is protein stability and not variations in the requirements of early and late origins. Further investigation into other reasons why early and late origins are different can then be initiated.

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

*Alanson Sample, Junior, Electrical Engineering*

*Ryan Wistort, Sophomore, Electrical Engineering*

*Mary Gates Scholar, Space Grant Scholar*

*Mentor: Alexander Mamishev, Electrical Engineering*

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

### **Failure of Retrieval Inhibition in Individuals with Chronic Posttraumatic Stress Disorder**

*Tiffany Woelfel, Senior, Psychology*

*Mary Gates Scholar*

*Mentor: Lori A. Zoellner, Psychology*

Individuals with PTSD will often report a loss of control over when they have thoughts and memories about the traumatic event. Previous studies testing the directed-forgetting effect, which could explain this phenomenon, have demonstrated that individuals remember items that they were instructed to forget worse than items they were instructed to remember. This “directed-forgetting” effect may be caused by a reduced ability to inhibit certain information during memory retrieval. This study examines performance differences of women with PTSD compared to trauma-exposed women without PTSD and non-trauma-exposed controls on a list-cued directed-forgetting cognitive task with threat-relevant, neutral and positive images. Trauma-exposed participants were all physical and sexual assault survivors. Participants viewed a series of images. For two of these image series they were cued in the middle of the list to either remember all the previous images they had seen or to forget all of them. The third list requested the participants to rate the valence of the first half of images. At the end of each image series, the participants were instructed to recall as many images as

possible while ignoring all previous instructions to remember or forget. Following a distracter task, participants were tested for recognition of the images with similar instructions. If a failure of retrieval inhibition is characteristic of PTSD, we would expect a less pronounced directed-forgetting effect in the cognitive task for recall, especially for threat-relevant stimuli. These findings may add to our understanding of PTSD symptomatology, providing a cognitive mechanism that is associated with intrusive thoughts and re-experiencing of the traumatic event. This research contributes to the literature describing the cognitive biases, maintenance of symptoms and natural recovery of PTSD.

### **Using Weakly Supervised Learning to Improve Prosodic Event Detection**

*Darby Wong, Senior, Computer Science*

*Mary Gates Scholar*

*Mentor: Mari Ostendorf, Electrical Engineering*

Prosody is the term used for the intonation, emphasis, and word grouping that people use to aid in spoken language communication. We use the term “prosodic event” to describe instances where there is a significant marker of prosody, such as a prosodic phrase boundary, in speech. Prosodic phrase boundaries are particularly important for allowing a listener to parse speech into syntactic phrases which help decode sentence meaning. The ultimate goal of our work is to enable the use of these cues in automatic syntactic parsing. Unfortunately, it is currently not possible to detect prosodic events in conversational speech with high reliability, in part because there is little data with prosodic annotation available for training models. To address this problem, we explore the usage of weakly supervised learning strategies. Several methods of weakly supervised learning are explored, including cotraining and bagging. We present an analysis of the results for each of these methods, as well as a discussion concerning the tradeoffs between one another.

### **The Functions of the Seven Arabidopsis Homologs to the Mammalian p27kip1 Gene Known as the Kip-Related Proteins (KRP Genes)**

*Jamie Wong, Junior, Biochemistry*

*Mentor: Keiko Torii, Biology*

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 have identified null mutants in five of the seven *KRP* (*KIP1-RELATED PROTEINS*) genes in Arabidopsis that are homologous to the mammalian cyclin kinase inhibitor p27kip1 using TILLING lines and Salk T-DNA insertions. We hope to discover the function and possible redundancy in function of the *KRP* genes. Using the null mutants identified, we have systematically crossed specific mutants to one another

to create double, triple, and even quadruple mutants. Thus far, no notable phenotype has been observed, hinting that some or all of the *KRP* genes are redundant in function. We hypothesize that, after creating a null mutant of some or all of these genes, the plants will exhibit a phenotype. From this phenotype, we may discover the function of these homologs in plants and compare if these genes too are important in cell proliferation.

### **Physiological Basis for High Yield in Modern Corn Hybrids**

*Huining Xu, Junior, Biology, US Pacific Northwest and Southwest China Exchange Program*

*Mentor: Elizabeth Van Volkenburgh, Biology*

Modern corn varieties have been selected for their ability to maintain productivity in dense plantings. Both yield and standard practice sowing density have increased over time. What makes modern hybrids yield better under denser plantings? Leaves of modern hybrids are held more erect than in older hybrids. In previous experiments, leaf angle was increased by exposure to light and to an auxin transport inhibitor (NPA), and decreased by neighbor detection. The goal of our project is to test the sensitivity of older and newer hybrids to auxin (NAA) using a growth assay. In addition we are testing the effect of auxin, sprayed on surface of leaves of young seedlings, on leaf angle development. We hypothesize that modern hybrids are less sensitive to auxin than the older hybrids. In one experiment, we isolate tissue segments from etiolated 6-day-old seedlings grown in vermiculite in dark. The segments are incubated in 10 ml KCl augmented with or without NAA in dark for 24 hr. We then measure segment length. In a second experiment, we spray NAA on leaves of 11-day-old corns for 5 days to see the change in leaf angle. Thirdly, leaf curvature was measured on a range of hybrids, and correlation between curvature and auxin-induced growth will be tested. We propose that modern hybrids are more tolerant to density stress because they are less sensitive to auxin, resulting in more erect leaves and less self-shading.

### **Shared Reading in Early Childhood Settings**

*Naomi Yi, Senior, Speech and Hearing Sciences, Linguistics*

*Zesbaugh Scholar*

*Amanda Hannon, Senior, Speech and Hearing Sciences, Zesbaugh Scholar*

*Mentor: Susan Sandall, Education*

This study explored the effects of infant/toddlers with and without disabilities participating in shared reading settings. The goal of our project also investigated whether their frequent exposure and interaction with books during this time in cross-age groups increased their literacy awareness. Kindergarten students read picture books to the infant/

toddlers twice a week for fifteen to twenty minutes. Each reading session occurred in the classroom during free choice time. By videotape recordings, kindergarten interviews, and collected teacher data we hope to see improvement of kindergarten student's attitudes toward reading and their concepts of print knowledge. We also hope to see increased interest in infant/toddlers interaction with books. Finally, we anticipate that these results will help teachers know more about the effects of shared reading.

### **Content-Based Image Retrieval: Insect recognition**

*Jenny Yuen, Sophomore, Computer Engineering*

*Mary Gates Scholar*

*Mentor: Linda G. Shapiro, Computer Science and Engineering*

Observation of the surroundings is important in the study of natural sciences. Keeping information of every type of known insect requires the creation and existence of large image databases. Therefore, efficient identification of insects requires the use of automated methods. Automated recognition and identification of a certain insect can be applied in various fields like knowing whether a patient who suffered from an insect bite is in danger or not; or determining the population of species of insects in some place. Our project focuses on the recognition and classification of insects of various species. Insects are characterized by a great diversity of features: antenna, wings, thorax size and proportion to the rest of the body, color, and many other features. We are given photographic images of insects of known species and want to train a program to determine the type of insect given another image outside of the training set. Using information from the image such as color, texture and possibly structure of the insect, we can determine features as the existence of wings, the shape of the insect, and other patterns. However, an image does not only contain the picture of an insect in it, but also a background and noise that adds uncertainty. We plan on applying probabilistic techniques to perform the initial segmentation. After this, we can apply other methods of pattern recognition to identify parts of the insect and determine its class. The research in this project is not finished. However, we have partial results that show notorious differences in color ranges between the background and the insect. Therefore, we expect to be able to create a program able to perform efficient segmentation in these images.

### **Coloniality has Evolved Once in Stolidobranch Ascidians**

*Liyun Zeng, Junior, Biology: Conservation Biology, Ecology and Evolution*

*Mentor: Billie Swalla, Biology*

The phylogenetic relationships of ascidians are very important for studying Deuterostome evolution. Deuterostomes contains three monophyletic groups, which

are echinoderms+hemichordate, urochordates and cephalochordate+vertebrates. These deuterostome relationships are strongly supported by 18S rDNA molecular phylogenetic trees. The urochordates are further divided into three classes: the ascidians, larvaceans and thaliaceans. MP, ML, NJ and ME analyses of the 18S rDNA of the Tunicata shows that it contains four distinct clades: Styelidae+Pyruridae, Molgulidae, Phlebranchia+Thaliacean and Larvacean. Ascidians exhibit a rich array of body plans and life histories, and the suborder Stolidobranchiata contain both colonial and solitary species, as well as several species with intermediate morphologies, called social species. We show data from the 18S rDNA phylogenetic tree of the Stolidobranchia suggesting that there is only one clade in the family Styelidae that have both colonial, social and solitary ascidians. Therefore coloniality has evolved only once in Stolidobranch ascidians. In contrast, the anural larva has evolved several times within the clades of the Molgulidae. We are also investigating the phylogenetic relationships of colonial ascidians in the Phlebobranch ascidians and Thaliaceans. This work will help understand the evolution of coloniality within ascidians.

### Basal Respiratory Exchange Ratio Is Altered With Statin Use in Normals

Colin T. Phillips, Junior, Biochemistry

Mentor: B. Gregory Brown, Cardiology

Statin therapy is prescribed for increasing numbers of patients. Previous work in statin myotoxicity has suggested a defect in fatty acid oxidation. The fasting respiratory exchange ratio (RER) provides a means to identify substrate use. This project assesses aerobic function and substrate utilization on statin therapy using cardiopulmonary exercise testing. Six normal control volunteers performed two identical exercise regimens six weeks apart while fasting on and off statins. The Orca® cardiopulmonary exercise testing system was calibrated to a known gas mixture before each test. The protocol consisted of 30 minutes of rest followed by 8 minutes of ramped exercise. Peak oxygen consumption (VO<sub>2</sub> max), anaerobic threshold (AT), ventilatory efficiency (VE / VCO<sub>2</sub>) and parameters of fuel selection, including basal RER, and the change in RER between rest and early exercise ( $\Delta$  RER) were recorded. A summary of the results is in the table below.

N	RER off statins	RER on statins	$\Delta$ RER* off statins	$\Delta$ RER* on statins	VO <sub>2</sub> max off statins ml/min/kg	VO <sub>2</sub> max on statins ml/min/kg	AT off statins ml/min/kg	AT on statins ml/min/kg	$\Delta$ VE / $\Delta$ VCO <sub>2</sub> off statins	$\Delta$ VE / $\Delta$ VCO <sub>2</sub> on statins
6	0.76 ± 0.03 †	0.86 ± 0.06 †	0.03 ± 0.04 ‡	0.07 ± 0.03 ‡	37 ± 13	37 ± 13	27 ± 7	25 ± 12	25 ± 4	25 ± 3

There was no change in VO<sub>2</sub> max, AT, or VE/VCO<sub>2</sub> for the subjects on statins. The basal RER was significantly increased on statin therapy († p=0.0001). The  $\Delta$  RER also demonstrated significant change on statin therapy (‡ p=0.03). While there was no change in aerobic function on statin therapy, parameters of fuel selection (fasting RER and  $\Delta$  RER) both increased. This suggests an alteration in fatty acid oxidation related to statin therapy in normals.

# **PRESENTATION SESSIONS**

## **PLEASE NOTE**

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

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## SESSION 1A

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### CHALLENGING FAMILIAR CONTEXTS IN LEARNING

*Session Moderator: Brad Portin, Educational  
Leadership and Policy Studies*

*Session Assistant: Tina Le, Sophomore, Pre- Major, Arts  
and Sciences*

**Mary Gates Hall Room 284**

#### **Curriculum Development for Foreign Study in Cuba**

*Casey Clevenger, Recent Graduate, Comparative  
History of Ideas*

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

The study abroad experience is increasingly recognized as an important component of undergraduate education. The Comparative History of Ideas Program has led efforts to make foreign study opportunities available to students at the University of Washington, and continues to apply original and unconventional approaches in designing its international programs. Introducing engaged learning components, self-reflective portfolios, and a focus on building dialectic learning communities, one of CHID's priorities is to create a foreign study experience that can be integrated into students' lives both before they depart for foreign study and after they return. During Early Fall Start 2003, the Comparative History of Ideas Program led its first Exploration Seminar to Cuba under the direction of Dr. Kari Tupper (August 25-September 19). The two objectives of my research project were 1) to design original curriculum for a preparation seminar co-taught to the 25 undergraduate students traveling on this program 2) to facilitate a well-connected program that enabled students to relate their learning experiences in Cuba to education and current issues at home. U.S. sanctions against Cuba and dissident political activities within Cuba have led to increasing tensions between the two countries. The state of U.S.-Cuban relations is rapidly becoming a salient issue in local and national politics. For this reason, I developed a course syllabus that focused on understanding the historical background and contemporary context of these conflicts through historical and literary sources. This material was key in providing students with adequate background knowledge, which enabled them to thoroughly engage the foreign study experience when they arrived in Havana. It also prepared students to integrate their study abroad experience into the rest of their education.

#### **Working with Dialogue: Preparing Students for Community Learning in an International Study Setting**

*Lowell Sheldon, Senior, Comparative History of Ideas,  
Communication*

*Mary Gates Scholar*

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

*Mentor: Lisa Coutu, Communication*

Since its inception, the department of Comparative History of Ideas (CHID) has worked to provide a different approach to education within the University of Washington. For over ten years CHID's international programs have been the centerpiece of their goal to transform the student role from passive receptacle into active participant in their own educational process. In these programs, the concept of "learning community" is emphasized as the model through which students can integrate textual analysis and personal experience to deepen the learning process and engage them fully in the topics at hand. Specifically, this research project looks at the implementation of a pre-program preparation seminar focused on interpersonal communication and dialogue as a way to facilitate the creation of a learning community on CHID's program to Cuba. My interest in this topic germinated on CHID's Winter 2002 program to South Africa. On this program I felt the current structure in place to create a learning community was incomplete. When I returned, I initiated coursework and independent study in the field of Speech Communication. I came to understand that dialogue, when understood both practically and theoretically, could play a primary role in facilitating the creation of a CHID learning community. With the assistance of my mentors, Dr. Kari Tupper and Dr. Lisa Coutu, I developed a preparation seminar that focused on the work of theorist John Stewart and philosopher Martin Buber. The hope was that with these newly acquired concepts and tools, students would have a foundation upon which to dialogically participate in the learning community during the Cuba study. After returning from Cuba, I interviewed participants in the program to systematically document the successes and failures of this pre-program model.

#### **Design + Innovation Lab**

*Daniel Johnston, Senior, Art: Visual Communication  
Design*

*Jim Nesbitt, Senior, Art: Visual Communication Design*

*Jason Tselentis, Graduate Student, Art: Visual  
Communication Design*

*Mentor: Douglas Wadden, Art*

The D + I Lab was established to develop opportunities for faculty and students to engage in both conceptual and applied problems in design. Clients can be on campus or private, public, profit or non-profit and may be identified by the design group as a research project or accepted as an applied investigation. Budgets and schedules are established with the client, who must participate with the design team in framing and reviewing all phases of the project. What we wish to present are two current projects. One was a grant from the National Park Service to develop

an information program that explains and promotes research opportunities in the seven regional national parks. The second is a prototype of a new home page and web presence for the university. With the NPS project the team moved to substitute a web-based solution for the printed catalogue program the client originally envisioned that is accompanied by a two-part mailer to announce the web site and encourage inquiries. With the university web site investigations, what we will present are selections from hundreds of screen captures that explored different animated introductory sequences to the proposed new home page. The team considered narrative, pictorial, typographical, identity driven and conceptually oriented versions of which the client has now chosen one. The homepage strives for simplification of the existing tangle of competing campus interest groups and message providers, while presenting a memorable academic and environmental portrait of the institution. The navigation is more logical and sequential, with more structure and greater clarity. Both projects have a changing gallery of photographs, many taken by the team for the sites, and both will hopefully be implemented this quarter.

#### **An Efficiency Analysis of the Top 50 MBA Programs and Undergraduate Pac-10 Business Schools using Data Envelopment Analysis**

*Justin O'Brien, Senior, Decision Sciences, Washington State University*

*Mentor: Bintong Chen, Management and Decision Sciences, Washington State University*

College rankings have become a popular source of information for prospective students, universities and the general public. These audiences tend to accept these rankings without understanding the methodology or meaning behind them. This thesis examines Data Envelopment Analysis (DEA) as a more effective tool for ranking the top 50 MBA programs, according to *U.S. News*, and the undergraduate business schools in the Pac-10. DEA calculates relative efficiency using a linear program in Excel. Efficiency is defined as the ratio of weighted sum of outputs to weighted sum of inputs. DEA takes the input and output data for each school and applies weights to them. Every school is given the opportunity to choose their own weights with the goal of maximizing their efficiency and minimizing that of their competitors. The same chosen weights are applied to each school. From this point a weighted sum is created for the inputs and outputs. These weighted sums are divided to complete the efficiency calculation. Once every school has had the opportunity to select weights an average is taken of all the scores to produce the final ranking. The main findings of the MBA portion are the top schools according to *U.S. News* are not the most efficient schools in the country. Two sets of MBA rankings are presented; one using the data from *U.S. News* and the other are including salary pre-MBA and post-MBA. The Pac-10 analysis includes Arizona, Oregon,

Washington, Oregon State, California and Washington State. An efficiency ranking of these six schools is offered. The conclusions showed DEA to be an excellent tool to rank college programs. This method is fair because it gives every school a chance to maximize their efficiency and is relatively easy using Excel to perform the calculations.

#### **Reforming How We Orient People to the Community and Environmental Planning Major**

*Michael Seliga, Senior, Community and Environmental Planning*

*Mary Gates Scholar*

*Mentor: Dennis Ryan, Urban Planning, Community and Environmental Planning*

Students come to (the now 10 year old) Community and Environmental Planning program from a variety of backgrounds with a broad range of personal goals. While this gives strength to the program, it also presents a challenge because incoming students have widely different conceptualizations of what CEP *is* as well as *what it ought to be*. To exacerbate this annual challenge, many students simply do not have the skills or “tools” necessary to participate in a new paradigmatic program such as CEP. I intend to help reform orientation, so that a new group of participants will be better introduced to the programs core values and practices in a manner which reflects those values. Much of my work in helping to reform this transitional period will be as an advocate, providing theoretical arguments for a particular approach. While continuing my research—through a weekly “democratic education seminar” and an extended literature review—I will create and introduce to the major 3-4 scenarios of how ‘to do’ orientation. Based on the most supported scenario, I will help facilitate a collaborative process necessary to change any CEP habit. Through this participatory process I will help produce a new orientation plan. Lastly, I will document the work performed throughout the next two quarters, so future students interested in making change can find some steps laid out for them. Most likely the current format of orientation will be extended from a 2 day intensive (plus non-required week-long leadership seminar), to a required two week long program before autumn quarter or throughout the first weeks of the quarter. Hopefully, at the end of the annual transitional period, new students have a better grasp of the CEP learning community, gained a clearer understanding of democratic process, learned valuable communication skills, and can recognize opportunities as well as understand constraints. The result of better preparation will be a strong sense of personal empowerment.

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## **SESSION 1B**

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## CELLULAR MECHANISMS OF DEVELOPMENT AND DISEASE

Session Moderator: Martha Bosma, Biology  
Session Assistant: Alvetina Gall, Freshman, Pre-Major,  
Arts and Sciences

Mary Gates Hall Room 271

### Murine Cytomegalovirus and Evasion of Host-Cell Anti-Viral Responses

Crystal Brown, Senior, Biochemistry

Howard Hughes Scholar

Mentor: Adam Geballe, Medicine and Allergy and Infectious Diseases

Cells respond to viral infections by shutting off protein synthesis through activation of the RNA-dependent protein kinase (PKR) and oligoadenylate synthetase (OAS) pathways. The E3L gene in vaccinia virus encodes double stranded RNA (dsRNA) binding proteins, which sequester dsRNA and thereby prevent activation of the PKR and OAS pathways. Vaccinia lacking the E3L gene (VV<sup>''</sup>E3L) fails to replicate efficiently. Recently, human cytomegalovirus (HCMV) was reported to contain a gene, TRS1, that rescues replication of VV<sup>''</sup>E3L. The genome of murine cytomegalovirus (MCMV), a mouse model of HCMV, was examined for genes homologous to TRS1. The (MCMV) gene that shares the most homology with TRS1 is M143 – both share certain US22 family member motifs and both are immediate early genes. Furthermore, preliminary evidence has shown that both M143 and TRS1 bind double stranded RNA. While M143 is essential for MCMV replication, TRS1 has been shown to be a non-essential HCMV gene. We are testing the hypothesis that M143 is functionally homologous to TRS1 in rescuing VV<sup>''</sup>E3L replication. M143 will be cloned into a vaccinia recombination vector and the resulting plasmid will be transfected into BHK cells that have been infected with VV<sup>''</sup>E3L. A recombinant virus containing the M143 gene will be isolated. By examining the replication of this recombinant virus compared to the parent, VV<sup>''</sup>E3L and a positive control such as VV<sup>''</sup>E3L with TRS1, in non-permissive cells such as primary fibroblasts and HeLa cells, we will determine whether M143 is able to rescue VV<sup>''</sup>E3L replication. If it does, we would conclude that M143 might have a role in viral evasion of anti-viral responses.

### Growth Inhibitory Effects of a Synthetic Retinoid on Breast Cancer

Sarah L. Chisholm, Sophomore, Pre-Major,

Neurobiology

Mentor: Karen Swisshelm, Pathology

While everyday we develop a better understanding of the biology of cancer, the search for safe and effective cancer therapies continues. Retinoids are compounds modeled after retinoic acid, the active metabolite of Vitamin A. Due

to their ability to regulate cell growth, differentiation, metastasis, angiogenesis, and apoptosis, the Chemoprevention Working Group to the American Association for Cancer Research has listed retinoids among the most promising substances in the cancer chemoprevention field. However, many of the retinoids investigated also exhibit toxic or teratogenic effects, necessitating a search for a compound with the beneficial effects of a retinoid, without the harmful side effects. One promising compound developed is the heterarotinoid SHetA2, which has thus far been shown to be effective in the treatment of ovarian cancer without evidence of the toxic side effects. These results led to the hypothesis that the drug would also be effective for the treatment of breast cancer. To test this hypothesis a series of in vitro experiments were designed to determine the compound's effects on various cell lines of normal and tumor mammary epithelial cells, monitoring the proliferative abilities of the cells when grown in the presence of varying concentrations of the SHetA2 compound. Through these experiments, we found that SHetA2 significantly decreased the proliferative abilities of various types of mammary epithelial tumor cells. In order to better understand how SHetA2 works, we also plan to isolate the downstream targets of the compound, enabling us to monitor the pathways by which SHetA2 effects cell growth and differentiation and gain the understanding necessary for the eventual use of the compound in the clinical treatment of breast cancer.

### Expression of Myelin Basic Protein through Development

Caroline Hoover, Senior, Cellular and Molecular Biology

Mary Gates Scholar

Mentor: Aimee Bakken, Biology

Myelin Basic Protein (MBP) is recognized as a key protein in the creation of functional myelin sheaths that coat many nerves in vertebrate organisms, especially in the central nervous system. Its several different forms have been studied extensively *in vitro* and in cell culture experiments, where it has been shown that expression levels vary between the different forms, and also during the program of myelination. Myelin is also found in cells that originate from the neural crest layer. Here we wish to use the frog *Xenopus laevis* as a system for studying the expression pattern of two different forms of MBP, the 14kD form and the 21.5kD form, as well as addressing how several different promoters affect this expression. We have used an MBP-Green Fluorescent Protein (MBP-GFP) fusion protein, which allows expression to be visualized through fluorescence, and then added this gene to the frog genome through the procedure of transgenesis. Preliminary findings indicate that expression varies through development, and that it may not be strictly limited to myelinating cells, but may also be found in other neural crest derivatives.

## **Characterization of Synchronous Activity in Embryonic Mouse Hindbrain Motor Neurons**

*Annette McCabe, Senior, Neurobiology*

*Mary Gates Scholar*

*Mentor: Martha M. Bosma, Biology*

Coordination of electrical activity between neurons is a common characteristic of the developing nervous system, which plays an important role in neuronal networking and synaptogenesis. The hindbrain, composed of the pons and medulla, is a region in which our laboratory has found synchronous activity early in development. Neurons that compose the trigeminal and facial nerves originate in the hindbrain and synapse onto muscles in the face and neck. At birth, these nerves will control critical rhythmic motor functions such as swallowing and the oral components of respiration. In order to observe the activity in these neurons, the hindbrain is loaded with an intracellular calcium indicator dye, Fluo-4, which fluoresces when calcium is present (whenever neurons are active). The motor neurons are distinguished from other neurons in the hindbrain by retrograde labeling with Dextran, a dye that fluoresces at a different wavelength than the calcium indicator. It is known that between embryonic day (E) 9.5 and E11.5 the activity of the hindbrain switches from long transients that are asynchronous and mediated by calcium channels, to short synchronous transients mediated, at least in part, by sodium channels. We are now characterizing the activity in the hindbrain from E11.5 to E14.5. We have defined the temporal and anatomical limitations of the synchronous activity, and have determined the neuronal channel composition within this time period by exposing live tissue to various channel blockers and neurotransmitters then observing the resulting fluctuations in activity. Evidence suggests that the electrical coupling between these neurons is due to gap junctions and may be led by pacemaker neurons that are interspersed throughout the hindbrain. Eventually we hope to fully understand the mechanism by which the neurons in the hindbrain are electrically coupled, to isolate pacemaker neurons, and to characterize the developmental role of the synchronous activity in the hindbrain.

## **Mechanisms of uPA-accelerated Atherosclerosis in Mice**

*Katherine Slezicki, Senior, Biology*

*Howard Hughes Scholar*

*Mentor: David Dichek, Cardiology*

Urokinase-type plasminogen activator (uPA) is expressed in human atherosclerotic lesions, primarily by macrophages. Whether uPA expression in macrophages accelerates or retards atherosclerosis is, however, unclear. To test the hypothesis that macrophage-expressed uPA accelerates atherosclerosis, we generated transgenic mice in which uPA overexpression is targeted to macrophages. The uPA transgene was bred into atherosclerosis-prone

mice (i.e., the C57Bl/6, apolipoprotein E-null background) and the mice were fed a high-fat diet. Compared to nontransgenic controls, the transgenic mice had accelerated atherosclerosis and early death. These results raised at least two questions: 1) Is the accelerated atherosclerosis and early death due specifically to uPA overexpression in macrophages or to “leaky” transgene expression in other cell types? 2) Through which downstream mediators does uPA overexpression accelerate atherosclerosis? To answer the first question, nontransgenic mice were lethally irradiated to destroy their bone marrow (BM) and transplanted with BM from uPA transgenic, or nontransgenic donor mice. This strategy should confine uPA overexpression to macrophages. Compared to recipients of nontransgenic BM, recipients of transgenic BM had increased atherosclerosis and early mortality. Thus, we concluded that increased uPA expression in macrophages is sufficient to accelerate atherosclerosis. To begin to answer the second question and determine whether uPA proteolytic activity, uPA protease-inhibitor complex formation, or plasminogen activation are critical mediators through which uPA accelerates atherosclerosis, we bred the uPA transgene into mice deficient in either the uPA inhibitor plasminogen activator inhibitor-1 (PAI-1) or the uPA substrate, plasminogen. Absence of PAI-1 did not affect the ability of the uPA transgene to accelerate atherosclerosis. Therefore, PAI-1 does not limit or contribute to uPA-accelerated atherosclerosis in this model. Whether uPA-mediated activation of plasminogen contributes to atherosclerosis in this model is being determined. These experiments provide clues to the pathogenesis of accelerated atherosclerosis and suggest new therapeutic targets for atherosclerosis prevention.

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## **SESSION 1C**

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### **CULTURE AND GLOBALIZATION**

*Session Moderator: Brian Reed, English*

*Session Assistant: Arianne Espinueva, Junior, Sociology*

**Mary Gates Hall Room 288**

### **Our Cinema, Ourselves: Women and Multiculturalism in Swedish Film**

*Anna K. Anderson, Senior, Swedish Language and Literature*

*Mentor: Andrew Nestingen, Scandinavian Studies*

In his book *Even in Sweden: Racisms, Racialized spaces, and the Popular Geographical Imagination*, Allen Pred argues that even in Sweden, a European nation-state widely supposed to be a model of social justice, everyday racism has come to shape attitudes of mainstream publics about diasporic people. His book outlines the role of group identity in the Sweden's efforts to become a multicultural,

heterogeneous society, but does not address how gender plays into the group identities involved in this process. Three recent Swedish movies by directors of Middle-Eastern descent shift focus onto conflicts between young Middle-Eastern Swedish women and their families. In my research, I will be looking at these films and the importance of challenging the accepted structure of multicultural identity development. Pred addresses many issues of identity in multicultural Sweden without ever addressing the role of gender in the identity conflicts. *Nationalisms & sexualities* editor Andrew Parker explains in his introduction that identity conflicts are enacted by men, who largely determine our senses of group identity. This is true of Pred's book as well as early Swedish films addressing this issue. *Jalla jalla* and *Hus i helvete* (*All Hell Breaks Loose*) from 2000, and *Vingar av glass* (*Wings of Glass*) from 2002 contest the male-driven group identity formula. These movies focus mainly on the daughters' independence, and especially her right in Sweden to choose to date a man of Swedish extraction. I studied *Vingar av glass* in depth in 2003. I will be focusing on *Jalla jalla* and *Hus i helvete* and incorporating my study of *Vingar av glass* to show that the role of gender is crucial to the in Sweden's identity conflicts, more important even than any other aspect in developing its multicultural identity.

### **Taking Humor Seriously: Satire and Identity in Israel**

*Raz Barnea, Senior, Comparative History of Ideas*

*Mary Gates Scholar*

*Mentor: Nicholas Halmi, English*

Israel's prominent satirical tradition expresses the tension between the utopian vision of Israel represented in Zionist writings and the press and the much harsher and more complicated reality of everyday life. Drawing from the disciplines of historiography, anthropology, and literary criticism, this project will explore the role and impact of Israel's most celebrated satirist, Ephraim Kishon, in expressing the tension in Israeli sentiments from the 1960's until the present day. Kishon's exaggerated and sardonic comedy paints a decidedly complicated picture that clarifies the plurality of cultural tensions, language differences, and religious multiplicity that the utopian vision denies in its admiration for its own ideal Israel. In exploring the cultural impact and transgressions of comedy, this project also contributes to the nuanced study of humor by putting forth a careful approach that balances historical context, the relevance of the everyday, and the politics of the complex and intense nation of Israel. In doing so, this project champions the study of humor in cultural studies by acknowledging humor's significance as a discursive tool and a fundamental strategy for negotiating power.

### **From Harvesters of the Sacred Leaf to Arbiters of Peace: The Ascent of Cocaleros in Bolivia**

*Vincent Gonzalez, Senior, Comparative History of Ideas, International Studies*

*McNair Scholar*

*Mentor: Angelina Godoy, International Studies, Law, Society, and Justice*

After nearly a month of sustained social protest, Bolivian president Gonzalo Sanchez de Lozada relinquished his post on October 17, 2003. Various analyses cited Bolivia's indigenous coca farmers (cocaleros) as the integral force in the build-up to Sanchez de Lozada's eventual resignation. The pivotal role played by Bolivia's cocaleros represents a departure from the historical record of protest and revolt in Bolivia. In the past, militant miners, military strongmen, and leftist intellectuals primarily exerted political pressure on the Bolivian state. Thus, in compelling the president's demise, cocaleros demonstrate a growing base of power while traditional social actors find their influence diminishing. I, therefore, ask how Bolivian cocaleros supplanted traditionally influential actors to emerge as Bolivia's most potent and influential social group. In this project I examine three dimensions that contribute to the ascent of the cocaleros: 1) the emergence of the international war on drugs; 2) economic restructuring in Bolivia; and 3) indigenous resurgence in Latin America. First, coca eradication programs catalyzed conflict between state security forces and the cocaleros, and led to numerous rounds of fractious negotiations between the state and cocalero leadership. Next, profound structural changes, including the dismantlement of state-led industries, liquidated the traditional power structure within the national labor union network. Traditionally representing the interests of miners and other workers, the cocaleros pushed the coca issue to the top of the union agenda. Finally, indigenous coca farmers articulate an Indian political identity in which the coca leaf stands as symbol of national identity. Within this context of eradication, structural change, and indigenous resurgence, the cocaleros forged political coalitions around broad social issues and filled the void left by traditional social actors.

### **Sexuality in Japanese Animation**

*Kristi Elaine Govella, Senior, Political Science, Japanese*

*Beinecke Scholar*

*Mentor: Leila Madge, International Studies*

Japanese animation, or "anime" as it is commonly referred to, is a phenomenon of Japanese popular culture that has gained wider acceptance in other parts of the world, including the United States. Over the last decade, anime has been increasingly seen as an intellectually challenging art form, as attested to by the number of scholarly writings on the subject; this medium builds on Japanese high cultural traditions while also making use of twentieth century film and photography. Anime is also distinct in that it deals with a wide array of surprisingly complex issues, many of

which fall outside the realm of what many American viewers typically consider “cartoon situations”. Homosexuality and homoeroticism are themes commonly found in anime, even in some works intended explicitly for children such as the widely popular series *Sailor Moon*, suggesting a difference in Western and Japanese attitudes towards these issues. Why are these themes more common in Japanese animation than in Western animation? Do they reflect a greater acceptance of homosexuality in Japan than in the West? What other things might these depictions suggest about Japanese culture? How do they connect to historical forms of Japanese art and entertainment? In this project, I address some of these questions by examining portrayals of sexuality in a variety of Japanese animation series and drawing connections between these depictions and Japanese cultural, societal, and historical trends.

### **The Roles of Novelty Records in U.K. Popular Culture**

*Zachary Kerr, Senior, Communication*  
*Mentor: Keith Stamm, Communication*

Despite the disdain they continuously gather from reviewers and listeners alike, novelty records are an essential genre of the U.K. music industry. They are released almost every week and yield respectable sales. This study investigated the trends existing in novelty records to comprehend the roles they play in the dwindling singles market in the U.K. At the same time, it sought to create an accurate definition of novelty records, which has never been officially provided by the U.K. music industry. A content analysis coded nostalgic factors, ties to media, and themes of 100 novelty records released in 2002 and 2003. The most dominant patterns focused on the fact that the records utilized a plethora of innovation and horizontal integration, especially television. Consequently, these devices propelled advertising and word-of-mouth appeal. In addition, novelty records primarily focused on the current events of British popular culture. Although the novelty record niche of the U.K. music industry is one sometimes ridiculed for its usage of lowbrow humor and shock gimmickry, it simultaneously celebrates the eccentricity and quirkiness of the British popular culture. Culture is an ever-changing process that would make it nearly impossible to clearly and concisely define such a vast genre filled with a multitude of ideas and premises. For this, U.K. novelty records were defined as a fickle musical genre that idolized a “here today, gone tomorrow” mentality. Yet, they nevertheless retain commercial appeal allowing them to flourish in the U.K. music industry today.

### **A “Western Feminist” and Her Propaganda: A Critique of Alice Walker’s Neocolonial Approach to Female Genital Surgeries and Metonymic Production of the Subaltern Woman in a “Global Sisterhood”**

*Veronica R. Lujan, Senior, English*  
*Mary Gates Scholar*

*Mentor: Gillian Harkins, English*  
*Mentor: Nikhil Singh, History*  
*Mentor: Chandan Reddy, English*  
*Mentor: Matthew Sparke, Geography*

This research challenges the methodology of a “Western feminist’s” attempt to represent the subaltern. In the novel *Possessing the Secret of Joy*, the documentary film “Warrior Marks,” and the book *Warrior Marks: Female Genital Mutilation and the Sexual Blinding of Women*, Walker campaigns against the surgical practice taking place in parts of Africa involving the alteration of woman’s exterior genitalia, which she calls female genital mutilation (FGM). She creates propaganda that persuades other “Westerner’s” to despise the practice by creating emotions that engender concern, therefore allowing her audience members to feel good about themselves for feeling so deeply others’ suffering. In early debate on the topic of what I choose to call female genital surgeries there was a binary of cultural relativism vs. the medical discourse. Walker attempts to escape the binary but falls into traps from each extreme. She succumbs to the universal ideas of the medical discourse by using medical ideas of “normal” and “abnormal” to create the subaltern as the “other.” Reducing the subaltern woman to the medical state of the vulva, Walker metonymically produces this binary of good vs. evil. Using Gayatri Spivak’s article “Can the Subaltern Speak?”, this paper tests Walker’s work’s level of success in her claim of speaking for the subaltern. By Spivak’s criteria, Walker only deciphers the subaltern’s words through a neocolonial veil, trusting her own knowledge of their experience as superior to their knowledge. Instead of speaking for them, she translates their words into an archive of propaganda that, according to accounts of screenings, successfully engenders emotional responses from its “Western” audience. Persuading them to her side of the neocolonial binary, Walker gains allies to join her as “Western” saviors swooping down to save the subaltern women who she sees as unable to save themselves.

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## **SESSION 1D**

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### **ENVIRONMENTAL AND BIOCHEMICAL ASPECTS OF ECOLOGY**

*Session Moderator: Frieda Taub, Aquatic and Fishery Sciences*

*Session Assistant: Shane Kinard, Sophomore, Pre-Sciences*

**Mary Gates Hall Room 238**

**\*Note: Titles and Abstracts in order of presentation.**

### **Are the Distributions of Nitric Oxide- and Carbon Monoxide-Producing Neurons Conserved Across Crustacean Species?**

Minhui Lin, Senior, Biology, Computer Science

Mary Gates Scholar

Mentor: Andrew Christie, Biology

Using antibodies to the biosynthetic enzymes of nitric oxide (NO) and carbon monoxide (CO) (nitric oxide synthase [NOS] and heme oxygenase 2 [HO-2], respectively), the distributions of putative NO- and CO-producing neurons were recently mapped in the stomatogastric nervous system (STNS) of the crayfish, *Cherax quadricarinatus*. Here, we map the distributions of NOS and HO-2 in the STNS of three other Astacidean species (*Procambarus clarkii*, *Pacifastacus leniusculus* and *Homarus americanus*), thus providing a picture of the phylogenetic conservation of gas-producing neurons in the crustacean STNS. In *C. quadricarinatus*, NOS labeling was found in two somata in each commissural ganglion (CoG) as well as in the neuropil of the CoGs and the stomatogastric ganglion, the latter neuropil originating from a pair of axons projecting through the superior oesophageal and stomatogastric nerves. In *H. americanus* we find the distribution of NOS labeling to be identical to that of *C. quadricarinatus*. With the exception of the projection pathway taken by the immunopositive axons innervating the STG (via the inferior oesophageal, oesophageal and stomatogastric nerves), the distributions of NOS labeling in *P. clarkii* and *P. leniusculus* too are the same as in *C. quadricarinatus*. In contrast to that of NOS, the distribution of HO-2 labeling in Astacideans is highly variable. In *C. quadricarinatus*, putative CO-producing profiles were seen in a neuroendocrine system located in the anterior portion of the STNS. We find no evidence of HO-2 staining in this neurosecretory system in *H. americanus* and *P. leniusculus*. In fact, in only *P. clarkii* was any CO-producing profile noted: a single soma in the oesophageal ganglion. Collectively, our results show that the distributions of putative NO-producing neurons in the STNS of Astacideans are somewhat conserved across species, whereas the distributions of putative CO-producing neurons are not.

### **Glutaminyl Cyclase Immunoreactivity in the Perocardial Organ of *Cancer productus***

Christina Ngo, Post-Baccalaureate, Biology

Howard Hughes Scholar, Mary Gates Scholar

Mentor: Andrew Christie, Biology

For both animal and plant proteins/peptides, glutaminyl cyclases (QCs) catalyze the conversion of N-terminal glutamine residues to pyroglutamic acid. Recently, the pyroglutamic acid-containing peptides red pigment concentrating hormone (pELNFSPGW-NH<sub>2</sub>) and corazonin (pETFQYSRGWTN-NH<sub>2</sub>) were identified and sequenced from the pericardial organ (PO) of the crab,

*Cancer productus*. The presence of these peptides in the PO suggest that this neuroendocrine tissue contains a QC-like enzyme. In this study we show a moiety immunoreactive to an antibody generated against bovine pituitary QC is present in the PO. Labeling with this antibody is present in both axons and peripherally located nerve terminals. The distribution of QC labeling in the PO is essentially identical to those of RPCH and corazonin. Double-immunostaining pairing the QC antibody with either anti-RPCH or anti-corazonin is planned to confirm the colocalization of the labels. Similarly, Western blotting is planned to identify the size of QC immunopositive moiety.

### **Effect of Oxygen Concentration on the Life Span of Long-Lived Nematode Mutants**

Maximillian Rogers, Senior, Aquatic and Fisheries Sciences, History, English

Mentor: Frieda Taub, Aquatic and Fisheries Sciences

The mechanisms that constrict the life span of organisms can be researched on long-lived mutant animals. This study examines the effects of three oxygen levels (1%, 21% and 41%) on the lifespan of the nematode *Caenorhabditis elegans*. The mean life span of the wild type, *daf-2*, *isp-1* and *daf-2/isp-1* mutants will be measured. Thus far the mean life span of the wild type has shown an average life span of 25 days at both the 21% and 41% oxygen concentrations, and 31 days at the 1% concentration. The results show that a decrease in oxygen concentration can positively affect the nematode lifespan. This confirms other reports. The three mutants will be studied soon; however based on the literature available on these mutations, which show them as increasing antioxidant defense, it is hypothesized that the life span of the mutants at higher oxygen concentrations will be significantly greater than that of the wild type. This study suggest that oxygen is involved in the determination of the nematode life-span.

### **Prevalence of *Renibacterium salmoninarum* Infection in Skagit Bay Chinook Salmon and its Implications for Disease Interaction between Hatchery and Wild Stocks**

Colleen Durkin, Senior, Oceanography, Biology

Mentor: Russell Herwig, Aquatic and Fisheries Sciences

In the Pacific Northwest, salmon are propagated in hatcheries or reproduce in the wild. These animals are susceptible to several diseases caused by bacteria, viruses, fungi and parasites. *Renibacterium salmoninarum* is a pathogenic bacterium that causes bacterial kidney disease in salmon and trout. The infection can be chronic, enabling perpetuation of the disease by contact between fish or by transmission of pathogenic organisms from female adult fish to eggs. The persistent nature of the disease may allow disease transmission between artificially reared salmon,

such as hatchery stocks, and wild salmon, including endangered populations within Puget Sound. The purpose of this study was to determine the prevalence of *R. salmoninarum* infection among juvenile Chinook salmon migrating into Skagit Bay. Because hatcheries in the Skagit River system claim a high marking rate on hatchery fish and wild fish are relatively abundant in Skagit Bay, a comparison of infection prevalences between hatchery and wild salmon was possible. Juvenile Chinook salmon were collected from nearshore surface waters at thirteen sites in Skagit Bay by surface trawl (towsnet) once per month from May to October 2003. A total of 577 kidney tissue samples were analyzed microscopically by counting bacterial cells stained with an anti-*R. salmoninarum* polyclonal antibody conjugated to fluorescein isothiocyanate. The sensitivity of the microscopic assay was established in separate experiments where uninfected kidney samples were spiked with dilutions of known concentrations of *R. salmoninarum*. The spiked samples were examined to index the number of cells counted to an intensity of infection. The infection prevalence and intensity of infection from the Skagit Bay Chinook salmon were related to seasonal progression, the timing of hatchery fish release, and the seasonal changes in water temperature. The patterns of infection prevalence will provide insight into potential disease interaction between wild and hatchery salmon.

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## SESSION 1E

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### INDIVIDUAL AND SOCIETY ISSUES IN PARENT AND CHILD DEVELOPMENT

*Session Moderator: John Neumaier, Psychiatry*  
*Session Assistant: Luke Butler, UW Graduate Student, Zoology*

**Mary Gates Hall Room 234**

#### **Parents' Developmental Expectations of their Newborns/Infants**

*Nicole Pete, Junior, Nursing*  
*McNair Scholar*

*Mentor: Pamela Jordan, Family and Child Nursing*

The specific aim of this study is to describe first time expectant parents' developmental expectations of their infant/child. The significance of this analysis is that relatively few studies have examined the actual information or knowledge parents have about how children grow, develop, and when they expect various developmental landmarks to occur. Many authors suggest that this lack of knowledge about child development can adversely affect parenting abilities. Parents who are aware of their infant's developmental capabilities will be better able to respond to the changing needs of the infant rather than limit their

infant's capabilities with their own misguided understanding of their capacity for socialization and interaction. This study will be a secondary analysis of data from "Survival Skills for First-time Parents: A Pilot Study," Pamela Jordan, PhD, RN, principal investigator, funded through an intramural research grant from the University of Washington School of Nursing. This was a pilot study of the Becoming Parents Program- a couple focused educational program for couples making the transition to parenthood, which involved 23 married couples. The specific data to be utilized will be responses to questions regarding the parents' developmental expectations of infants/children. Data from the parents' responses to these questions during pregnancy will be analyzed for this study using a simple content analysis. Responses will be analyzed together and separately for mothers and fathers. The goal is to provide descriptions of the time frames reported for the various developmental capabilities and to then examine the degree to which these are realistic or appropriate.

#### **Postmodern Parteras: Shifts in Childbirth Culture in the United States and Mexico**

*Jane Bush, Senior, Comparative History of Ideas*  
*Mary Gates Scholar*

*Mentor: Cynthia Steele, Comparative Literature*

The universal physiological event of childbirth varies drastically from culture to culture. Within this diversity, however, the Western medical model of childbirth has emerged as the dominant system arising out of global histories of modernization and colonialism. In Mexico, the state of Chiapas has a history of resistance to colonialism, and a current context of postmodern resistance to imposed cultural and political change. With respect to childbirth, this resistance has resulted in a preservation of Maya birth practices. In the United States, although the medical model is the preeminent model for childbirth, the development of the role of the *doula* – a woman who supports and advocates for the birthing woman throughout labor – has emerged in opposition to the power structure of the hospital. This comparative study of childbirth culture and history seeks to illuminate parallels between the evolution of resistance to the medical model in the United States and Mexico, focusing on *parteras* (midwives) in Mexico and *doulas* in the United States. The methods include an analysis of anthropological, historical and medical texts with an emphasis on deconstructing the relationship between the power structure of the colonizer/colonized and the power structures inherent in different birth systems. Textual analysis is interwoven with narrative of personal experiences with birth in Mexico and the United States.

#### **Limitations of Self-Regulation in Preschool Children**

*Jamie Gum, Senior, Psychology*

*Mary Gates Scholar*

*Mentor: Stephanie Carlson, Psychology*

Self-regulation is central to our daily functioning as it provides the foundation for school, work, relationship, and health-related competencies. What is more, self-control abilities are stable over time with preschool performance on regulatory tasks predicting social and cognitive competence well into adulthood. Given its importance for successful functioning, it seems logical that supplies of self-control would be quite plentiful. Research, however, suggests the opposite, indicating that self-regulation is a limited resource that may be depleted following excessive self-regulatory demands. While empirical evidence clearly supports this phenomenon in adults, the absence of child populations from the literature is surprising. We have begun to address this issue by adapting existing methodology to investigate self-control depletion in preschoolers. Forty-eight four-year-olds were randomly assigned to one of three waiting conditions, each designed to manipulate self-control to a different degree. Children in a control condition were simply asked to wait quietly, whereas children in cookie and broccoli conditions were presented with both types of food and instructed to eat one of the food types but not the other. After 5 minutes, all children received a problem-solving activity measuring persistence. If adult patterns hold true in children, as we expect they will, children instructed to eat the broccoli and not the cookies will experience greater self-control taxation and can be expected to demonstrate less persistence on the problem-solving task than children instructed to eat the cookies or simply to wait. By showing that excessive self-control demands negatively impact children's ability to exercise self-regulation, we will uncover an important challenge to children's self-regulation development and perhaps also gain a better understanding of how to optimally facilitate this development during the preschool years.

### **Understanding the Age Factor on Children Identified with Emotional and Behavior Disorders**

*Michele Brittany-Bacha, Senior, Interdisciplinary Arts and Sciences: Mass Communication*

*Mentor: Gregory J. Benner, Education*

There are about 470,000 youth in the United States receiving special education and related services under the category of emotional and behavioural disorders (EBD) and those numbers are growing. While the inclusion of students with disabilities into mainstream classroom teaching has increased since Congress passed the Individuals with Disabilities Education Act (IDEA) in 1975, figures from the U.S. Department of Education indicate that approximate 50% of students with EBD drop out of school (2001) and consequently suffer from low employment levels and poor employment histories. Additionally, other studies have proven that such students

were arrested within 5 years of dropping out (Chesapeake Institute, 1994), leading to the conclusion that students with EBD are plagued with lifelong implications that keep them at a disadvantage to integrating into society. Antisocial behavior patterns become increasingly stable and resistant to intervention efforts (Kazdin, 1993; Walker & Severson, 2002). Therefore, it is hypothesized that as students with EBD age, their behavioral problems will tend to remain stable or worsen. In order to determine the effect of age, a randomly selected kindergarten through twelfth grade students with EBD receiving services in two suburban school districts will be sampled by collecting data from their school records. In particular, the following will be analyzed: (1) Child Behaviour Checklist: Teacher Report Form (CBCL: TRF) that measures social adjustment; (2) IQ; and (3) the WJ-III in order to determine the affect of age. This research is in progress; therefore concrete conclusions cannot be made.

### **Cumulative Risk and Physiological Reactivity in Relation to Children's Adjustment Problems**

*Alissa Bazinet, Senior, Psychology*

*Mentor: Liliana Lengua, Child Clinical Psychology*

The development of psychopathology and behavior problems in children has been linked to a variety of risk factors, including low socioeconomic status, single-parent family status, family history of psychological problems, marital discord, size of family, and lack of social support. "Cumulative" risk models suggest that it is the number of risk factors present, rather than exposure to any one individual factor or combination of factors that is most important in predicting children's adjustment outcomes. Studies that have examined the effects of cumulative risk have shown that exposure to a higher number of risk factors is related to an increased likelihood of developing adjustment problems in children. Additionally, children exposed to high levels of risk may show an increased reactivity to stress (as indexed by physiological measures). This study is investigating the relationship between cumulative risk and physiological reactivity in a community sample of children ages 8 to 12. Children's physiological reactivity was assessed across a series of emotion-eliciting tasks, and measures of heart rate, skin conductance, and peripheral blood volume were obtained at baseline and during tasks. Cumulative risk was assessed using parental reports on questionnaire measures. We hypothesize that cumulative risk scores will predict greater physiological reactivity, and in turn, that physiological reactivity will be related to children's later adjustment outcomes.

### **Water, Not Chocolate: Type II Diabetes Education for Hispanics**

*Pamela Mejia, Senior, Biology, Washington State University*

*Mentor: Jill Armstrong Shultz, Biology, Washington State University*

Type 2 diabetes is a public health crisis in the United States. Among Hispanics, the rate of diabetes, diabetes-related complications, and diabetes-related death is two to three times higher than among non-Hispanic whites, and the incidence is projected to increase significantly within the next ten years. Diabetes education for Hispanics must be culturally sensitive to the unique needs of this population in order to be effective. The goal of this research was to identify the issues affecting self-care and effective diabetes education for Hispanics with Type 2 diabetes. Current literature on diabetes education research was reviewed in-depth. A small sample of diabetes educators from selected Hispanic communities in Washington State provided in-depth interviews on topics identified as primary concerns for Hispanics with diabetes. Issues facing Hispanic diabetes patients were found to include the impact of traditional gender roles, lack of family support, the use of traditional foods and remedies, and barriers imposed by economic limitations. The responses obtained from providers reinforced the findings from the literature review. Survey results were integrated into a proposed program of diabetes education for Hispanics. The proposed program utilized Social Cognitive Theory, a theory that addresses influences on self-regulated behaviors. In order to minimize the devastating effects of the diabetes epidemic within the Hispanic community, it is necessary to identify major challenges that face this community. Health care providers must understand these issues in order to develop a method of providing effective, culturally-competent diabetes education to the vulnerable Hispanic population.

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## SESSION 1F

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### INNOVATIVE STRUCTURES, SYSTEMS, SOLUTIONS

*Session Moderator: Alvin Kwiram, Chemistry, Vice-Provost for Research Emeritus*

*Session Assistant: Katie Liu, Sophomore, Pre-Major, Arts and Sciences*

**Mary Gates Hall Room 254**

**\*Note: Abstracts in order of presentation.**

#### **Modification of Iridium Metal Complex for use of as a Catalyst in Carbon-Hydrogen Bond Activation**

*Jared Silvia, Junior, Chemistry*

*Goldwater Scholar, Mary Gates Scholar, Space Grant 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 hydrotris(3,5-dimethylpyrazolyl)borate iridium(III) trimethylphosphine dihydride ( $\text{Tp}^*\text{Ir}(\text{PMe}_3)_2\text{H}_2$ ) has been studied as a possible starting material for such a catalyst. The initial focus of the research was upon modifying the ligand set of the iridium metal center to yield a more reactive compound. Modification of the ligands was carried out using air-free schlenk techniques with the hope of eventually reaching the dinitrogen hydride complex versus the starting dihydride one. Such a change was carried out through the initial protonation of the dihydride to give the dihydrogen hydride complex. From this point, the dihydrogen ( $\text{H}_2$ ) was replaced with the dinitrogen ( $\text{N}_2$ ) group by exposing the reaction to high pressures of nitrogen gas. Characterization of products is performed predominantly through the use of proton and phosphorous NMR spectroscopy, and mass spectroscopy. Initial results indicate the dinitrogen complex has been created with some success, but there were several side products. From these results, an alternative pathway is being developed to give a more efficient reaction scheme to reach the desired dinitrogen complex. An alternative pathway has been devised that relies on the formation of a hydridochloride (HCl) complex prior to dinitrogen complex formation. From this point, carbon-hydrogen bond activation of benzene has been attempted, but activation was not observed. As progress continues, further work will be performed to assess the ability of the complex to activate a number of different hydrocarbons.

#### **Synthesis of Magnetically Dilute Conducting Polymers**

*Trisha L. Andrew, Junior, Chemistry*

*Mary Gates Scholar*

*Mentor: Natia Frank, Chemistry*

“Conducting plastics,” or linearly conjugated organic polymers, have recently been of great interest to the research community because of the diversity of their potential applications in modern electronic and photonic devices. Due to their stability and structural planarity, thiophene and thiophene-based polymers are prominent among the candidates for a “conducting plastic;” moreover, the parent thiophene molecule is relatively easy to functionalize and a wide variety of thiophene derivatives are commercially available, thus making the synthesis of thiophene polymers straightforward, and, ultimately, cost-effective. However, optimum use of these thiophene polymers often requires n- or p-type doping, where electron donors or acceptors (respectively) are systematically incorporated into the base thiophene polymer to encourage/enhance conductivity without reacting irreversibly with adjacent thiophene moieties. In this vein, we have

attempted to synthesize a p-doped thiophene polymer where the electron acceptor is a phenyl nitronyl nitroxide, a stable organic radical.

### **Synthesis and Characterization of Nanoparticles for Studies of Single-molecule Electroluminescence**

*I-Kang Ding, Junior, Chemistry*

*Mentor: David S. Ginger, Chemistry*

Semiconductor nanoparticles exhibit size-dependent optoelectronic properties and flexible processing chemistry. The color-tunable and efficient luminescence of these particles makes them strong candidates for use in light-emitting diode (LED) applications. Such applications require easy injection of holes and electrons into the nanoparticles in order to produce a device with a low drive voltage. On the other hand, efficient radiative recombination of injected electrons and holes can be observed only if the dangling bonds on the surfaces of the nanoparticles are well-passivated. Because attempts to passivate the surface often increase the barriers to carrier injection, efforts to optimize these properties are often at odds. To address this issue, we synthesized a series of CdSe/CdS core-shell nanoparticles with varying shell thicknesses. We will show that these nanoparticles can be processed into thin films and monolayers that are free of excess organic materials while preserving the efficient fluorescence that the nanoparticles exhibit in solution. We have characterized the nanoparticles and the nanoparticle films using absorbance spectroscopy, fluorescence spectroscopy, optical microscopy, and atomic force microscopy. We anticipate that these results will allow us to study the electroluminescence of single nanoparticle, which will in turn enable us to refine the synthetic procedure to produce more efficient nanoparticle chromophores for electroluminescent device applications.

### **Steady-State, AC-Temperature Calorimetry with regards to Nanotubes**

*Damien Ramunno-Johnson, Senior, Physics*

*Mentor: Oscar Vilches, Physics*

A steady-state technique for measuring heat capacity using AC heating is described. Heat is applied, sinusoidally in time, to nanotubes thermally coupled to a reservoir. The resulting equilibrium temperature of the nanotubes contains a term that is both inversely proportionally to the heat capacity, and measurable with high precision. Various corrections are made, and the result is a highly sensitive measurement of the heat capacity. Then, a measurement of the heat capacity of clean nanotubes is performed to create a background heat capacity. Films of varying amounts are then placed on the nanotubes, and the heat capacity is then repeated over a range of temperatures. Then, with data analysis it is possible to know the heat capacity of films covering the nanotubes.

### **Photometric Measurements on the ZaP Flow Z-Pinch Experiment**

*Kristopher Yirak, Senior, Physics, Astronomy*

*Mary Gates Scholar*

*Mentor: Professor Uri Shumlak, Aeronautics and Astronautics*

*Plasma* is the name given to the fourth state of matter – a gas so energetic that its molecules disassociate into electrons and ions, creating a “particle soup.” The ZaP Flow Z-Pinch Experiment is an innovative plasma physics experiment studying the stabilization of a plasma column. Plasma columns, or Z-pinches, are normally highly unstable. However, recent results from ZaP suggest that a Z-pinch with a sheared particle flow can survive for over 2000 times its normal lifetime. This extended period of time is referred to as the “quiescent period.” The understanding and prolongation of the quiescent period is a high priority because many applications of sheared-flow Z-pinches would benefit from steady state or long-pulsed operation. The movement of charged particles in the column generates a magnetic field (similar to the way a current-carrying wire creates its own magnetic field), and so magnetic probes in the experiment play a large part in describing the behavior of the Z-pinch. Unfortunately, the motion described by these probes may not correlate exactly with the motion of the plasma itself. To investigate the behavior of the plasma in another fashion, a linear photodiode array (PDA) has been introduced. In this instrument, sixteen photodiodes are aligned linearly perpendicular to the plasma column. The plasma’s bright emission allows the PDA to observe the motion of the Z-pinch as it moves into and out of each photodiode’s field of view. Results indicate that the PDA agrees with the magnetic probes during the quiescent period and that the correlation between the signals decreases when the column goes unstable.

### **Precision Measurements of Solar Nuclear Reactions**

*Patrick N. Peplowski, Senior, Physics*

*Mary Gates Scholar*

*Mentor: Kurt Snover, Physics, Center for Experimental Nuclear Physics and Astrophysics*

Nuclear fusion occurs in the core of the sun, and although we cannot observe the core directly, we can measure these reactions in the laboratory. Of particular interest are the fusion of a helium-3 nucleus with a helium-4 nucleus to form a beryllium-7 nucleus ( ${}^3\text{He} + \alpha \rightarrow {}^7\text{Be}$ ) and the fusion of a beryllium-7 nucleus with a proton to form a boron-8 nucleus ( ${}^7\text{Be} + \text{p} \rightarrow {}^8\text{B}$ ). These reactions are part of the Proton-Proton (PP) Chain that powers the sun by converting hydrogen into helium. These reactions are being measured using the particle accelerator at the Center for Experimental Nuclear Physics and Astrophysics (CENPA) at the University of Washington. These reaction rates must

be known with high precision in order to understand the fluxes of solar neutrinos and neutrino oscillations, which is one of the most active areas of physics research today. An experiment to measure the fusion rate of  ${}^7\text{Be}+p\rightarrow{}^8\text{B}$  was recently completed, and preparations are currently underway to measure the  ${}^3\text{He}+\alpha\rightarrow{}^7\text{Be}$  fusion rate. The measured fusion rate for the  ${}^7\text{Be}+p\rightarrow{}^8\text{B}$  reaction will be discussed, along with the implications for neutrino measurements and solar models. The results from preparations for the  ${}^3\text{He}+\alpha\rightarrow{}^7\text{Be}$  fusion rate measurement will be discussed, along with the plans for future research in this area.

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## SESSION 1G

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### IN VIVO, IN VITRO, IN SILICO: EXPLORATIONS IN BIOLOGY AND BIOCHEMISTRY

*Session Moderator: Rachel Klevit, Biochemistry*  
*Session Assistant: Tatiana Deras, Sophomore, Pre-Major, Arts and Sciences*

**Mary Gates Hall Room 287**

#### Investigation of the Highly Conserved NKFDE Motif of the cGMP-binding GAF Domain of PDE5A

*Yuya Kobayashi, Senior, Biology, Political Science*  
*Mary Gates Scholar*

*Monica R. Sekharan, Graduate Student, Biochemistry*  
*Mentor: Rachel E. Klevit, Biochemistry*

Phosphodiesterase 5 (PDE5) is involved in the regulation of cellular concentrations of cyclic nucleotide secondary messengers, cGMP. Along with four others in the phosphodiesterase superfamily, PDE5 contains two GAF domains, a cyclic nucleotide-binding regulatory region. Within all PDE GAF domains, there is a highly conserved five amino acid motif (Asn, Lys, Phe, Asp, Glu) referred to as the NKFDE motif. Because of the high degree of conservation, the NKFDE motif was initially predicted to be the cyclic nucleotide binding site; however, additional structural studies indicated that the NKFDE residues were not in direct contact with the cyclic nucleotides. In this study we used mutagenesis, one-dimensional and two-dimensional NMR spectroscopy, and binding assays to investigate the roles of each of the NKFDE residues. Any mutation of residues within the NKFDE motif has resulted in overall decrease in structural stability, indicated from increased proportion of aggregated species. Mutations in some residues of the NKFDE motif affected cyclic nucleotide binding affinity, and possibly, specificity.

#### Directionality of Ribosome Frameshifting in E. Coli

*Vi Dan Nguyen, Sophomore, Physics*

*Mary Gates Scholar*

*Mentor: Jon Gallant, Genome Sciences*

Classically, it is established that ribosome advances three nucleotides, or one codon, along mRNA with each successive amino acid addition. However, it was observed in several cases of studies of natural RNA sequences (e.g., *Escherichia coli* prfB, mouse mammary tumor virus, human immunodeficiency virus type 1) that the ribosome::mRNA interaction could occur in a non-triplet manner. This means that ribosome could shift its reading frame by skipping one nucleotide forward (3'), called a [+1] frameshift; or draw backward one nucleotide (5') called a [-1] frameshift. Our project investigates the relative frequency of ribosome frameshifting in each direction on the same sequence. The reference reading frame is TTT TCC, and is called 0 frame or normal reading frame. We made constructs in which active  $\beta$ -galactosidase synthesis demanded either a [+1] frameshift or [-1] frameshift, as well as one in which a [+2] frameshift led to active enzyme production. Frameshifting at the TCC codon above was stimulated by inhibiting the attachment of its encoded amino acid, serine, to tRNA through addition of a specific inhibitor, serine hydroxamate (SHX). To measure the activity of frameshifting we first used a disc test, and analyzed the blue rings around a disc of SHX formed by the activity of  $\beta$ -galactosidase breaking down X-Gal. We hypothesize that (+1) frameshift will give the most activity of  $\beta$  galactosidase, then (-1), and then (+2). However, the disc test results were inconclusive. Next, we performed four liquid culture experiments, one using bubbler tube cultures and the others done at micro-culture scale in a 96-well block format. Exponential cells were induced with cAMP, ITPG without inhibition in the control group, and with SHX inhibition in the experimental group. After about one mass doubling, we lysed the cells, and measured  $\beta$ -galactosidase production colorimetrically. However, neither test showed a dramatic difference amongst the frameshift reporter constructs in the synthesis of  $\beta$ -galactosidase. More tests and further analysis are still in process.

#### Structure and Function Studies on Human $\alpha\beta$ -Crystallin

*Satoshi Mark Noguchi, Senior, Cellular and Molecular Biology, Music*

*Mary Gates Scholar*

*Mentor: Ponni Rajagopal, Biochemistry*

The protein  $\alpha\beta$ -Crystallin ( $\alpha\beta$ ) has multiple cellular functions, including functioning as a small heat shock protein (sHSP) under cellular stress to act as a molecular chaperone, and maintaining eye-lens transparency. Since no high-resolution structural data of  $\alpha\beta$  or other mammalian sHSPs currently exist, our project's goal is to use multi-dimensional nuclear magnetic resonance (NMR) spectroscopy to determine the three dimensional folding

structure of this protein and to elucidate functional mechanisms. We have investigated the effect of different salt concentrations and pH on the secondary structure through circular dichroism analysis. We have also sought to characterize the chaperoning properties of  $\alpha$ B by forming complexes with unfolded substrates, e.g. Insulin  $\beta$ -chain and  $\alpha$ -Lactalbumin. We used a limited proteolysis reaction (protein cleavage by trypsin) visualized by polyacrylamide gel electrophoresis and matrix-assisted laser deionization mass spectroscopy to look at how  $\alpha$ B binds to these substrates. We found that  $\alpha$ B did not bind the substrate if it was not unfolded completely. Hence, it was not possible to draw definite conclusions from these experiments. At present, we are in the process in the making truncation and point mutations of the 100-residue core domain of  $\alpha$ B in order to diminish the conformational heterogeneity observed in the NMR spectra. We intend to express and purify these mutants for further NMR studies that will form the basis for structure determination.

### **BRCA-1 and BARD-1 homologues in *C. elegans***

*John Roberts, Senior, Biochemistry*

*Mentor: Rachel Klevit, Biochemistry*

*Mentor: Devin Christensen, Biochemistry*

*Mentor: Pradipsinh Rathod, Chemistry*

Human breast cancer affects one in eight women in the United States. A gene predisposing women to breast cancer has been identified: a mutation in one allele of the BRCA1 gene elevates the risk for contracting breast cancer to 80 percent. Ten years after its discovery, the biochemical function of the protein encoded by the BRCA1 gene remains elusive. Recently, the genome of the nematode *C. elegans* has been sequenced, and genes have been identified that have some sequence similarities to the human BRCA-1 gene and its natural binding partner, BARD1. This discovery raises several questions about the nature of the *C. elegans* genes, and the proteins encoded by those genes. Do the homologous proteins from *C. elegans* interact the same way as do BRCA1 and BARD1 in humans? Are these genes conserved even in organisms as far removed from our species as *C. elegans*? Do the homologous proteins carry out a similar function for the *C. elegans*? Answers to these questions will give researchers a much more basic model organism for experiments with the BRCA and BARD genes.

### **Hydrogen Bonding Interactions in Protein/Small-Molecule Complexes**

*Joshua M. Tasman, Post-baccalaureate, Biochemistry*

*Mentor: Gabriele Varani, Biochemistry and Chemistry*

In proteins we find the ultimate junction of form and function: it is the structure of the protein which is key to the remarkable specificity and efficiency of reactions involving these molecules. When a protein associates and forms a complex with (or binds to) another molecule, the

protein may be activated or deactivated for further reactions, or the function of the protein may be changed entirely. Whether a protein will bind with a molecule is largely dependent on the structure of both; non-bonding intermolecular interactions such as hydrogen bonding play a large part in determining binding. Currently, there are large published libraries of the three-dimensional structures of proteins. If we could predict the interaction of a protein and another molecule based on their structures, we could screen a database of small molecules to identify compounds with a high chance of binding with this protein. The ability to accurately predict a protein's interaction with other molecules would aid both the elucidation of interactions that occur within the cell, as well as identification of rationally-designed pharmaceuticals which target specific cellular mechanisms. However, there are many difficulties inherent in current protein binding simulations, which model interactions from "bottom-up" computational approaches. The aim of this research project is to take advantage of the increasingly large number of experimentally derived protein / small-molecule structures, and develop a "top-down" statistical model of hydrogen bonding interactions between proteins and small molecules. It is hoped that this type of model will capture some of the complexities currently lacking in the first-principles approach. The integration of this statistical model into protein binding simulations will be a measure of the success of this approach.

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## **SESSION 1H**

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### **LIVING SYSTEMS**

*Session Moderator: Christian Grue, Aquatic and Fishery Sciences*

*Session Assistant: Amy Paul, Junior, Biology*

**Mary Gates Hall Room 228**

### **Population Genetics and Juvenile Life-History Evolution of Chinook Salmon in the Skagit River Basin of Puget Sound**

*Elizabeth Heeg, Senior, Zoology*

*Mentor: Paul Moran, Conservation Biology Division, Northwest Fisheries Science Center*

Chinook salmon show extraordinary diversity in life history strategies throughout their range. It is currently unknown to what extent this variation is a product of local adaptation as opposed to phenotypic plasticity resulting from environmental variation. Chinook salmon have two general life-history types, so called "stream-type" and "ocean-type" life histories. Stream-type fish live in their natal stream for up to one year before migrating directly to the ocean. Ocean-type fish, on the other hand, migrate to saltwater within the first year. Chinook populations within the Skagit River basin exhibit three life-history sub-types within the

ocean type. This study is part of a multi-disciplinary research effort to understand both the population genetic structure of this and other river systems as well as the stock-specific spatial and temporal distribution of juveniles in the estuarine rearing environments. As a first step, we created a baseline microsatellite data set of reference populations from selected sites throughout the basin. Our results showed rough geographic continuity, although bootstrap values were low. In spite of uncertainty in exact relationships among populations, the samples appeared to be well differentiated as reflected by both FST and contingency tests of allele frequencies. We conclude that additional samples are needed to assure full representation of the basin. Nevertheless, the levels of divergence we see suggest promise for the next step in our study; that is, the assignment of juveniles with various life history types to their population of origin. Mapping life-history forms onto observed evolutionary relationships and describing the distribution of individual fish will better inform decisions regarding habitat recovery and will provide a more complete understanding of the evolutionary forces that contribute to the remarkable diversity observed in Chinook salmon populations.

#### **Varnish Clams and Pea Crabs: New Host or Dead-End Relationship?**

*Jared Mitts, Senior, Fisheries*

*Mentor: Greg Jensen, Aquatic and Fishery Science*

*Pinnixa faba* and *Pinnixa littoralis* are two small crabs, commonly known as pea crabs, native to the Puget Sound/San Juan waters. They are found in their adult form only inside of horse clams, *Tresus capax*, though the juvenile form is found in other clam species. Until recently only a small percentage of pea crabs have been found in the other species of clam, but now with the introduction of the invasive varnish clam, *Nuttallia obscurata*, some accounts have noted an infestation rate of 35%. The goal of our research is to examine the infestation rates of the two species of pea crabs in varnish clams, and to see if those in varnish clams have the potential to relocate into their natural host, the horse clam. The first goal will be achieved through surveys of local beaches where the varnish clam has taken hold. Second, we will use video surveillance of horse clam/juvenile pea crab interactions in the lab to see if and how the pea crabs are able to enter horse clams.

#### **Indirect Effects of Marine Protected Areas on the Predation Pressure within Marine Ecosystems**

*Shannon Smith, Senior, Biology and Economics*

*Mary Gates Scholar*

*Mentor: Megan Dethier, Biology*

Over the past century, there has been widespread decline in global marine fisheries. In response to this worldwide exploitation of marine organisms, Marine Protected Areas (areas with restricted fishing) have become an increasingly

utilized tool in managing these resources. Many Marine Protected Areas have been implemented to protect specific over-harvested species, yet these policies also have indirect effects on other species within the marine ecosystem and their interactions with each other. This research investigated the effects of Marine Protected Areas on the predation rates of different predators. Three marine reserves (no fishing allowed) in the San Juan Islands, Washington, were studied to answer three questions: 1. Are there different relative predation pressures inside and outside of marine reserves? 2. Does relative predation pressure differ among different sized predators depending on reserve status? 3. What do these predation pressures imply about the populations of large and small-sized fish inside and outside of marine reserves? To answer these questions, a caged tethering experiment was performed in which live prey was tethered inside one of three treatments: an open frame which let in all predators, a large mesh cage that only let in small predators, and a small mesh cage control, which let in no predators. Trends in the data showed lower predation by small-sized fish occurred inside reserves than outside. These trends suggest that small-sized predators may be in lower abundance inside reserves than outside due to increased predation pressure resulting from higher densities of large-sized predators. These trends also imply that small-sized predators may change their foraging behaviors when living among higher densities of large predators.

#### **Indirect Effects of Marine Reserves on Several Species of Snails, Small Crabs and Scallops in San Juan Channel, Washington**

*Kevin R. Turner, Senior, Fisheries and Zoology*

*Mary Gates Scholar*

*Mentor: Megan Dethier, Biology*

In 1990 three marine reserves were established in San Juan Channel, Washington, with the goal of protecting bottomfish from harvest. I studied the indirect effects of these reserves on small invertebrates, including several snail, crab and scallop species, by comparing population densities and individual sizes between reserves and paired non-reserve locations. At one location, one snail (*Trichotropis*), all small snails pooled, and scallops (*Chlamys spp.*) existed in higher densities in the reserve than in its paired non-reserve. These responses may be due to interactions with small fishes, which are eaten by large fishes and are predators on and competitors with the snails and scallops. At the same location, the size-frequency distribution of all small crabs pooled was found to be skewed to smaller sizes in the reserve area than in the non-reserve area, probably due to an increase in large fishes in the reserve. Principal component analysis did not show correlations to any physical parameters, suggesting that these effects are a result of reserve status. These results support the hypothesis that marine reserves designed to protect large fishes can have indirect effects on some elements of the invertebrate community, although

the effects may not be seen universally among all species or at all reserves.

**Investigation into an Overlooked Secondary Sexual Characteristic: Variation in Male Adipose Fin Morphology in Spawning Populations of Sockeye Salmon (*Oncorhynchus nerka*)**

*Peter Westley, Senior, Aquatic and Fishery Sciences*

*Mentor: Thomas Quinn, Aquatic and Fishery Sciences*

Pacific salmon (genus *Oncorhynchus*) undergo extreme morphological transformations as they approach reproductive maturity. Secondary sexual characteristics, such as prominent hooked jaws and dorsal humps, increase in relative size during the spawning season. Although the adipose fin on male salmon has no obvious function, it too increases in size during maturation. Discrete populations of spawning salmon invest varying amounts of energy into the maintenance of econdary sexual characteristics, often as a result of the balance between natural selection (in the form of bear predation) and sexual selection (in the form of female choice or male competition) experienced by individuals on the spawning grounds. I investigated male adipose fin morphology in eight discrete breeding populations of sockeye salmon (*O. nerka*) spawning in Bristol Bay, Alaska in relation to other secondary sexual characteristics (jaw size, hump depth). To test the hypothesis that adipose fin size would differ significantly between populations, sexually mature fish were captured at the mouths of their natal streams or beaches, anesthetized, and measured. Adipose fin size varied significantly between populations. Populations characterized by large dorsal humps and large jaws tended also to have large adipose fins; however, this was not an absolute rule. Individuals within populations that had large humps and jaws for their length tended also to have large adipose fins, but again this varied among populations. The results of this study are the first to report significant variation in adipose fin size between discrete breeding populations and further supports the notion that we should begin to change our thinking concerning this overlooked trait.

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## SESSION 1I

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### MOVEMENT, MEDIA, AND THE ART OF RUG WEAVING

*Session Moderator: Betsy Cooper, Dance*

*Session Assistant: Heather Hooper, Freshman, Pre-Major*

**Mary Gates Hall Room 389**

**\*Note: Abstracts in order of presentation.**

***Tipping Point: Investigating Mathematics, Space, Gravity and Human Individuality through Choreography***

*Marisha Doan, Senior, Dance, Russian Language and Literature*

*Mentor: Elizabeth Cooper, Dance*

*Mentor: Jennifer Salk, Dance*

In January of 2003 I embarked on an intense journey in choreography and performance with a cast of seven dancers that culminated in a dance called *Tipping Point*. My objectives and research methods for *Tipping Point* developed out of a few essential choreographic questions: What are the capabilities of a group spatially and mathematically? How can I use my dancers' individuality to build the dance? How can movement phrases be manipulated? How do I want dance and music to relate? In short, the dance I wanted to choreograph explored spatial pattern and form, human individuality, and different modes of movement phrasing and musical phrasing. I began my research by leading my dancers through various improvisational structures to generate the core movement material. I then mathematically and spatially spliced and shaped the material. These spliced phrases were then assigned in different number groupings or adapted into partnered duets and trios. For musical accompaniment I chose *Electric Counterpoint* by Steve Reich. I studied the music meticulously, marking patterns in the musical notation and finding ways to match the movement to its form. The musical concept of "counterpoint" also informed my choreographic choices. The dance that resulted from my inquiries is a complex interweaving of patterns and groupings that flow and "tip" into and out of one another. The dance evolved both conceptually and visually to embody the term "tipping point" or the point at which small things amass to create a large impact. In the dance this was most poignantly demonstrated by the dancers' relationship to gravity in off-balance and falling to recovery. *Tipping Point* was performed for the Dance Major's Concert May 28-31, 2003. In June 2003 I received a first place award for outstanding choreography for my work. This year I was asked by the UW Dance Department to prepare *Tipping Point* for the American College Dance Festival Association March 17-21, 2004.

**Apply for Cyborg Nation Citizenship! Accessing the Cybernetic Third Space via the Postmodern Database**

*Tiffany Addelle Dierking, Senior, Studio Art: Mixed Media, Western Washington University*

*Mentor: Julia Sapin, Art History, Western Washington University*

This paper reinterprets Homi Bhabha's idea of a "Third Space," an intellectual construct that suggests a way of deconstructing the cultural binaries that define race, sexuality and global power constructs in terms of a "Postmodern Database." The Postmodern Database, a term

coined by Hiroki Azuma, embraces Postmodernism, as a birth of information networks encompassing traditions, history, laws, language, and cultural identity, rather than mourning the death of the linear “Grand Narrative,” in a Postmodern world. When the Postmodern Database is coupled with the Third Space, there is an emergence of a Cyborg Culture, which draws from no single cultural context. It is a constructed culture built from the parts and pieces of all cultures. Through visual analysis of works by contemporary artists Mariko Mori and Vivan Sundaram, I will illustrate my reinterpretation of a third space. Both of these artists use the Postmodern Database by drawing imagery from across cultures, time, fiction, and geography to create work that incorporates a constructed identity made of divergent parts: in other words a Cyborg identity. This research reveals that Cybernetic Third Space is not just the bridge between Postcolonial and Posthuman studies, but is an inclusive means of representation. The Cybernetic Third Space is a construct made possible due to technological advances, like the Internet, which render geography and culture secondary, and make self-representation primary. Ultimately, this research seeks to emphasize the role of technology-based forms of communication and representation in increasing effective inter-cultural discourse.

### **Bound to Normalcy: Alienation and Intersectionality in *Buffy the Vampire Slayer***

*Ari Okano, Senior, Political Science, English*

*Mary Gates Scholar*

*Mentor: Andrea Simpson, Political Science*

When the television show, *Buffy the Vampire Slayer*, debuted in 1997 as a continuation of the 1992 comedic film of the same name, critics and fans of the film were surprised. The audiences’ surprise stemmed from the change in tone between the film and the television series. While the film was lighthearted and sarcastic, the television series developed an emotional depth and dark edge that the film lacked. Indeed, throughout the show’s seven seasons, the protagonist of the series, Buffy, feels alienated from the suburban society she lives within and protects as “The Slayer.” The purpose of my study is to explore Buffy’s feelings of alienation, and the messages that the show purveys to the viewer through the central protagonist. My analysis of the television series, *Buffy the Vampire Slayer*, has three components. First, I examine the materiality of the settings and the characters’ physical appearance on the show; second, I explore the concept of “normal,” and how normalcy is connected to heterosexuality and race; and finally, I discuss the Season Six musical episode, “Once More with Feeling.” I argue that one can read Buffy’s alienated state as stemming from her identification with the abnormal. In other words, Buffy identifies with the forces of evil she protects the suburban world from: the vampires, demons, and ultimately hell itself.

### **Thread Counts: An Investigation of Fair Trade Rug Weaving and the Artisan**

*Anna Marie Seymour, Senior, Art: Fibers*

*Mary Gates Scholar*

*Yukari Greer, Freshman, Art: Fibers*

*Mary Gates Scholar*

*Mentor: Layne Goldsmith, Art: Fibers*

Our research was an investigation of the hand-woven rug-weaving industry in Katamandu, Nepal. We sought to understand how this industry works and the connections it has with the contemporary rug market in the United States. The importance of Fair Trade and its effect on the artisans in the rug-weaving industry was also vital to our investigation. To do this we conducted international business transactions with three different weaving companies in Nepal. We designed rugs on our own, as well as doing commission work for clients in the Seattle area and facilitated the connections for other students commissioned designs in the School of Art. Meerah Bhattari, the founder of Fair Trade Nepal and of the Association of Craft Producers met with us in August of 2003 and invited us to visit her facility in Nepal, where Nepalese artisans are being paid a fair wage to produce items that are being sold internationally. To further this research we traveled to Nepal and visited each of the rug weaving companies we had communicated and conducted transactions with in the past. While in Nepal we looked into how the Rugmark label that prevents child labor was implemented, as well as the effects of a fair trade practice for the artisans. We also collaborated with Meerah Bhattari to understand the need for more international contemporary design could lead to future markets for the Association of Craft Producers. We learned how the economy of scales affects the wages and living standards of the artisans in Nepal. We discovered how to merge our artistic abilities with fair production of a handmade product while producing an international exchange that creates economic and social gain for both the designer and the craftsman.

### **Fellini Retrospective**

*Eric Burrirt, Junior, Cinema Studies*

*Mary Gates Scholar*

*Mentor: Willis Konick, Comparative Literature*

The goal of my project was to illustrate the recurring themes and cinematic genius of Federico Fellini. I put together a retrospective/montage of Fellini’s films that was shown while a live band played music from his films. To prepare for this retrospective, I watched all 24 of Fellini’s films and had to track down several on the Internet and ebay. I also wanted to get inside the mind of Fellini, so I read an autobiography entitled *Fellini on Fellini*. After I watched the films I went through them again, and taped the parts that I found to be stereotypically Fellini’s style with recurring themes. I transferred these tapes onto my computer and edited approximately 1,000 scenes, which

then had to be cut down to a 45-minute presentation. After months of viewing the various clips from editing and reading the autobiography on Fellini, I discovered certain motifs throughout his work. These were motifs of women, films within films, circus elements such as clowns, structures, and the Catholic religion. There were other motifs, but these struck me as being the most important elements of his films. The last two weeks I received help from an editor to aid me in putting clips I had edited into a 45-minute montage. Since I had gone through all the clips I wanted to insure that the montage represented Fellini's style. After the retrospective played on the opening night of Felliniana at Meany Hall (the UW festival that honored Fellini), I received positive reactions from people who attended. These included Barbara Steele who was one of the actresses in Fellini's most famous film, Peter Bondanella who met Fellini and wrote a book about him, Frank Burke who also wrote a book on Fellini, and Fellini art expert Ricardo de Mambro Santos.

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## SESSION 1J

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### PEOPLE, PLACE, AND CULTURE: DISCOURSES OF SOCIAL JUSTICE

*Session Moderator: Christopher Campbell, Urban Design and Planning, Community and Environmental Planning*

*Session Assistant: Jenny Kroon, Sophomore, Pre-Major, Arts and Sciences*

**Mary Gates Hall Room 242**

**\*Note: Abstracts in order of presentation.**

#### **Socially Just Cities and the Importance of Public Space**

*Christina Aravena, Senior, Urban Studies*

*Melissa Coffey, Senior, Urban Design and Planning*  
*G'Nel Ferretti, Recent Graduate, Interdisciplinary Arts and Sciences*

*Andrew King, Senior, Urban Design and Planning*

*Jessica Stines, Senior, Urban Design and Planning*

*Mentor: Lisa Hoffman, Urban Studies*

Truly public space in urban landscapes is increasingly hard to find in today's consumer-based economy, where profit motives and mass consumption encroach on spaces that have traditionally been used by workers, activists, students, or the homeless. In this paper we argue that to maintain or create socially just cities it is vital to protect and use public spaces, and to demand accessibility for all people, not just consumers. The Puget Sound region provides many examples of public spaces that are restricted to certain people, thus reflecting private and class specific values while inhibiting social interaction and true democracy.

#### **Ethnicity & Urban Nature: An Evaluation of Seattle's Urban Park Usage by Immigrant Communities**

*Scott Guter, Senior, Community and Environmental Planning*

*Celeste Gilman, Senior, Community and Environmental Planning*

*Mentor: Christopher Campbell, Urban Design and Planning*

*Mentor: Vivek Shandas, Urban Design and Planning*

Recent immigration from all parts of the world is changing the ethnic landscape of American urban areas. Approximately 2,200 immigrants or refugees become permanent residents of the US daily, and a majority of these people settle in large metropolitan areas (Census 2000). Studies suggest that recent immigrant populations have proportionally higher birth rates than native-born Americans and subsequently may have a greater need for using public open space (US Census Bureau). As cities become increasingly diverse, urban decision-makers need to respond to the new needs and requirements of its changing citizenry. The aim of this research is to explore the relationship between open space and park usage within racially diverse areas of Seattle. Specifically, we are interested in exploring Seattle Parks and Recreation's current park programming design, and how future park programs might best respond to immigrant needs. To complete our analysis we will use on-site observation and surveys to assess the uses, attitudes, and behaviors of ethnic groups in 4 selected parks throughout Seattle. We will use a statistical method to compare means and to determine who uses the parks and what they do in them. Due to seasonal considerations, the observations and surveys will be conducted and analyzed by early Spring 2004. One outcome of this analysis will be to provide information to Seattle Parks and Recreation about the particular programming needs of new immigrant families. This study could help inform the city of recent trends in park usage and park designs appropriate for its new citizens.

#### **Immigration and Human Rights**

*Kimberly Logan, Junior, Political Science, Geography*

*Mentor: Suzanne Withers, Geography*

How easy is the solution to stopping illegal and undocumented immigration? In addition to the economic, social, and political effects that immigration has on urban areas, the question of human rights protection must also be addressed. Is it 'right' to send illegal migrants back to their country of origin? What sort of 'rights' do they have when they enter the US, even as non-citizens, providing that they are working? I will investigate the different factors that play into encouraging people to migrate to certain areas and the difficulties that arise in controlling immigration using statistics from the US government and independent non-governmental organizations. The role of pressure

groups in governmental decisions will be examined as an example of many of the independent forces that impact 'the immigration question' to determine how much of an influence they have in the process.

### **Comparative Analysis of Hispanic Poverty and Community Change in Kittitas County**

*Jennifer Devine, Senior, Geography, International Studies*

*British Marshall Scholar, Martin Honors Scholar, Mary Gates Scholar, McNair Scholar*

*Mentor: Lucy Jarosz, Geography*

My individual research project is part of a larger project entitled, "Reinterpreting geographies of poverty and inequality in the American Northwest." The larger project "attends to the ways in which cultural and economic processes intersect to produce place-specific constructions of poverty and the poor, resulting from broader processes of uneven development."<sup>1</sup> Research demonstrates that the economic sector in the rural Northwest that is most closely associated with poverty is large-scale agriculture.<sup>2</sup> In Washington State in particular, this sector employs a considerable number of Hispanic as well as white workers. Therefore, to fully understand poverty in these agricultural communities, research needs to comparatively examine the lives of its white and Hispanic residents. We need to understand how labor markets, work experiences and their intersection with the cultural and political constructions of poverty structure both opportunity and exclusion for both of these groups. This investigation examines both similarities and differences of Hispanic and white workers' experiences in Kittitas County. Using qualitative methods, my individual project establishes Hispanic personal and community histories of livelihood and labor in the area, investigates rural and social change, and determines how Hispanics discuss poverty and the rural poor in contrast to white populations in Kittitas County of Washington State. Upon concluding an oral history with a local family, I incorporate the broader structural changes in the community as ascertained from the first set of interviews to produce a comparative analysis of both Hispanic and white community members. This project unpacks the dynamic social forces and structures that historically and contemporarily shape Hispanic landscapes in Kittitas understood from the perspective of a family's history.

<sup>1</sup> From Professors Lawson and Jarosz NSF grant proposal.

<sup>2</sup> From Professors Lawson and Jarosz NSF grant proposal.

### **Forging a New Path: Lifestyles and Resistance in Seattle's Egalitarian Communities**

*Anneliese Steuben, Senior, Geography*

*Mentor: Lucy Jarosz, Geography*

In my research, I am exploring the experiences of people living in two secular communal households in Seattle, and

discovering the many meanings that their alternative lifestyles hold for them. In particular, I am interested in the ways in which these individuals' lifestyles are conceived of as a means of resistance, and how their particular life histories have led them here. I am employing qualitative methodologies, doing participant observation in the households and conducting life history interviews with a few participants. Instead of engaging with a large number of participants in the interest of a 'representative' sample, I have chosen to work in-depth with a few individuals in order to uncover more deeply and meaningfully the ways in which larger social, economic, and cultural processes play out in the course of people's lives. My methodologies are influenced primarily by a feminist approach, in that I am seeking to create an egalitarian relationship with the participants, develop a free-flowing interview style, and allow positive space for all of the personal experiences, feelings, perceptions, and understandings that are shared throughout the research process. In my final analysis, I would like to place my discoveries into the geographic dimension of scale by showing how resistance against macro-forces can take form on the micro-scale of the individual and the household, and not solely at the national, regional, or even local scales typically analyzed. As of March 1, 2004, I have not yet begun the participant observation and interviewing process, but plan to have it completed by the time of the Undergraduate Research Symposium.

### **Commercial Microfinance, Development, and Women in India**

*Amy Piedalue, Senior, Women Studies, International Studies: South Asia*

*Mary Gates Scholar*

*Mentor: Professor Priti Ramamurthy, Women Studies*

Microfinance is a broad term, which includes lending programs more specifically referred to as "microcredit," as well as savings and similar financial services. The "micro-" prefix simply refers to the small-scale nature of these financial services, which are designed to target poor people, and thus do so in manageable increments. My research focuses on the discourse of microfinance as articulated by dominant players like the World Bank and the Ford Foundation and its potential for including women, especially poor women, in development processes in India. My main research questions are: Why is there a broad emphasis on commercialization within the microfinance sector in India? What does such an emphasis mean for social justice movements aiming to make development in India more accountable to Indian women and more inclusive of their perspectives and needs? In order to answer these questions, I am interviewing the administrators of various institutions involved in microfinance in India. I have also collected reports, news briefs, and other secondary source materials on microfinance, women and development in India. My

research method aims to de-construct the discourse on microcredit produced by mainstream development institutions. Based on my preliminary explorations, I argue that mainstream microfinance players consider commercialization the only means of expanding microfinance and reaching large numbers of poor people, in light of limited resources. Such a commercial focus removes microfinance from its grassroots origins, and by concentrating on including poor Indian women in markets reproduces the failures of development programs past.

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## SESSION 1K

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### REDUCED GRAVITY

*Session Moderator: Gerald Seidler, Physics*  
*Session Assistant: Kathleen Nguyen, Freshman,*  
*Academy for Young Scholars*

**Mary Gates Hall Room 295**

#### **The Effects of Varying Acceleration Functions on Rayleigh-Taylor Flow in a Microgravity Environment: A Vomit Comet Experiment**

*Jeffrey C. Boulware, Senior, Aeronautics and Astronautics*

*Jonathan Axup, Senior, Aeronautics and Astronautics*

*Kakani Young, Senior, Aeronautics and Astronautics*

*Mary Gates Scholar, Space Grant Scholar*

*Mentor: Robert Breidenthal, Aeronautics and Astronautics*

Rayleigh-Taylor flow occurs when a relatively light fluid is accelerated into a heavy one. It is associated with accelerating flows of non-uniform density such as supernovae. In inertial confinement fusion, an array of pulsed laser beams simultaneously illuminate a hollow pellet containing isotopes of hydrogen. Under the intense laser pulse, the outer layer of the shell of the pellet ablates off, causing the deuterium-tritium mixture within the shell to accelerate inward. As the compression proceeds, the density near the center increases and light fluid is accelerated into it, leading to Rayleigh-Taylor flow. Any mixing of the plastic shell with the hydrogen isotopes tends to poison the nuclear reaction, raising the ignition threshold. A recent theory predicts that the acceleration profile influences the amount of mixing. In order to test the theory, the experiment will be performed in microgravity aboard the KC-135A (also known as the Vomit Comet) aircraft as a part of NASA's Reduced Gravity Student Flight Opportunities Program. A microgravity environment will allow us to begin a run with a minimal acceleration of much less than 1g. Previous experiments with variable acceleration on Earth have involved high accelerations and velocities with complex, expensive equipment and limited values of the ratio of final to initial acceleration. By

beginning with a near-zero acceleration, the experiment could reach a final acceleration on the order of 1g, yielding a large ratio of final to initial acceleration while limiting the final speed to a modest value. Scientific findings of the participants and their experiences aboard the Vomit Comet will be submitted for publication.

#### **Verde Base: An Automated Lunar Greenhouse**

*Kam Yee, Junior, Interdisciplinary Arts and Sciences: Science, Technology, and the Environment*

*Mentor: Colin Danby, Interdisciplinary Arts and Sciences*

A plan cultivated to provide food supply for a permanent station on the Moon. Verde Base: An automated lunar greenhouse is based in a lava tube in the South Pole region, using inflatable liners to enclose a pressurized environment. It will yield grains such as wheat and rice for a 6-12 person crew. Plants will be grown in a lunar regolith derived soil combined with starter compost brought from Earth. An experiment was conducted on Earth for this feasibility study with simulated regolith and compost. Radishes were grown to determine which regolith-compost ratio produces the best results for growth. Inedible plant products will be reused as compost to fertilize the soil in future planting cycles. Verde Base will use a combination of solar panels and a sunlight reflection system to heat, light, and power the greenhouse during the day as well as survive the 14-days long lunar nighttime. The enclosed system will use robots to farm and store plants for use, as well as to mine water at the South Pole. This research was conducted as part of the NASA Institute for Advanced Concepts' Student Visions of the Future Program. Verde Base could become a possible construction project in the next 10-50 years.

#### **The Mars Gravity Biosatellite Project: System Architecture and Mission Summary**

*Kakani K. Young, Senior, Aeronautics and Astronautics*

*Mary Gates Scholar, Space Grant Scholar*

*Mentor: Adam P. Bruckner, Aeronautics and Astronautics*

Mars Gravity Biosatellite is a joint venture among three universities: the University of Washington (UW), the University of Queensland (UQ), in Australia, and the Massachusetts Institute of Technology (MIT). The goal of the project is to launch a small population of mice to low Earth orbit aboard a spacecraft whose spin will create "artificial gravity" identical to that on the Martian surface. This mission will conduct the first in-depth study of how mammals live, grow, and develop in a reduced-gravity environment. The Mars Gravity Biosatellite will launch from Kennedy Space Center in 2006, housed in the Falcon launch vehicle. Once the satellite is deployed from the Falcon, it will be spun up to a rotation rate of 30 RPM. During the 35-day orbital mission data will be obtained

on the health and behavior of the mice. At the completion of the mission the satellite will fire its de-orbit thruster, and the re-entry vehicle containing the habitat module will separate from the carrier spacecraft. Following atmospheric re-entry, the vehicle will land at the Woomera Range in Australia. The mice will be retrieved and taken to laboratories for further study. UW is responsible for the carrier spacecraft, or bus, which contains the orbital systems that provide navigation, propulsion, power, communications, and environmental regulation throughout the mission. The carrier bus has many different interfaces with the re-entry vehicle and payload module: structural, electrical, data, and thermal. These interfaces, as well as the dynamics of the entire satellite at all phases of the mission, describe the system architecture. A summary of the mission and details of the carrier bus system architecture will be presented.

#### **James Hutton and Plate Tectonics: Parallels in Time?**

*Eleda Johnson, Senior, Geology, Washington State University*

*Mentor: A.J. Watkinson, Earth and Space Sciences, Washington State University*

The research question being investigated is the potential parallels between two significant events in the historic development of geology, the publication of James Hutton's *Theory of the Earth* and the advent of plate tectonics, as well as how each fits into a developed framework of scientific development. To investigate the relationship between Hutton's *Theory of the Earth* and plate tectonic theory once the context of each was established, Thomas Kuhn's model for scientific development was introduced and applied to each to define a working framework for making comparison. It was found that the history of geology follows the lines of Kuhn's model quite closely with both Hutton's theory and the theory of plate tectonics fitting into specified stages of scientific development. There were some special components in the areas of deep time and a historical element that separated geology from most of the common applications of Kuhn's theory. However, in terms of method, it was worthwhile to establish a framework for evaluating these specific events and in assessing their major similarities and differences.

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## **SESSION 1L**

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### **TRANSLATIONAL BIOENGINEERING**

#### **RESEARCH**

*Session Moderator: Pierre Mourad, Applied Mathematics, Applied Physics*

*Session Assistant: Michelle Meinhardt, Freshman, Pre-Major, Sciences*

### **Mary Gates Hall Room 231**

#### **Using High Intensity Focused Ultrasound to Disrupt the Blood Brain Barrier & Enhance Drug Delivery to the Brain**

*Elizabeth K. Dahl, Senior, Cellular and Molecular Biology, Anthropology*

*Mary Gates Scholar, Space Grant Scholar*

*Mentor: Pierre D. Mourad, Neurological Surgery, Center for Industrial Medical Ultrasound, and Applied Physics Laboratory*

Despite advancement in the treatment of many cancers, therapies for brain tumors have gone without significant change over the past few decades. One major impediment to treating brain tumors is the blood brain barrier (BBB), which is comprised of tightly aligned endothelial cells lining the walls of blood vessels in the brain. In the central nervous system (CNS) the BBB plays a protective role, restricting the movement of molecules into the brain. As a result, many therapeutic compounds known to be successful in vitro are prohibited from entering the CNS in vivo. We have found that application of high intensity focused ultrasound (HIFU) to the brain causes disruption to the tight junctions between endothelial cells of the BBB. This technique opens the BBB in a selective, yet reversible manner without causing tissue damage. This capability allows a method for drug delivery to the CNS to destroy both malignant brain tumors and isolated residual tumor cells involved in tumor recurrence after surgical resection. In order for HIFU-induced BBB disruption to be clinically useful, HIFU treatment must be shown to provide a means for safe and effective drug delivery to the CNS. It is currently unclear how the HIFU-treated regions of the brain evolve overtime and what, if any, long-term negative effects are associated with this brief BBB opening. Preliminary work suggests that it is possible to disrupt the BBB without causing tissue damage. My current work aims to replicate these findings by identifying a protocol that reversibly opens the BBB acutely in such a way as to maximize flux into the treatment site, while minimizing damage to the surrounding tissue. This protocol will be used to assay any long-term HIFU effects to the treatment site. Successful completion of this work will mark an important step towards the implementation of HIFU therapy into clinical practice to treat neurological disorders.

#### **Doppler Guided High Intensity Focused Ultrasound Treatment of Vascular Injury Using an in Vitro Model**

*Robyn Greaby, Senior, Bioengineering, Anthropology*

*Mary Gates Scholar, Space Grant Scholar*

*Mentor: Shahram Vaezy, Bioengineering*

High Intensity Focused Ultrasound (HIFU) is a method for delivering a large amount of energy to a point in the

body to produce coagulative necrosis while sparing the intervening and surrounding tissues from harmful exposure. Thus it has the potential to provide non-invasive treatment of internal bleeding. The purpose of this study is to develop an *in vitro* model of a human artery to test Doppler guided HIFU treatment of vascular injuries. An *ex vivo* porcine carotid artery was embedded in a 0.75% agarose gel. A pulsatile pump that can produce flow between 0.05 and 0.5 L/min was used to pump a dyed fluid through the artery with 70 pulses/min, simulating the flow through a human artery. The artery was punctured to simulate a percutaneous vascular injury. The puncture and the artery were visible through the agarose gel and could also be imaged with ultrasound. A HIFU transducer with a frequency of 3.33 MHz and a focal distance of 6 cm was used to treat the injury. Pulsed and color Doppler were used to detect the injury, target the HIFU transducer to the site of the injury, and monitor treatment. The intensity at the treatment site is 1000-2000 W/cm<sup>2</sup>. Pulsed wave Doppler ultrasound shows that the model produces a triphasic flow through the artery similar to that seen in the human femoral artery. The flow of fluid from the puncture site was stopped with a 15 second application of HIFU with the focus at the site of the puncture. Additional studies are being conducted to determine average time to stop fluid escape and verify results.

#### **A Model to Explore Biological Mechanisms Governing Cell Polarization**

*Eliana Hechter, Junior, Computer Science*

*Mary Gates Scholar, Space Grant Scholar*

*Mentor: Garrett Odell, Biology*

One of the most astonishing findings in genome science is the striking conservation of genetic sequences from one organism to another. At the Center for Cell Dynamics one emerging view is that groups of genes interact within conserved networks to regulate cellular processes present in many eukaryotic cells. Cells draw on a common toolkit of such networks to accomplish similar jobs in different contexts, ranging from cell division to cell motility. Within this range, one of the most puzzling is that of cell fate determination. Most embryos start as a single cell that divides to make thousands or millions to form the animal's body. All cells have identical nuclei with identical genes. What then determines some cells as pharynx specialists and others as brains? One of the principal ways in which embryos make cells distinct is through asymmetric cell divisions – divisions that produce daughters with different developmental potentials. In *C. elegans*, the egg segregates a number of cell polarity/fate determinants to its anterior and posterior halves shortly after fertilization. When the cell divides asymmetrically, the two daughters inherit these determinants unequally and thus become different, assuming discrete fates. Most of the machinery *C. elegans* uses to accomplish asymmetric cell division is highly conserved, and will tell us much about how other

organisms, including humans, accomplish this task. This process involves three sets of players: sperm-donated centrosomes and their microtubules (the sperm aster); the actomyosin cortex; and cell fate/polarity determinants, most notably PAR and MEX proteins. We are developing a mathematical/computer model to explore how local mechanical and chemical interactions among the three players lead to the coherent movement of the embryo's cortex away from the site of sperm entry, carrying with it PAR and MEX proteins, actin, and myosin.

#### **Steering Structure for a Catheter Bronchoscope**

*Joseph M. Hobbs, Senior, Bioengineering*

*Mary Gates Scholar*

*Mentor: Eric Seibel, Mechanical Engineering, Bioengineering*

Because of the branching, tapering structure of the human lung, the use of bronchoscopes in diagnosis and staging of cancer is limited by the diameter and stiffness of current state-of-the-art devices. These devices use coherent bundles of up to 10,000 optical fibers to transmit images from the distal tip (inserted into the lung) through the insertion tube to an ocular lens near the proximal handle or to a camera for display on the monitor. There is a direct trade-off between image quality and diameter/flexibility with these endoscopes. Dr. Seibel et al. are currently perfecting a new imaging device which uses only a single optical fiber. This device has foreseeable miniaturization below 1mm diameter with equal or better image quality as compared to current devices. However, the necessary steering structure of current bronchoscopes (used for navigating the lung) would be very difficult, and therefore costly, to miniaturize. A new steering structure is indicated. Constraints for the steering structure were defined to match the geometry of human lungs, the current practical use of bronchoscopes according to UWMC clinicians, and the mechanical limitations of the single optical fiber. The new structure was designed to exhibit a minimum bend radius within 5% of that of the optical fiber. It was also designed with planar features in the interest of low-cost, manufacturability for single-use disposability. A 20:1 scale mock-up of the structure was used to verify the bending concept before a 2:1 scale prototype was machined and assembled from Delrin AF. This prototype achieved predicted bending performance. However, this performance is expected to change with the addition of the imaging device and a protective outer sheath. Future prototypes should integrate these features as well as a control mechanism in order to verify and the bending performance before the issue of assembly is addressed.

#### **Using Diagnostic Ultrasound as Guidance for High Intensity Focused Ultrasound to Treat Neurological Diseases and Disorders**

*Lisa Nguyen, Junior, Neurobiology*

*Mary Gates Scholar, Space Grant Scholar*

*Mentor: Pierre D. Mourad, Neurological Surgery,  
Center for Industrial Medical Ultrasound, and Applied  
Physics Laboratory*

High-intensity focused ultrasound (HIFU) has been used to generate therapeutic lesions in a variety of tissues. A therapeutic lesion is a volume of tissue destroyed for therapeutic reasons. Potentially, HIFU could be used to treat tumors within the brain. Aiming HIFU remains a critical issue, however, with magnetic resonance imaging (MRI) being the main approach to guiding HIFU therapy. The advantage of MRI is its exquisite detail; the disadvantages include its expense and lack of real-time feedback. Recently, it was shown that diagnostic ultrasound (US) could image the site of a HIFU application in liver but without HIFU damage to the tissue. The authors called this site a 'HIFU pre-lesion.' In this way, they showed that one could use diagnostic US, a more versatile (gives real-time information; physical manipulation is easy) and economical imaging modality than MRI, to guide the placement of a therapeutic HIFU lesion in liver. In our preliminary studies we have constructed a combined diagnostic and therapeutic US system that can create therapeutic HIFU lesions, imageable with US, *in vivo*. We are currently working to identify HIFU protocols that can create pre-lesions and protocols to generate therapeutic lesions in the brain. We are also using the same protocols in liver and comparing the biological effects induced by these protocols in liver and in brain. The anticipated result is identification of acoustic protocols which create a HIFU pre-lesion in the brain that can successfully guide the placement of a therapeutic HIFU lesion. Therefore, successful completion of the project will mark an important step towards the implementation of US-guided HIFU therapy to treat diseases and disorders of the brain.

#### **Predicting Pelvic Arterial Hemorrhage**

*Amber M Schwed, Junior, Neurobiology  
Mary Gates Scholar*

*Mentor: C. Craig Blackmore, Radiology, Harborview  
Medical Center*

The pelvic bones assist in stabilizing the body in activities such as sitting, standing, or walking. To fracture the pelvis requires high energy – high speed motor vehicle crash, long distance fall, etc. Pelvic fracture can cause hemorrhage from regional arteries. Invasive angiography can identify arterial hemorrhage but with complication risks. The purpose of our study is to develop a noninvasive method of predicting pelvic hemorrhage that can enable rapid treatment of arterial injury and reduce blood loss. Retrospective data collection was done on 783 patients that presented with pelvic fracture at Harborview Medical Center between 1/1/97 and 5/1/01. Factors, such as emergency department hemodynamic status and radiographic findings were evaluated to identify predictors of arterial hemorrhage. We created a prediction rule for

pelvic hemorrhage using the best combination of predictors. We are validating our prediction rule prospectively. Out of 783 patients with pelvic fractures 62% were male, the mean age was 37.4, and 119 (15%) had arterial hemorrhage. The risk ratio was used to define predictors of arterial hemorrhage. Predictors include: obturator ring fracture with  $\geq 1$ cm of displacement (RR=2.6), diastasis of the pubic symphysis  $\geq 1$ cm (RR=2.6), pulse  $\leq 130$  (RR=3.3), and hematocrit  $\leq 30$  (RR=4.8). The prediction rule is able to stratify patients into those with  $<3\%$  probability of arterial hemorrhage, and those with  $>50\%$  probability of arterial hemorrhage. Validating our prediction rule is ongoing for the next eighteen months. We expect that our prediction rule will predict arterial hemorrhage in patients with pelvic fractures, aiding triage and resulting in better treatment outcome.

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## **SESSION 2A**

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### **ADVANCED MATERIALS AND SYSTEMS**

*Session Moderator: Rajendra Bordia, Materials Science  
and Engineering*

*Session Assistant: Jenny Kroon, Sophomore, Pre-Major,  
Arts and Sciences*

**Mary Gates Hall Room 271**

**\*Note: Abstracts in order of presentation.**

#### **Exploratory Development of Environmental Micro-chamber Modules for Genomic Research Applications**

*Michael Wang, Senior, Applied and Computational  
Mathematical Sciences*

*Mentor: Susan L. Fink, Microbiology*

*Mentor: Joseph S.H. Chao, Electrical Engineering*

*Mentor: Deirdre R. Meldrum, Electrical Engineering*

The Microscale Life Sciences Center (MLSC) at the University of Washington has a central goal to develop integrated biologically-active microsystems capable of measuring multiple parameters in single cells in realtime for specific biological applications. Ultimately, the microsystems we develop will have far-reaching applications for both basic and applied research in broad areas of biomedical systems biology, including fundamental research into cellular function and dysfunction and pathogenesis mechanisms, and applied work such as diagnostics, pharmaceutical screening, and drug design. A major barrier to understanding the complex interactions of pathogens with host cells is the inability to gather data from synchronously infected populations. We propose to develop and use microsystems to study Salmonella-infected macrophages and focus on a newly emerging biological paradigm: proinflammatory programmed cell death. Our

initial efforts will examine the proinflammatory programmed cell death of *Salmonella enterica* serovar Typhimurium infected macrophages. The goal of this project is to measure events in real time during the infection process in both the host cell and the infecting agent, and to assess the role of heterogeneity in the outcome of the infection – for instance, lysis of the macrophage and replication of the bacteria. Images of Salmonella expressing green fluorescent protein (GFP) infecting the macrophage host cells will be taken through a laser scanning confocal microscope. Macrophages require a sterile ~37 C° microenvironment and good perfusion of growth media with uniform 20% O<sub>2</sub> and 5% CO<sub>2</sub> concentrations. To date, I have worked with the lab of our application partner, Prof. Brad Cookson at the University of Washington, to acquire the skills and training needed to culture macrophages and salmonella in bulk for this and other engineering module level development experiments within the MLSC.

### **Infrared Optical Properties of Mn<sub>1.68</sub>Cu<sub>0.6</sub>Ni<sub>0.48</sub>Co<sub>0.24</sub>O<sub>4</sub> Thin Films Studied by FTIR and Raman Spectroscopy**

*Derrick Speaks, Senior, Materials Science and Engineering*

*Mary Gates Scholar*

*Mentor: Fumio S. Ohuchi, Material Sciences and Engineering*

This study investigates the optical properties of spinel-oxides in thin film forms. Materials containing transition-metal-cations, such as Mn, Co, Cu and Ni, exhibit several unusual properties, including large optical transparency between vibrational and electronic energy absorption edges. Having the special ability of being able to absorb only a specific narrow range of the IR spectrum, these materials are ideal for tunable infra-red (IR) sensors. Metal Organic Decomposition (MOD) was used to fabricate thin films of Mn<sub>1.68</sub>Cu<sub>0.6</sub>Ni<sub>0.48</sub>Co<sub>0.24</sub>O<sub>4</sub> on Si substrates by dip coating, followed by pyrolyzing the residual organic compounds used initially as solvents. Samples were subsequently annealed in air at 700, 750 or 800 oC to change the oxidation states of Mn ions from Mn<sup>+4</sup> to Mn<sup>+3</sup>. This study describes the recent investigation on the Reststrahlen frequency measured by Fourier Transform Infrared spectrometry (FTIR). Effects of the Mn oxidation states on the Reststrahlen frequency are described in an attempt to tune the optical absorption window range of this material.

### **Polymer Derived Ceramic Coatings on Steel**

*Alberto Isiordia, Senior, Materials Science and Engineering*

*Gates Millennium Scholar*

*Mentor: Rajendra Bordia, Materials Science and Engineering Department*

The transformation of polymers into ceramic materials by thermal treatment in a controlled atmosphere is a new process that is being established to create nano-structured ceramics for a variety of uses. Our research is focused on using polymers to produce ceramic coatings on steel substrates. The coatings must have a variety of characteristics including good adherence between a dense defect-free ceramic coating and the steel substrate. This research project involves three phases. In phase 1, the focus is on the optimization of the solvent and the fillers in the pre-ceramic polymer to produce dense coatings. Phase 2 focuses on the examination of the microstructure and phase 3 is focused on the evaluation of the adhesion between the coating and the substrate. Currently, two filler combinations have produced good adhesion between the steel substrate. We are focusing on developing a reproducible process to make the coatings by identifying the optimal viscosity range of the polymer/filler/solvent combination. Once the coating process has been optimized, the coating and substrate will be evaluated using flexure tests.

### **Carbon Fiber Reinforced Polymers for Earthquake Retrofitting**

*Curt Groth, Senior, Materials Science and Engineering*

*Mentor: Rajendra Bordia, Materials Science and Engineering*

Earthquake retrofitting for added support to bridges and buildings is essential to provide safety to those who use them. This study was performed with the hope that the current steel jacket supports could be replaced with stronger and lighter carbon fiber composite jackets to better ensure the strength of a concrete beam. Carbon fiber shells were processed out of pre-impregnated carbon fiber that measured 4” on a side and about 12” in height. The corner radii and ply thickness were varied for testing (1/4”, 1/2”, 3/8”, 1”, 2” corner radii and 2&3/4, 4&3/4, 8&3/4 plies). These shells were filled with concrete and the concrete was put under compressive loads to simulate loads that would occur during an earthquake. The study showed that as the corner radius became larger, the maximum load the carbon fiber could with-stand increased. An example of this was the 4&3/4 ply shell handling a load of 126 kilopascals at 1/4” corner radius and 192 kips at 2” corner radius. For rectangular columns, the failure mode is a competition between tensile and shear failures. In cylindrical columns, shear stresses are not present and only tensile failure is observed. The study has focused on optimization of the jacket thickness for different corner radii. The experimental results are compared to predictions of numerical simulations.

### **Waste Elimination through Continuous Improvement: Six Sigma, Total Quality Management, and Just-in-Time**

*Mrityunjay Tripathi, Junior, Industrial Engineering*

*Mentor: Benita M. Beamon, Industrial Engineering*

The objective of the Lean Manufacturing philosophy is to eliminate wastes (non-value-added activities that increase costs, lead times and inventories) through continuous improvement. Advanced manufacturing strategies, such as Six Sigma (6S), Total Quality Management (TQM) and Just-in-Time (JIT) are often treated as separate techniques for production system improvement. Indeed, they are often studied individually, in terms of their evolution, objectives, and benefits. In this paper, we identify the commonalities of these strategies, and show how they each represent different sides of the same Lean Manufacturing argument: that the objective of effective and efficient production system operations is to reduce waste through continuous improvement.

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## SESSION 2B

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### BIOLOGICAL AND GEOLOGICAL FEATURES OF ECOSYSTEMS

*Session Moderator: Daniel Schindler, Aquatic and Fishery Sciences*

*Session Assistant: Amy Paul, Junior, Biology*

**Mary Gates Hall Room 228**

**\*Note: Abstracts in order of presentation.**

#### Impacts of Human Residential Development on Pacific Northwest Lakes

*Justin Fox, Senior, Biology: Ecology, Evolution, and Conservation Biology*

*Mentor: Tessa Francis, Biology*

*Mentor: Daniel Schindler, Aquatic and Fishery Sciences, Biology*

In the littoral zone of lakes, coarse woody debris (CWD) may be a key regulator of both productivity and community structure. The specific functions of CWD are largely unknown, but it is likely that CWD serves as substrate for periphytic algae, provides complex habitat used by benthic invertebrates as habitat and refuge from predatory fish, and traps allochthonous organic matter in shallow habitat. On lakes in the Pacific Northwest, residential development has been shown to be associated with declines in CWD. Further, lakeshore development is also associated with reduction in sediment organic matter, which is used by both microbes and benthic invertebrates as an energy source. Benthic invertebrates are key players in lake food webs as they contribute directly to the break down of organic matter and serve as important food subsidies for pelagic predators, yet little is known about the impact of CWD on benthic invertebrate communities. In this study we examined the relationship between CWD abundance and benthic

invertebrate community structure. We collected benthic invertebrate samples from two developed and two undeveloped lakes in the Pacific Northwest during the summer of 2003, and CWD abundance was measured on these same lakes during the summer of 2002. Our results show that benthic communities in developed lakes are very different relative to those in undeveloped lakes, and that these differences are likely due to the role of CWD in providing littoral habitat quality. Ultimately, changes in both CWD abundance and benthic invertebrate community structure may have important consequences not only within littoral zones but also for entire lake ecosystems.

#### Side Channel Use By Salmonids in the Sauk River, Washington

*Jason A. Addison, Senior, Geological Sciences, Aquatic and Fishery Sciences*

*Mary Gates Scholar*

*Mentor: Dave Montgomery, Earth & Space Sciences*

Habitat use by salmonids is a critical concern for river restoration efforts in the Pacific Northwest. This analysis examines the distribution of salmonids within side channels of the Sauk River, Washington, during seasonal low-flow conditions. The Sauk is an unconstrained low-gradient river, characterized by numerous meanders and side channels, with an unconsolidated alluvial substrate. Nighttime snorkel surveys were conducted on two types of side channels: surface-fed channels with a direct connection to the Sauk River, and groundwater-fed channels. The surface-fed channels had greater discharges and higher mean velocities than the groundwater-fed channels. Juvenile *Oncorhynchus kisutch* were found to be the dominant salmonid in groundwater-fed channels ( $p < 0.05$ ), while juvenile *O. mykiss* and *O. clarki* were dominant in surface-fed channels ( $p < 0.05$ ). All three species were found in significantly greater numbers in pool habitats ( $p < 0.05$ ), as compared to either glide or riffle habitats. A possible reason for the observed pattern of side channel use may relate to body form or differential channel hydraulics. These observations are particularly relevant because they show that individual side channel characteristics, such as water source and associated flow regime, may alter the distribution of juvenile salmonids. Therefore, channel restoration efforts that focus on the use of side channels as a primary objective need to consider the preferences of salmonids in terms of differential habitat utilization. This issue relates directly to the necessity of maintaining high levels of habitat diversity within the context of dynamic fluvial systems.

#### Do Small-Scale Stream Restoration Projects Work?: A Case Study Analysis

*Eliza Ghitis, Senior, Earth and Space Sciences*

*Jason Addison, Senior, Geology, Aquatic and Fishery Sciences*

*Mary Gates Scholar*

*Mentor: David R. Montgomery, Earth and Space Sciences*

In the Pacific Northwest, widespread anthropogenic modifications to dynamic fluvial systems have disturbed aquatic and terrestrial biology. Channel alterations have perturbed floodplain processes, causing loss of habitat and the decoupling of erosion and deposition cycles. Many governmental agencies and non-governmental organizations throughout the region have attempted to repair this damage in specific locations with a limited geographical extent. Common restoration methodologies include removal of invasive species, planting of native vegetation, and the introduction of large woody debris into streams. This study focused primarily on determining if restoration projects could be evaluated based on stated goals or implied objectives from accompanying documentation. A secondary purpose was to investigate the effectiveness of current restoration methodologies. To accomplish these tasks, we assessed several restoration sites located in western Washington State as a series of case studies. Each site was independently reviewed in its own context, with evaluation objectives based on the sponsoring agencies' stated goals, and their actual impacts upon the local environment. Evaluated restoration sites included Riley Slough, Griffin Creek, Patterson Creek, Cherry Creek, and North Creek. Field data was collected during the winter & spring low-flow season of 2004, and included measurements of hydrologic parameters, topographic analysis, and biological inventories. An integrated analysis of all sites revealed a range of observations that can be used to refine restoration ecology in the Pacific Northwest.

### **Ecological Effects of Marine Protected Areas: Soft Sediment Infaunal Response to Recreational Clam Digging in the San Juan Islands**

*Jennifer Griffiths, Senior, Biology, Dance*

*Mary Gates Scholar*

*Mentor: Megan Dethier, Biology*

Marine reserves are essential tools for scientific research and potentially for resource management, yet there is a lack of quantitative research on reserves. Recreational clam digging is a very common intertidal disturbance, but ecologists and policy makers lack an understanding of its impact on soft sediment infaunal communities. Impacts of clam digging on clams have been studied, but research is lacking about secondary impacts on non-clam infaunal species. I surveyed three reserve and three non-reserve beaches in the San Juan Islands and conducted manipulative experiments to quantify secondary impacts of recreational clamming. Clamming has a strong negative effect on the species richness, family richness, and abundance of infaunal organisms, especially polychaete worms. It is essential that policies be developed with an understanding of how to maintain the biological richness and productivity of clamming beaches.

### **Evaluating the Utility and Applicability of Computer Models for Volcanic Conduit Processes**

*Kirsten Chojnicki, Senior, Earth and Space Sciences*

*Mary Gates Scholar*

*Mentor: George Bergantz, Earth and Space Sciences*

An increase in populations at risk from volcanic hazards necessitates the improvement of eruption forecasting and risk assessment to prevent fatalities and economic losses. Physical modeling of volcanic processes can enhance the understanding of eruption dynamics and can reveal information vital for forecasting future eruptions. Through exploration via numerical models of two well-documented eruptions, Mt. St. Helens in 1980 and Mt. Pinatubo in 1991, the impact of the physical interplay of geologically relevant variables on mass flux and eruption style will be studied. Observations of eruptive behavior constrain initial conditions, including initial pressure, temperature, magma composition, water content, and conduit information, and eruption products, such as column height, mass flux, and particle size distributions. Using well-constrained geologic data two models varying in sophistication will be compared to determine which best carries forward information on the time dependent processes of volcanic eruptions.

### **Assemblages of Ankaramites from Mauna Kea, Hawaii**

*Lindsay Morgan, Senior, Geology*

*Mentor: I. Stuart McCallum, Earth and Space Sciences*

The Hawaiian volcano, Mauna Kea, has many alkalic basalt lavas, including ankaramites, which have some of the highest alkalinity of any basaltic lava. Ankaramites, although found in many places on the Hawaiian Islands, have rarely been studied. They are rich in olivine, clinopyroxene and feldspar phenocrysts, and include trace amounts of iron-titanium oxide, ilmenite and ulvospinel, and chromite. The cpx are large phenocrysts, some more than twice the size of the olivines phenocrysts in the same sample. Phenocrysts of cpx that are much larger than the olivines, commonly indicate multiple magma sources; because typical Hawaiian lavas precipitate olivine first, and cpx later, which crystallizes larger olivine crystals. It is unknown if these ankaramites contain phenocrysts that formed in equilibrium with each other. To determine this, an electron microprobe was used to analyze the composition of the basalt and comparisons are being made with other alkalic basalts from Mauna Kea using their whole rock analyses. Preliminary results show that the olivine phenocrysts of the ankaramites have a composition around  $Fe_{80}$ , with the rims more Fe rich. The cpx have a composition around  $Wo_{47}En_{80}Fs_{20}$ . Using MELTS, an algorithm that creates outputs of reasonable mineral assemblages under different pressure and temperature conditions, different alkalic basalts from studies of Mauna Kea, including ankaramites, are being tested for their

potential formation conditions. These different conditions will lead to a conclusion as to the way fractionation in the magma chamber(s) occurred. Once this is understood it may be possible to determine whether or not the phenocrysts in the ankaramites fractionated from a single magma source or by some other process.

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## SESSION 2C

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### COMPUTING ALGORITHMS FOR DATA AND SCIENTIFIC ANALYSIS

*Session Moderator: Nathan Kutz, Applied Mathematics*

*Session Assistant: Constantinos Papadopoulos, Junior, Computer Engineering*

**Mary Gates Hall Room 287**

**\*Note: Abstracts in order of presentation.**

#### Computing Conserved Quantities of One-Dimensional Evolution Equations

*Michael Nivala, Senior, Mathematics*

*Mentor: Bernard Deconinck, Applied Mathematics*

Conservation laws for partial differential equations

$$\frac{\partial \rho}{\partial t} + \frac{\partial J}{\partial x} = 0 \quad \frac{\partial u}{\partial t} = F(u, u_x, u_{xx}, \dots)$$

(where  $u$  can be a vector, and  $x$  indices denote derivatives) are important in both the analytical and numerical analysis of such equations. A conservation law is given by an equation of the form

(here  $\rho$  is a conserved density and its accompanying flux). The goal of my project is to design and implement algorithms in Maple for the explicit symbolic computation of such densities and fluxes. I will first consider partial differential equations with polynomial dependence of the dependent variables, ultimately moving to more general systems. The main tool will be to exploit scaling symmetries of the underlying system.

#### Creating Weekly Timetables to Maximize Employee Preferences

*Caleb White, Post-Baccalaureate, Economics, Applied and Computational Mathematical sciences*

*Mentor: Rekha Thomas, Mathematics*

We develop a method to generate optimal weekly

timetables for tutors at the University of Washington Math Study Center using stated and inferred preferences. These timetables were previously generated using heuristics. We show that it is possible to create timetables using a model based on Integer Programming that are superior to the previous schedules. We compare two variants of our model. The first involves the progressive relaxation of constraints and the second incorporates a cost for constraint relaxation directly into the objective function. We find that the second approach generates better schedules. We find that using our model instead of the old system creates improvements in the value of the objective function of up to 7.2%. Less prosaically, our model creates schedules that increase the satisfaction and happiness of the individual tutors and provides greater convenience to them in their daily lives.

#### Transient Analysis and Re-Synthesis with ATS

*Alex Norman, Senior, Computer Engineering*

*Mentor: Juan Pampin, Digital Arts*

ATS is a powerful analysis-transformation-synthesis system for spectral modeling of sound. In its current implementation, ATS's analysis engine decomposes a digitally recorded sound into two components: a sinusoidal component consisting of a collection of time-varying sine waves, and a critical-band noise component consisting of time-varying band limited noise. With analysis data, users can re-synthesize a convincing copy of the original sound using a bank of noise-modulated sinusoidal oscillators. The main advantage of this parametric decomposition model is that users can create a wide variety of new sounds by manipulating the analysis data before or during re-synthesis. While this Sines+Noise model works well with a large variety of sounds, it fails to model transients (i.e. the sudden onset of percussive sounds) in a way that is useful for musical transformations and re-synthesis. An extra component for the analysis/re-synthesis system is necessary to model transient elements correctly. Tony Verma et al. have proposed an elegant transient modeling system that could provide ATS with this extra decomposition layer. The model proposed by Verma et al. uses the DCT (discrete cosine transform) to transform time-domain transients into sine waves. After transients are transformed into sinusoidal components, they can be detected and modeled using ATS's robust sinusoidal analysis tools. The task at hand is to merge this model into the pre-existing ATS system and actualize it in software. Once implemented, this new decomposition layer will need parameterization to be fully integrated with ATS and be useful for transient analysis

and transformation. The most common application of this system would be time compression/expansion. Since the sine components produced by the DCT of a transient vary in frequency according to the transient's location, previous time stretching methods will need to be adapted to work with DCT-modeled transients.

## **River in the Light of ArchJava: The Use of User-Defined Connectors in Ubiquitous Computing Systems**

*Aiman Erbad, Senior, Computer Engineering*

*Mentor: Craig Chambers, Computer Science and Engineering*

Ubiquitous computing systems are challenging to design and implement because they interact with hundreds of devices. The devices used change periodically depending on the state of the system and the specific command or event that is being processed. River is a ubiquitous computing system that uses SQL queries to address the challenge of specifying the devices at the end points of communication primitives, such as events and function calls. The current implementation parses the SQL queries at run time and it doesn't support any compile time syntactic or semantic analysis. Moreover, the devices specified by the queries are not guaranteed to support the required functionalities. In our new design we use user-defined connectors in ArchJava to improve River by adding compile time syntactic analysis and type checking. Using ArchJava's connectors helped in making sure that the devices specified by the queries actually support the required functionalities. The connectors library is reusable and easy to extend.

## **LitLinker: Design and Evaluation of a Text-Mining Interface**

*Meredith M. Skeels, Senior, Informatics*

*Mary Gates Scholar*

*Mentor: Wanda Pratt, Information School, Division of Biomedical and Health Informatics*

Medical literature expands so quickly that researchers cannot stay up-to-date in all fields, especially those outside their specialization. As a result, important but unapparent relationships between medical concepts, which could lead to breakthroughs, are lost within the literature. LitLinker bridges this gap using a text-mining system that finds new connections between medical concepts by searching MEDLINE, a database of medical literature. Users provide a starting term and LitLinker responds with other terms likely to be connected to the starting term. LitLinker results are complex because of the large number of documents and terms used to make these novel connections. This complexity poses a challenge for interface design. To help users keep track of where they are within the results, our interface uses colors and spatial orientation to display the three types of terms: starting terms, linking terms, and target terms. We use lines of varying width to show the strength of the literature connection between these terms. This provides a visual abstraction of information, which allows users to quickly spot strong connections before delving into details. After developing a prototype of our interface, a task-based usability evaluation was conducted with 10 participants. Participants were given a description of the text-mining process, but were not given an introduction to

the interface. They were asked to complete a set of tasks and were interviewed about their experience using LitLinker. Results from this usability evaluation showed that most users understood how terms were connected and were able to navigate the interface. Feedback from participants of the usability evaluation will inform the next stage of interface development, which will involve implementing a web-based interface and conducting an evaluation with medical researchers.

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## **SESSION 2D**

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### **GENES, IMMUNITY, AND METHODS OF STUDY**

*Session Moderator: Aimee Bakken, Zoology*

*Session Assistant: Michelle Meinhardt, Freshman, Pre-Major, Sciences*

**Mary Gates Hall Room 231**

**\*Note: Abstracts in order of presentation.**

#### **Malaria and Drug Resistance: What Can Genetics Do?**

*Brian Rezvani, Senior, Cellular and Molecular Biology*

*Howard Hughes Scholar, Mary Gates Scholar*

*Mentor: Carol Sibley, Genome Sciences*

Malaria is a life-threatening parasitic disease that causes more than 300 million acute illnesses and one million deaths annually. As a result, malaria imposes significant economic costs on the poorest countries in the world, crippling much-needed development. Recent studies show that in Sub-Saharan Africa alone, malaria is responsible for costs of \$8 billion per year. *Plasmodium falciparum* is the most deadly of the four types of human malaria and there is no vaccine available; currently, drugs are used to both prevent and treat the disease. One of these drugs, pyrimethamine, is a competitive inhibitor of the essential *P. falciparum* enzyme, dihydrofolate reductase (*dhfr*). However, point mutations in the *dhfr* gene confer resistance to pyrimethamine and related compounds. Selection of these point mutations is rapidly compromising the efficacy of these drugs. A strain of the budding yeast, *Saccharomyces cerevisiae*, has been engineered which has its endogenous *dhfr* knocked out and is dependent upon a *P. falciparum dhfr* instead. Using this model allows us to study the *P. falciparum dhfr* enzyme efficiently and inexpensively, and to identify *P. falciparum* mutants that can confer resistance to drug treatments. In the ongoing attempt to fight malaria, researchers have developed a new *dhfr* inhibitor, chlorcycloguanil. Chlorcycloguanil has passed clinical trials and is currently being deployed. Alarmingly, studies show that mutations in the 16<sup>th</sup> and 108<sup>th</sup> amino acids of the *P. falciparum dhfr* can occur resulting in *dhfr* alleles

that are resistant to chlorocycloguanil. Our work will show whether similar mutations in 16<sup>th</sup> and 108<sup>th</sup> amino acids of the *P. falciparum* DHFR could be selected for with the common triple mutant background, conferring resistance to chlorocycloguanil, as shown in the WT background. This will result in more effective drug deployment and will be a strong indicator of where resistance to chlorocycloguanil will rapidly spread.

### **Activation of Cell-Mediated Immunity using pH-Responsive Polymers**

*Jared Kirkham, Senior, Bioengineering*

*Howard Hughes Scholar*

*Mentor: Suzanne Flanary, Bioengineering*

*Mentor: Pat Stayton, Bioengineering*

Traditionally, vaccination has been defined as the administration of a weakened pathogen for the purpose of priming the immune system against that pathogen. Although traditional vaccines have eliminated or severely reduced many infectious diseases, there still remain agents, such as HIV and hepatitis C, for which traditional vaccines have not been successful. Molecular vaccines composed of protein or nucleic acids show promise for combating such recalcitrant infectious diseases. Moreover, molecular vaccines can be employed to thwart non-infectious diseases such as cancer and various autoimmune diseases. Maximally effective vaccines must induce both cell-mediated immunity and humoral immunity characterized by Cytotoxic T Lymphocyte activity and antibody production, respectively. However, most molecular vaccines only activate humoral immunity, and thus their immunostimulatory effect is limited. In order to activate cell-mediated immunity, the molecular vaccine must be delivered to the cytoplasm of antigen presenting cells (APCs). In this project, a pH-responsive polymer has been developed for enhancing the delivery of protein vaccines to the cytoplasm of APCs. At physiological pH (7.4), the polymer is hydrophilic, while at acidic pH (<6.0), the polymer is hydrophobic and can disrupt lipid membranes. In theory, if a molecular vaccine is attached to this polymer and the resulting conjugate is endocytosed by an APC, the conjugate will enter the acidic (pH 5.5-6.0) environment of the early endosome, lyse the endosomal membrane, and release the biomolecule to the cytoplasm for presentation and subsequent activation of cytotoxic T-cells. An in vitro T-cell activation assay was employed to test whether the polymer-protein vaccine conjugate activates cell-mediated immunity to a greater extent than the naked protein vaccine. Preliminary results suggest that the polymer may be effective, but its design must be optimized in order to maximize activation of cell-mediated immunity.

### **Exploring the Wnt Pathway and its Role in T cell Activation and Proliferation Using a Stochastic Model**

*Afshin Mashadi-Hossein, Junior, Bioengineering*

*Mary Gates Scholar*

*Mentor: Anamika Sarkar, Bioengineering*

In the recent years computational biology has been increasingly central in enhancing our understanding of the complex biochemical processes in the cellular and sub-cellular levels. Mathematical modeling can be a low-cost method, with a high predictive power, and thereby enable biologists to study biological phenomena resultant from molecular interactions in nonlinear processes. Unlike the large-scale biochemical reactions, intercellular signal transduction [and other cellular regulatory processes] are comprised of small numbers of different multi-state molecules and their networked interactions. Such a system results in occurrence of stochastic demographic changes within the set of the biochemical molecules involved. In order to account for these stochastic changes, biological models should be analyzed using stochastic algorithms. This project has two objectives 1) Developing a stochastic model for an important biological pathway known as the Wnt Pathway 2) Exploring the influence of the Wnt pathway in the functional activities of one of the cellular components of the adaptive immune system, CD4<sup>+</sup> T cells. The Wnt pathway is a highly conserved signaling cascade known to be involved in physiological processes ranging from embryogenesis to development of tumors. Based on a model developed by Lee et al [1] we constructed a stochastic version of the Wnt model. Stochastic analysis will be done using the well known Gillespie's algorithm [2]. Stochastic simulation of the Wnt pathway can provide us with a more realistic quantitative understanding of this signaling cascade. Furthermore, this model will be incorporated into the model of the T cell which is currently being developed at the UW Cell Systems Initiative. A quantitative analysis of the model will give us more insight on the role of the Wnt pathway in activation and proliferation of T cells.

[1] Lee Ethan, Salic Adrian, Krüger Roalnd, Hinrich Reinhart, Kirschner Mark W (2003) The Roles of APC and Axin Derived from Experimental and Theoretical Analysis of the Wnt pathway. *PLoS Biology* 1: 116-132.

[2] Gillespie, D. T. (1976) A general method for numerically simulating the stochastic time evolution of coupled chemical reactions, *J. Comput. Phys.*, **22**, 403-434

### **Gene Conversion Tract Length in Hybrid Meiotic Yeast Cells**

*Teresa Lee, Senior, Cellular and Molecular Biology*

*Mentor: Breck Byers, Genome Sciences*

Gene conversion is known to occur at a higher rate in meiosis than in mitosis. Since most gene conversion studies were done with highly inbred (laboratory) yeast strains, we would like to study gene conversion frequencies in a hybrid yeast which we created by mating a lab yeast strain (S288c) to a clinical strain (YJM789) isolated from a human

lung infection. A second goal of our study is to determine whether the tract length of gene conversion is affected by insertion of a G-rich sequence that stimulates gene conversion into the ARG4 region. To identify markers for monitoring tract length, we sequenced the ARG4 region in the uncharacterized YJM789 strain. By comparing this sequence to S288c, we found single nucleotide polymorphisms, or SNPs between the strains, which allowed us to measure gene conversion tract length at ARG4. To generate gene converted tetrads, we dissected our hybrid yeasts and scored the haploid progeny for segregation of heterozygous nutritional markers. Contrary to the ratio previously described for inbred strains, we have seen an overall preference for 1<sup>+</sup>3<sup>-</sup> gene conversion events regardless of the size of the heterozygosity that exist at each locus. We use restriction enzyme digestion (PCR-RFLP) to estimate the tract lengths at ARG4 in converted tetrads and then sequence the implicated regions. Although we were able to conclude that the size of the heterozygosities do not affect gene conversion rates, we cannot make any concrete conclusions about gene conversion tract lengths at the present moment because the results are still preliminary.

#### **Understanding the Male Contribution to Fertilization**

*Ariel Altaras, Senior, Biology, Norwegian*

*Mary Gates Scholar*

*Mentor: Barbara Wakimoto, Biology*

The male contribution to fertilization has not been studied extensively, and the identity and action of sperm-specific factors important to fertilization and embryonic development is not well understood. *Drosophila melanogaster* is an excellent model organism to use for the study of fertility because the genome is sequenced, and there are many genetic tools available. In addition, many mutants affecting male fertility are available. We hope to better understand male fertility by working with five early developmental arrest mutants in *Drosophila*. These mutants are male sterile, yet show normal sperm motility and sperm entry into the egg. After the sperm enters the egg, these mutants fail to decondense the sperm head. One of the mutants, *snky*, encodes a protein with several proposed transmembrane domains. Two other mutants, *agho* and *kugi* have been genetically mapped, and examined for correct localization of the *snky* protein. Using these mutants, we hope to define a pathway of interacting molecules important for fertilization. Identifying these genes and their protein products through further research will lead to a better understanding of fertilization and the male contribution. The male factors important in *Drosophila* may also be conserved in other species, including humans, and the information from research on these mutants may be applied to studies in other organisms.

#### **Pharmaceutical Companies Influence on the Patient/Physician Relationship**

*George Ford, Senior, Russian and East European Studies, Pre-Health Sciences*

*Mary Gates Scholar*

*Mentor: Denise Dudzinski, Medical History and Ethics*

As a primary researcher for the Basic Ethics Curriculum I assist in the formulation of medical ethics modules for medical residents on a broad spectrum of topics. My research on the interdependent relationship between pharmaceutical companies and physicians has been particularly interesting. Employing a broad synthesis of germane medical journal studies and opinions both in support and in defense of pharmaceutical influence reveals a controversial and evolving debate. My current findings demonstrate a growing conflict of interest between pharmaceuticals and physicians that may compromise the physician/patient relationship. Evidence suggests that physicians believe they are impermeable to pharmaceutical gifts and sponsorship, though multiple studies prove otherwise. Scientific studies demonstrate that physicians are overly inclined to prescribe newly promoted drugs and are likely to prescribe less appropriately as a result. The cost of health care is subsequently increased, as generics and older, less expensive equivalents are sidestepped for newer drugs that often lack greater efficacy. Physicians are seemingly bred in a culture of entitlement in which gifts are not only accepted, but expected. Current voluntary measures to ethically regulate pharmaceutical influence have met with limited success and many institutions are in an evolutionary process of creating rules to govern pharmaceutical interactions. Yet, other evidence point to critical enhancements in health care that has been the result of clinical and research cooperatively between physicians and pharmaceuticals. Additionally, the mass quantity of new drugs and information is often difficult for physicians to assimilate and this obstacle seems eased by interaction with informed pharmaceutical sales representatives. These complimentary factors in juxtaposition with current deleterious conflicts of interest demonstrate a need to find an ethically permissible framework to protect physician/patient interests while concurrently taking advantage of beneficial collaboration with pharmaceutical companies. Pharmaceutical influence on physicians needs to be reformed and limited to relevant collaborations which ensure the integrity of the patient/physician relationship.

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## **SESSION 2E**

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### **HUMAN EXPRESSION AND BEHAVIOR**

*Session Moderator: Kathleen Noble, Women's Studies*

*Session Assistant: Tina Le, Sophomore, Pre-Major, Arts and Sciences*

**Mary Gates Hall Room 284**

**\*Note: Abstracts in order of presentation.**

### **Depression and Pleasant Events in Assisted Living Residents with Dementia**

*Stephanie Grompe, Junior, Nursing*

*Mentor: Rebecca Logsdon, Nursing, DeTornyay Center for Healthy Aging*

The purpose of this project is to determine the association of pleasant events to depressive symptoms, cognitive level, quality of life, overall health status, and functional status in boarding home residents with dementia. Data were collected as part of a larger investigation of dementia care in Washington State Boarding homes, in which 183 residents in 30 facilities were evaluated. Residents' mean age was 82 years (SD=4.2), and dementia duration was 7 years (SD=4.2). Measures included the Pleasant Events Schedule-AD, the Cornell Scale for Depression in Dementia, the Mini Mental State Exam, the Quality of Life-AD, a resident self-assessment of health, and the Lawton-Brody Activities of Daily Living Scale. We hypothesized that the frequency and enjoyment of Pleasant Events would be positively associated with levels of functioning and quality of life. Our preliminary statistical analysis indicates that higher levels of Pleasant Event frequencies and enjoyment are strongly associated with better functionality measured by the Activities of Daily Living and Instrumental Activities of Daily Living Scales ( $r = -.33$  and  $r = -.39$ , respectively,  $p < .001$ ). Pleasant Events are also associated with cognitive functioning ( $r = .28$ ,  $p < .001$ ) and quality of life as reported by the resident ( $r = .29$ ,  $p < .001$ ). The relationship between depressive symptoms and pleasant events is less clear, but we found significant associations between potentially mediating factors that we are exploring further. If our hypothesis is correct, the associations we find may have potential implications for clinical interventions for depression and dementia.

### **Does Emphasis on the Therapeutic Relationship Relate to Improved Outcomes for Depression?**

*Gareth I. Holman, Senior, Psychology, Comparative History of Ideas*

*Mary Gates Scholar*

*Ursula S. Whiteside, Graduate Student, Psychology*

*Mentor: Robert J. Kohlenberg, Psychology*

*Mentor: Jonathan W. Kanter, Psychology, University of Wisconsin – Milwaukee*

A functional analysis of the phenomenon of depression highlights the role of interpersonal functioning and interpersonal problems. Likewise, a functional analysis of psychotherapy suggests that these problems also arise in the therapeutic relationship, presenting opportunities for learning of unique therapeutic value. We have assessed emphasis on the therapeutic relationship in a sample of cognitive and behavioral therapy sessions ( $n=150$ ) using the Cumulative Record of In-Vivo Interactions (CRIVI).

The CRIVI is an observer-based, turn-by-turn coding system in which therapist speech was classified as either focusing on the therapeutic relationship or not. Reliability was calculated for each rater compared to expert criterion raters using interclass correlation coefficients. This study assessed the frequency of emphasis on the therapeutic relationship in Cognitive Therapy and Behavioral Activation for depression and evaluated the degree to which emphasis on the therapeutic relationship mediated outcomes in both interpersonal functioning and depression.

### **The Asymmetric Costs of Action and Inaction**

*Frederick R. Leach, Senior, Psychology*

*Mary Gates Scholar*

*Mentor: Jason Plaks, Psychology*

People frequently come to points in their lives when they must make a decision to take or refrain from action. Their evaluations of the potential erroneous outcomes play an important role in the decision choice. Previous research has shown that individuals differentially evaluate errors of commission and omission across retrospective time; when thinking about the distant past, people report more regret over their errors of omission, and when considering the near past, people express more regret about their errors of commission. Previous work has indirectly suggested a similar pattern in prospective thinking. The present research sought to provide direct evidence that people exhibit a parallel pattern when thinking about the future. We expected people to anticipate more regret over errors of commission in the near future and more regret over errors of omission in the distant future. We further hypothesized that this pattern of differential evaluation could be explained by differences in the mental representation or construal of each error type. We predicted that errors of commission would be more easily represented in a concrete fashion, whereas errors of omission would be more easily represented in an abstract fashion. The results are discussed as they relate to Construal Level Theory.

### **The Affect of Mediated Discourse on Citizens' Association of Certain Concepts and the Resulting Influence on Survey Response**

*Heather Cope, Junior, Political Science and Communications*

*Mary Gates Scholar*

*Mentor: Adam Simon, Political Science*

The new theory of programming asserts that elites (including members of Congress, journalists, lawyers and even judges) inject their policy preferences into daily discourse and those interjections influence citizens' responses to surveys. To establish the validity of this theory, key terms related to chosen topics, the frequency of these words in elite discourse and the use of these terms by survey respondents were determined. The topics selected were partial birth abortion (PBA), Medicare and the federal budget. In the study of PBA, the main focus was on the

various words to describe an unborn child — namely “baby” and “fetus” — and the terms used to describe PBA, including PBA and “intact dilation and extraction (DAE).” Using the computer program Sim Stat, the text from newspaper articles related to those two groups of terms was placed into categories of, amongst other things, baby, fetus, PBA and DAE. Later, the frequencies of key terms in Congressional discourse, certain television news programs, a related Supreme Court case— *Stenberg v. Carhart* — and public opinion surveys were found, along with the history of PBA. As the data was collected, relationships in the data between these sources were analyzed. The same processes will be used to study the topics of Medicare and the federal budget. This research is in progress; therefore, concrete conclusions cannot be made.

### **Love and Work: The Legacy of the UW Early Entrance Program**

*Sean Hughes, Junior, Neurobiology*

*Christina Chan, Sophomore, International Studies*

*Mentor: Kathleen Noble, Women Studies, Robinson Center for Young Scholars*

Cultivating promising young scholars is one of the best investments that any society can make in its future. At the University of Washington’s Robinson Center for Young Scholars, we are actively engaged in making that investment, optimizing young people’s development and inspiring them to achieve personal and professional excellence and become active members of their communities. Each year, we serve hundreds of families and youth throughout the State of Washington through our educational programs and the research and teaching conducted by our faculty. One of our most innovative and enduring programs is the Early Entrance Program (EEP). For more than 25 years, EEP has been the gateway through which some of the brightest young scholars in Washington State enter the UW. Each year 16 students (ages 12-14) are admitted to the preparatory Transition School on campus, which compresses most of secondary school into three academic quarters and offers students comprehensive college preparation in English, history, physics, pre-calculus, and ethics. Students graduate to EEP at the end of the year and become fully matriculated UW undergraduates. Vast amounts of research have been directed at the effect of gifted education programs on

students in primary and secondary schooling. However, very little addresses the emotional, academic, and vocational effects of radical acceleration for very bright students. This longitudinal follow-up study was designed to enhance our understanding of patterns of work, education, and social affiliation that may characterize this radically accelerated population of academically talented individuals. The results of this study are the focus of this presentation.

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## **SESSION 2F**

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### **ENVIRONMENTAL POLICY, ECONOMICS, AND ETHICS**

*Session Moderator: Richard Gammon, Program on the Environment, Oceanography, Chemistry*

*Session Assistant: Tatiana Deras, Sophomore, Pre-Major, Arts and Sciences*

**Mary Gates Hall Room 238**

#### **Relating the Penetration of Ultraviolet Radiation to Watershed Characteristics of Sub-alpine Ponds in Olympic National Park, WA**

*Jackie L. Carter, Senior, Biology, Aquatic and Fishery Sciences*

*Mary Gates Scholar*

*Mentors: Wendy J. Palen, Biology, Aquatic and Fishery Sciences*

*Mentor: Daniel E. Schindler, Biology, Aquatic and Fishery Sciences*

Light plays a number of critical roles in structuring aquatic ecosystems. In particular, ultraviolet radiation (UVR) can be damaging to many aquatic organisms. Prior studies have established that the concentration of dissolved organic matter (DOM) in the water is the most important factor in the absorption of UVR, and therefore controls the exposure of aquatic organisms to harmful levels of UVR. DOM that absorbs UVR is derived primarily from watershed and wetland vegetation, though no study has yet identified which specific watershed characteristics best predict the UVR transparency of individual sites. We evaluated over 25 watershed features including the size, vegetation cover, and soil properties of 12 sub-alpine ponds in Olympic National Park, WA. Each characteristic was related to the differences in the UVR transparency at each site. In our preliminary analysis we found that the best single watershed predictors of transparency were the depth of the organic-horizon and percent organic composition of the soils, followed by variation in the cover of the dominant sub-alpine vegetation (*Vaccinium* and *Phyllodoce* spp.). For sub-alpine ponds of the Pacific Northwest, these results lead us to conclude that the strength of the connection between terrestrial soils and UVR transparency of water is stronger than that with vegetation cover or large-scale watershed features.

#### **A Framework for Extracting Historic Ecologically Relevant Data from Non-Ecological Documents**

*Marco Hatch, Junior, Aquatic and Fishery Sciences*

*Mentor: Sandy Wyllie-Echeverria, Marine Affairs*

*Mentor: J.D. Russell Lawrence Barsh, Samish Nation Center for Study of Coast Salish Environments*

Historic ecological baseline surveys commonly fail to

utilize available data contained in non-ecological documents such as diaries, log books, and maps. For example, diaries often contain shell fishing locations, log books commonly reference observed Indigenous fishing locations, and maps display *Ostrea lurida* (Olympia oyster) beds. This oversight limits restoration projects in lands formerly occupied by Indigenous Nations and can prevent ecosystem based conservation programs of terrestrial and aquatic habitats controlled by Indigenous People. To assist in the development of restoration and conservation actions that are historically accurate and culturally dynamic, we created a framework for extracting ecologically relevant data from non-ecological documents in a form that can be exported to a Geographic Information System (GIS) database for integration into a systems-based restoration or conservation programs. While our system demands a certain level of biological expertise as well as knowledge of the cultural history, including past and present place names, of the region under investigation, the net result provides a visual georeferenced system conforming to any audience. This procedure also provides added benefit to those charged with restoring systems, altered by industrial and commercial activity, to a state more in keeping with ecological sustainability. In the following presentation we discuss the details of our methods and present the results of a pilot study undertaken in the Northern Straits Salish Historic Area in the North Puget Sound region of Washington State.

### **Chemical Weapons Disposal: Solutions for an Aging Arsenal**

*Justin P. Hurt, Senior, Environmental Science*  
*Mentor: Michael Kucher, Environmental Studies,*  
*Interdisciplinary Arts and Sciences*

With the advent of the Chemical Weapons Convention (CWC) of 1990 and the current emphasis on the prevention of terrorist acts using Weapons of Mass Destruction (WMD), what is the best method for disposing of America's archaic and decaying chemical weapons arsenal? Conventional scientific wisdom suggests many methods, including incineration, chemical and biological neutralization, and long-term burial as potential remedies. The most certain fact about our now defunct chemical agent stockpile is that to do nothing would be the most dangerous course of action. Based on cost benefit, technological limitation, and current availability, what is the best alternative to keeping this toxic legacy around, or are there other options available? The various methods will be investigated and compared in terms of history, mechanics, economics, effects to the environment and public health, and expedience in disposal. Many scientists and politicians support the most available and cheapest technology, incineration, but it carries its inherent risks to the environment. Neutralization is gaining prevalence in the scientific community despite its high cost and increased amount of low-level hazardous waste, as it is proving

effective in the chemical demilitarization process in the former Soviet Union. It is demonstrated how incineration, as the least expensive, most accessible and most expedient current technology is the best available for the problem, as completely effective and inexpensive neutralization techniques will not meet the deadlines set for the destruction of the stockpiles according to the CWC and the U.S. Government's desire to prevent further proliferation and address public health concerns.

### **Strolling down the Shores: Exploring Public Beach Access in the City of Seattle's Shoreline Master Program**

*Megan Matthews, Senior, English*

*Mary Gates Scholar*

*Randi Adair, Senior, Community and Environmental Planning, Environmental Science and Resource Management*

*Mary Gates Scholar*

*Dieter Eckels, Senior, Sustainable Resources Sciences and Conservation Biology*

*Andy E-Sok Hong, Senior, Informatics*

*Laura Ann LaFrance, Post-Baccalaureate, Fisheries and Biology*

*Emily Neff, Junior, Community and Environmental Planning*

*Mentor: Craig ZumBrunnen, Geography, Program on the Environment*

Under Washington State's Shoreline Management Act, all municipalities must develop Shoreline Master Programs (SMP) to protect the ecological functions of Puget Sound's shorelines. SMPs have created controversy between government agencies, citizens, environmentalists and developers, largely because no studies have been undertaken to determine whether the guidelines have actually increased the protection or restoration of local waterfronts. Our study attempts to provide an initial exploration of one management plan; it examines how the city of Seattle has acted to implement two of the goals from its 1976 SMP, which are to provide "for maximum public use and enjoyment of the shorelines of the city" and to "preserve, enhance and increase views of the water and access to the water." Because Seattle will revise its SMP in 2009, this is an opportune moment to review whether the current policy has been effective. Significant public interest exists around increasing beach access because much of Seattle's waterfront is owned privately. Our research group is using several methods to measure changes in Seattle's public beach access. These will help to develop a comprehensive picture of what Seattle has done and what actually has happened on the beach since the SMP went into effect. We will conduct GIS analysis of shoreline access points, review shoreline access hearings and permits, and interview city officials who played key roles in the SMP's development. We will also review existing news archives to gain insight on how the public

responded to changes in beach access. Our final goal is to provide the city with essential data that can help them evaluate the efficacy of their land use policy. By quantifying changes in public access, we will lay the groundwork for future researchers to conduct a comprehensive evaluation of the SMP.

**The Effects of Boat Noise on the Vocalization Density and Diversity of Southern Resident Killer Whales (*Orcinus orca*) in Haro Strait**

*Leslie A. McGinnis, Senior, Biology: Ecology, Evolution, and Conservation Biology,*

*Mary Gates Scholar*

*Mentor: David Bain, Psychology*

Boat traffic and the noise associated with it are believed to be potential causes of the decline of the southern resident killer whale (*Orcinus orca*) population. Many previous studies have demonstrated the harmful effects of anthropogenic noise on marine mammals. These noises are particularly harmful due to the way in which killer whales hear, forage, and communicate. This study investigated the possible effects of boat noise on the vocalization density and diversity of J pod in the southern resident community of killer whales. Whale vocalizations were recorded with an underwater hydrophone array at Lime Kiln Lighthouse on San Juan Island, Washington. Densities of discrete calls, whistles, and unstereotyped calls were analyzed in situations with and without boat noise. Relative usage of five discrete calls was also analyzed. No statistically significant results were found between recordings of whale vocalizations with and without boats. This could suggest that killer whales do not change their vocalizations around boat noise or that the sample size was too small to see any of these changes.

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## SESSION 2G

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### MAKING SENSE OF HISTORY

*Session Moderator: Carol Thomas, History*

*Session Assistant: Arianne Espinueva, Junior, Sociology*

**Mary Gates Hall Room 288**

**\*Note: Abstracts in order of presentation.**

**Thermoluminescence Dating in Mississippi: An Archaeological Approach to Dating the Past**

*Christina Jean Fusch, Senior, Anthropology, Near Eastern Languages and Civilization*

*Mentor: James Feathers, Anthropology*

In this undergraduate research project, my goal is to take an archaeological perspective to dating specific pottery collected from different sites near the Clay County,

Mississippi. These samples have been transported to the University of Washington for dating by scholars Janet Rafferty and Evan Peacock from Mississippi State University. These researchers hope to test hypotheses about the occupation and the abandonment of several sites in the uplands and lowlands during the few hundred years before European contact in this region. In my research, I am using Thermoluminescence (TL) dating techniques to date the collected pottery sherds. By using TL dating, an estimate of the age of these samples can be formed by heating small pieces of the sherds and measuring their luminescence. The progress thus far is the communication with scholars Rafferty and Peacock regarding this debate and permission to date some of the pottery that they have collected. Currently, the samples have undergone initial tests and are producing final results that will affect these hypotheses. Furthermore, in addition to my own samples, others from the same region have also been tested. With more samples analyzed, these scholars can hope to obtain a wider range of evidence that will be applied to their hypotheses. It is also important to note that, with TL dating, the process requires much time and testing to achieve accuracy.

**Sick Horses & Sick Men: Understanding Ancient Surgery through the *Hippiatrica***

*Emily Munro, Senior, Classics, History*

*Mentor: Lawrence Bliquez, Classics*

Scholars have extensively studied the practice of human medicine by the ancient Greeks and Romans. Ancient veterinary medicine, on the other hand, has been a topic more often overlooked by academics, especially the area of veterinary instruments. The number of surviving medical instruments that have been identified as veterinary tools is few, and we believe the reason is that those who cared for animals frequently used human surgical implements. The research project will argue this by examining Late Roman references of surgical tools in the veterinary corpus entitled, *Hippiatrica*. This work (which as a whole has not been translated into a modern language) is the result of a command of the Byzantine emperor in the tenth century that his staff collect important veterinary literature into one body of work, making a sort of digest. Although the chronology of the original Greek veterinary sources is controversial, the methods and procedures involved are probably based on sources as far back as the 4<sup>th</sup> century B.C. Our method consists of translating the original ancient Greek references into English, explaining the use of these tools relative to the disease or condition that they were employed to treat, comparing their use to ancient sources on human surgery, and providing illustrations of excavated surgical tools in order to have a visual basis for these types of instruments. Although this project is still in process, it is already clear that there was a close tie between veterinary and human medicine, which can be made clearer in reference to their respective surgical procedures.

**Roman Law and Rural Society in Early Byzantine Anatolia: An Examination of the *Life of St. Theodore of Sykeon***

*Brendan Haug, Senior, Classics*

*Mary Gates Scholar*

*Mentor: Joel Walker, History*

*Mentor: Carol Thomas, History*

Historians have recently begun to criticize the use of Roman legal texts as evidence for social conditions in the late antique world. When used in isolation, the law codes produce the appearance of a rigid, totalitarian state brutal and thorough in its application of punishments. Current research, however, is revealing that the multiplicity of laws in late Roman legal codes reflect the government's inability to enforce its own legislation. This project continues this trend by searching for indications of the existence or non-existence of law and legal procedures in one particular late antique community, that of Sykeon in Central Anatolia (Modern Turkey). This was accomplished through a study of the *Life of St. Theodore of Sykeon* (d. A.D. 613), the biography of a contemporary ascetic monk or 'holy man'. Such texts offer valuable insight into life in ancient rural communities. In conjunction with study of the Theodosian Code, a fifth century Roman legal codification, this project discusses the legal basis of specific interpersonal disputes amongst villagers in the *Life* and examines the way such episodes were actually resolved. By virtue of his extreme asceticism and piety, Theodore became an inspired patron and mediator to whom villagers brought their troubles, neglecting official legal adjudication. Late antique legal obstacles encouraged this trend. Trials were time consuming, court fees were repressively costly, and the courts themselves gave special privileges to government officials, such as the right to be tried only in the capital (Constantinople). It is clear that in Theodore's village community, the Roman legal system had vanished. While no precise date can be pinpointed as the 'end of classical antiquity,' the disappearance of formal legal procedures and the rise to prominence of the divinely inspired holy man indicate a profound change in the history of the ancient world.

**Colonialism's Forgotten Cultures: European Jews in sub-Saharan Africa**

*Spencer D. Lamm, Senior, History*

*Mentor: Sarah Abrevaya Stein, History*

Colonial sub-Saharan Africa between 1870 and 1930 was a highly complex intersection of native Africans, colonists, and ethnic immigrants. It is the position of this research project, Colonialism's Forgotten Cultures: European Jews in sub-Saharan Africa, that Jews played a significant role in the development of the economic and social strata of colonial southern and central Africa during this period. As merchants and traders, Jews were able to work both within and across the interstices of colonial society by serving as

intermediaries between Africans and Europeans, playing key roles in the nascent diamond industry, and building internal and external trading networks. However, this story has been largely forgotten because most Jewish merchants emigrated from the Russian and Ottoman Empires and were therefore not associated with the structures of colonial power in sub-Saharan Africa. This project, therefore, is focused on pursuing a greater understanding of the role Jews played in the growth of commercial networks in and beyond colonial Africa, and the effect of Jews' presence on the emerging colonial sense of racial awareness. Currently, the South African Yiddish-English weekly *Der Afrikaner* is the primary focus of research. After 1909, merchants in the region of Johannesburg were required to publicize changes to the titles of their businesses and they did so within the pages of *Der Afrikaner*. By documenting these announcements, with a focus on specific time periods and types of business, the intent is to gain an increased understanding of the impact Jewish merchants had on the business community and the relationships between Jews and other ethnic immigrant merchants within the Johannesburg region.

**Questioning A Career in History**

*Eric Dolan, Senior, History*

*Mary Gates Scholar*

*Mentor: Carol Thomas, History*

The award of a Mary Gates fellowship during the summer of 2003 enabled me to examine the work of a scholar both inside and outside the classroom. Though I had written on and explored a number of topics in my university career, I had not undertaken a sustained research project. Entering my senior year of study, I hoped to engage in a project associated with antiquity with the intention of clarifying my plans for the future. My summer research allowed me to combine these two goals: I worked with Professor Carol Thomas in preparing materials for a course on Greek history. My research was directed to the means of conveying essential aspects of a culture by bringing to life major periods through the lives of individual figures, in contrast to the more geographical focus of previous courses. After we settled on a number of possible choices, I then began to study and assess their value as historical sources. The research allowed me to read widely in both primary and secondary sources, with emphasis on both overall themes and the unique aspects of each individual. The result was a collection of readings focused on ten individuals beginning with Odysseus and concluding with Karamanlis. Another element of the research involved the reading and appraisal of a draft of a concise history of Greece. Blending well with the earlier work, I learned about the process of preparing a scholarly work that would represent a culture, and be of interest, to an audience outside the classroom as well. As hoped, this experience was a valuable tool in assisting me to build a path beyond college. The necessary commitments of time and energy were well

worth the trouble in demonstrating the responsibilities and opportunities involved in continuing the pursuit of history.

### **Racism and North African Integration in France**

*Monya Kian, Senior, International Studies*

*Mary Gates Scholar*

*Mentor: Daniel Chirot, Jackson School of International Studies*

Immigration from North African countries has been a contentious issue in France since the 1980s. Increased unemployment and uneasy sentiments about the presence of Islam in France has made peoples of Algerian, Moroccan, and Tunisian origin targets of discrimination. Racism and xenophobia reflect the fact that these North Africans are not fully accepted or integrated in French society. The purpose of this thesis is to understand why North African integration in French society continues to be problematic and challenging. By interviewing North Africans in France, I am able to hypothesize that their integration in French society is hindered by their negative perceptions of the French. North Africans feel resentment for the racism they face in France and for the French colonial past. This negative perception contributes to their sense of separation from French society. For North Africans to integrate into French society and for racism to decrease, North Africans and the native French need to relinquish negative perceptions of the other.

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## **SESSION 2H**

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### **PHYLOGENETICS, BEHAVIOR, AND ENVIRONMENTAL BIOLOGY**

*Session Moderator: Merrill Hille, Biology*

*Session Assistant: Luke Butler, UW Graduate Student, Zoology*

**Mary Gates Hall Room 234**

#### **Primate Phylogenesis—Reactions of Serum Albumin**

*Kelly Bui, Senior, Psychology*

*Mentor: Glover Barnes, Urology*

We are studying Prostate Specific Antigen (PSA) as a molecular marker in determining the phylogenetic relationship among primates. The primate species include Human, Chimpanzee, Gorilla, Baboon, Macaque, and Lemur. In order to establish the baseline immunological reactions among the primates and use it as a control against PSA reactions, primate blood serum and tissue extracts containing the antigen albumin were reacted with Rabbit anti-human serum albumin (HuSA). A precipitation line forms when an antibody encounters a corresponding antigen. Spur formation between two species' serums

reflects the presence of differential antigens that distinguish one species from the other and serve as an indication of divergence in their phylogenetic development. Using simple gel diffusion method, relationships among the primate species have been demonstrated as follows: (1) There was distinct spur formation when human and lemur serums were paired against Rabbit anti-HuSA; (2) Similarly, a strong spur formation was present with Macaque and human serum, and with Baboon and human serum; (3) There was weak spur formation when Gorilla was paired with human serum; (4) The absence of spur formation with human and chimpanzee serums demonstrates that there is little or no difference in the antigenic makeup of these two species, meaning they are very closely related. With the baseline established for primate serums compared with human serum, primate serum paired with another species' serum other than human is being done to expand the baseline data. Because the baseline results showed a general and predictable phylogenetic relationships among the primates, it is expected that PSA, an organ-specific antigen, will be a more interesting molecular marker, providing an in depth, and perhaps temporal picture of primate phylogenesis.

#### **Maternal Stress Does Not Affect Sexual Maturation in Japanese Quail Progeny**

*Noelle Ebel, Senior, Cellular and Molecular Biology*

*Mentor: Lisa Hayward, Biology*

Levels of corticosterone (Cort) in birds are elevated upon exposure to stressors. Factors such as food shortage, proximity of predators, disease or injury all increase circulating Cort. Recent work has shown that elevated plasma Cort in a laying Japanese quail (*Coturnix coturnix japonica*) results in elevated yolk Cort in their eggs. Further, exposure to maternal Cort early in development causes chicks to grow more slowly and show higher elevations of Cort in response to a standardized stressor. Other work has shown that quail artificially selected for reduced adrenocortical responsiveness (low stress quail) have an accelerated onset of puberty. Furthermore, maternal stress is known to slow puberty in rodents. Therefore we predicted that quail treated with corticosterone (Cort) early in development would reach puberty later than controls.

To test this prediction, we injected 48 eggs with Cort to simulate the effects of maternal stress and 48 additional eggs with an oil control. Through daily assessment of male foam production and female egg production we quantified reproductive development in quail from the two treatments. We found that maternal stress (simulated by increased levels of Cort by egg injection) does not affect sexual maturation in Japanese quail. Both male and female Cort birds did not differ in onset of foam and egg production from their control counterparts. While elevated levels of Cort in yolk may have harmful effects, there may be a

benefit in this signal of maternal condition. Photoperiod was also varied during this study and the interaction between photoperiod and Cort treatment is discussed.

### **Call Type Stability of J-pod Killer Whales (*Orcinus orca*) in the San Juan Islands**

*Autumn A. Miller, Senior, Zoology, Aquatic and Fisheries Sciences*

*Mary Gates Scholar*

*Mentor: David Bain, Psychology*

Killer whales (*Orcinus orca*) communicate through the use of discrete pulsed calls. These calls are characterized by specific frequencies and durations. In addition, the proportion of occurrence of each call is largely believed to be stable over time. However, recent research has shown structural differences in calls over time and differences in call usage across matriline. The purpose of this study was to evaluate the stability of the proportion of occurrence of calls over time from one group of killer whales. I evaluated call types from 1980 and 2003 from a group of killer whales that inhabit the San Juan Islands, Washington and identified the calls based on an existing catalogue of calls. The three most common calls, in addition to an “unidentifiable” category, were analyzed using a  $\chi^2$  test to detect differences in the occurrence of each call type. The difference in the proportion of occurrence of the calls tested indicated that the usage of one call type, S3, had changed over time. These results are complimented by other research showing instability in the call structure and call usage among different matriline. Therefore, the discrete pulsed calls of killer whales may change over a shorter time frame than originally thought. Caution should be exercised in future studies evaluating the effect of some variable on discrete pulsed calls if call type stability is viewed as a static element of the study.

### **Effects of Elevated Levels of Corticosterone in Yolk on Fluctuating Asymmetry in Japanese Quail**

*Joshua Richardson, Senior, Zoology*

*Mary Gates Scholar*

*Mentor: John Wingfield, Biology*

It has recently been found that Japanese quail hens (*Coturnix japonica*) with high circulating levels of corticosterone lay eggs with correspondingly high levels of corticosterone in their yolk. Maternal transfer of corticosterone, a hormone involved in the stress response, may influence the development of the chick, and may help prepare it to face a stressful environment. To simulate maternal transfer of corticosterone, Japanese quail eggs were injected with an amount of corticosterone equal to one standard deviation above the average endogenous level of corticosterone in the yolk of this strain. At 14 days, left and right tarsus measurements were taken to assess fluctuating asymmetry, the asymmetry between paired bilateral traits. This can be used as a measure of

developmental stability, the ability of an organism to produce a stable phenotype under a given set of environmental conditions. Quail from corticosterone-injected eggs showed greater fluctuating asymmetry in tarsus length than controls. While these results suggest that corticosterone transfer can have an adverse effect on developmental stability, when the above study was repeated with a dose equivalent to two standard deviations, different results were obtained. Quail raised from corticosterone-injected eggs showed less fluctuating asymmetry than controls. In addition to receiving a higher dose of corticosterone, birds in this study also were weighed daily until ten days of age, which increased the amount of stress experienced. These new results suggest that corticosterone may be beneficial at a higher dose, or under stressful conditions, by increasing developmental stability. To test this hypothesis, a study is underway that will place corticosterone-injected and control quail in either stressful or non-stressful conditions. The corticosterone-injected quail should show lower levels of asymmetry than controls in the stressful conditions, and higher levels of asymmetry in the non-stressful conditions if this hypothesis is correct.

### **Quantitative Description of the Spatial Pattern of Marine Mammal Strandings in San Juan County, Washington**

*Morgan Sternberg, Senior, Fisheries: Conservation Management*

*Mentor: Miles Logsdon, Oceanography*

Marine mammal stranding data, consisting primarily of pinniped and cetacean carcasses, have been collected since 1982 in San Juan County, Washington. The frequency and spatial pattern of these observations may be linked with fetch, beach orientation, and public accessibility of the beach. A local drift card study described a non-uniform distribution of beach deposition around San Juan County, which provides insight into the likelihood that marine mammal carcasses distribution will be non-uniform as well. Both the drift card and stranding geographic data were converted into common geographic projections. A Geographic Information System (GIS: ArcGIS 8.3) software, was used to visually depict patterns of both stranding and drift card data along with the variables of fetch, beach orientation, and public accessibility. We hypothesized that the number of stranding observations would increase as fetch increased due to an increased likelihood that these beaches receive wind-driven drift material and also that the number of stranding observations increase as the index of public accessibility increases due to an increase in the ease of access for public observation. We further expect that northern and western-facing beaches will have the highest deposition rates because local pinniped and cetacean sightings suggest that they are most abundant in those regions. By describing the spatial pattern of deceased marine mammal strandings in San Juan

County future collection strategies for the purpose of biological data and disease testing programs can be maximized.

### **Seasonality of Common Raven Ranging Behavior**

*Grant Stokke, Senior, Wildlife Science, Botany*

*Mary Gates Scholar*

*Mentor: John Marzluff, College of Forest Resources*

Territories are diverse in their nature, established for various specific reasons, and enhance the survival and reproduction of territorial individuals. There is much controversy over whether the common raven (*Corvus corax*) is territorial during the breeding season only or year-round, and the functions of raven territoriality are uncertain. This study aims to enhance the current knowledge of territoriality and ranging behavior seasonality in ravens by estimating home range and core area sizes during breeding (May through September) and non-breeding (October through April) seasons, and by observing the spatial overlap of seasonal utilization distributions of adult ravens in the vicinity of Forks, Washington. Each raven is equipped with a backpack-mounted radiotransmitter, and is located at least once per month with radiotelemetry techniques. Ranging behavior is expected to fluctuate seasonally due to competition, food supply, seasonal territoriality, juvenile behavior, or a combination of these factors. Seasonal changes in raven behavior could affect sensitive species, such as the threatened marbled murrelet (*Brachyramphus marmoratus*).

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## **SESSION 2I**

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### **SHAPING OUTCOMES: POLITICS AND ECONOMICS**

*Session Moderator: Melody Ivory, Information School*  
*Session Assistant: Alvetina Gall, Freshman, Pre-Major, Arts and Sciences*

**Mary Gates Hall Room 242**

**\*Note: Abstracts in order of presentation.**

#### **The Sparkle of Difference: Localized Hybridity in Responses to Coca-Cola**

*Kathleen Belew, Senior, Comparative History of Ideas*

*Mary Gates Scholar*

*Mentor: Matt Sparke, Geography*

The Coca-Cola Company reaps significant annual profits from its status as the most-recognized brand in the world. With recognition in more countries than the United Nations, Coke seems to have a hold on the world visually, as well; in almost every snapshot of the local, one will see the red-

and-white. Coca-Cola exemplifies both Americanization and an increasingly global world. By focusing on the example of Coca-Cola, I explore the question of whether globalization will lead to homogeny. First, by examining the micromarketing efforts of The Coca-Cola Company itself, it becomes apparent that a homogenous world would mean significant product losses for Coke stockholders, considering the time and effort The Company has spent conforming to local tastes and inventing consumer "traditions." Second, resistance to homogeneity is present on an indirect level, exemplified by Coke consumption in locales where people don't subscribe to the Coca-Cola world vision, such as the indigenous town of San Juan Chamula in Chiapas, Mexico. The situation there has the potential to indirectly threaten the earnings of The Company through stockholder disapproval. Third, the introduction of two political alternative colas (Mecca-Cola and Qibla-Cola), expresses a direct threat to The Company on the meta-brand level. Through an interdisciplinary investigation of these three interpretations of Coca-Cola (micromarketing, misinterpretation and resistance), I find that global homogeneity is impossible. And although a thin reading of the situation cannot hope to express the complexities of local response, which is neither automatic acceptance nor resistance, a close look reveals that Coca-Cola may be experiencing a threat that could change the tide of global flow.

#### **Democracy, Discourse, and Colonial Reminiscence in the Global City**

*Rowan S. Ellis, Senior, Urban Studies*

*Mary Gates Scholar*

*Mentor: Chandan Reddy, English*

The global city has incited much conversation about the socio-economic polarization which exists in light of contemporary economic structures, broadly named globalization. In the following work, the mechanisms, justifications, and logics which negotiate this polarization will be examined in the context of the redevelopment discourse surrounding the dichotomous spaces of Manhattan Island. Through the creation and deployment of a Wall Street-Harlem metaphor, a binary understanding of difference in the global city will be unmasked as a strategic component of the liberal justification for the contradictions, which will be shown as inherent to the

global city. Further, understandings of difference in the global city become a non-departure from the contradictions embedded in the notions of readiness for self-rule which characterized colonialism. Ultimately, while this likening of globalization with colonialism serve as a critique of contemporary social, political and economic systems, it also represents the potential for an exposure of the vulnerability of the logics and mechanisms behind urban inequality under globalization.

## **Is Nationalism a Cause of War? The Balkan War of 1912, Prelude to WWI**

*Jacob F. English, Senior, Political Science*  
*Mentor: Elizabeth Kier, Political Science*

The idea behind this paper was to take one theory and test the evidence against any available counter-evidence. Being that I am intrigued with the history of the Balkan Region I chose to study whether or not Nationalism was used to cause of the 1912 Balkan War. My primary goal was to test whether the Balkan elite manipulated Nationalism to gain support for and start the war or whether the change in the regional balance of power made the war possible. Through my research the findings suggested that the shift in the balance of power between the Great Powers created a window of opportunity for the Balkan States to seek greater independence from the Ottoman Empire that had a great deal of control over the Southern Balkan region. The findings of my research may also be applied to other conflicts in the region. Therefore, this study and theory of Nationalism and War may be applied to several of the numerous conflicts throughout the history of this region. A final question to be asked is whether or not a pattern exists in regards to the wars fought in the Balkan Region.

## **The Struggle over Jan Hus**

*Clayton Hanson, Senior, Slavic Languages and Literatures, European Studies, Linguistics*  
*Mentor: Josette Baer, Russian, Eastern European and Central Asian Studies Program Visiting Fellow*  
*Mentor: James Felak, History*

The figures of Jan Hus and his followers occupied particularly important places in the national consciousness of Czechs during the First Czechoslovak Republic. However, the particular image of Hus and the Hussites was shaped by a variety of politicians and intellectuals throughout the late 19<sup>th</sup> and early 20<sup>th</sup> century. Thus, this presentation will trace the development of the idea of Hus from the 19<sup>th</sup> century with a particular focus on the critical period immediately prior to, during and shortly after the First World War. This period was the height of the debate among T.G Masaryk, Josef Pekar and others over the meaning of Czech history and it is important to see in this debate the development of certain historical ideas about Czech history and how they incorporated Hus and the Hussites into their frameworks. This project will also attempt to demonstrate why and how Hus was adopted as a symbol over competing historical figures such as St. Wenceslas and Cyril and Methodius. Finally, this project will then briefly trace how the idea of Hus continued to develop during the Communist and present eras.

## **Power Structures and Empire**

*Doug Jensen, Senior, History*  
*Mary Gates Scholar*

*Mentor: Nikhil Singh, History*

Official discourse, particularly in matters of foreign policy, is saturated by politically expedient exhortations in the United States. While this may seem to be a relatively new phenomenon in the midst of what the Bush Administration calls the “War on Terror,” the ideas presented by political officials, and the actions that result from these ideas are not spontaneous creations. Indeed, the current ideology of those in power has much in common with the ideals and logic of liberalism as it emerged in the 19<sup>th</sup> century. Hence, if we are to gain some kind of understanding of this present moment, it is necessary to view similar periods of international aggression in the past. The United States’ invasion of the Philippines is such an example. Upon examining a wide variety of sources including news accounts from the period, speeches made by political figures, letters to the editor, and personal accounts, three methods of control and dominance that lie within the “language of freedom” emerge. First, factual events were deliberately misrepresented by authorities. Secondly, assumptions not subject to the burden of proof were widely espoused. Finally, the logic of officials such as Theodore Roosevelt or John Hay centered on extremely authoritarian conceptions of “freedom.” The results of these methods in practice make it immediately clear that if peoples of the world are to ever discover what democracy or freedom mean, then the actions of the powerful have extremely little to offer them in their search.

## **Resource Wealth, Democracy, and Development in the United States**

*Eric Mvukiyeye, Senior, Political Science*  
*Mary Gates Scholar*  
*Mentor: Erik Wibbels, Political Science*  
*Mentor: Ellis Goldberg, Political Science*

Over the years studies in comparative politics have suggested that dependence on revenues extracted from oil and other natural resources causes political instability (dictatorships, civil unrests, and civil wars) and poor economic performance in “rentier states”, and hinders democracy and development. Though theoretically plausible, empirically testing this argument causes some problems. To assess its validity, proponents of this argument have relied on cross-national samples of countries that experienced political and economic instability even before the arrival of revenues from natural resources. Thus, while there might be a correlation between natural wealth and economic and political instability in rentier states, it is not clear whether there is causality between natural wealth (independent variable) and dictatorship and / or poor economic performance on one hand, or democracy and development on the other (dependent variable). In other words, we know very little about the direct impact of natural resources on government survivability, the propensity for democracy, or economic development. The research

project *Resource Wealth, Democracy, and Development in the U.S. States* uses innovative approaches to get around the empirical and methodological problems associated with cross-national comparisons. It seeks to examine whether wealth from natural resources causes political and economic instability in rentier states by analyzing the historical development of the fifty states of the United States. We have collected data on state electoral politics and dependence on natural resources for much of the last 100 years. We expect to find that higher levels of natural resource dependence will be associated with poorer state-level economic growth and uncompetitive politics, as indicated by the persistence of single party governance through time.

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## SESSION 2J

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### THE ENVIRONMENT AS POLICY, PLANS, AND SOCIAL PRACTICES

*Session Moderator: Dennis Ryan, Urban Design and Planning*

*Session Assistant: Katie Liu, Sophomore, Pre-Major, Arts and Sciences*

**Mary Gates Hall Room 254**

**\*Note: Abstracts in order of presentation.**

#### **Mexico in the Shadow of NAFTA**

*Kianna Bradley, Senior, International Studies: International Political Economy*

*Mentor: Mary Callahan, International Studies*

More than 10 years after the implementation of NAFTA in Mexico, an examination of what it has meant for the people is critical prior to creating similar such agreements with South and Central America. In this paper, I will first discuss the historical context leading up to the development of NAFTA and the economic and political changes that occurred through this process. Next, I will argue that NAFTA has had broad-sweeping, detrimental impacts on Mexican lives in a variety of areas from labor, family, gender, and the environment. Specifically, after the initiation of NAFTA, the explosive growth of maquiladoras along Mexico's borders has resulted in permanent low paying jobs for Mexican labor. Contrary to NAFTA's promises to raise environmental protection standards in Mexico, the environment has seen further degradation. Inequality of women and greater suppression of worker's rights are two of the many byproducts of NAFTA and the negative impact has been felt in the lives of Mexican families. Additionally, NAFTA has appeared to exacerbate political corruption and the evidence shows a vastly greater gap between the rich and the poor in Mexico since NAFTA was put into place. Finally, I will discuss in my conclusion

how the above listed detrimental effects of NAFTA have resulted in circumstances comparable to colonialism, whereby the US has acted out a role of neo-colonizer.

#### **The Duwamish Tribe's Relationship to Salmon Conservation**

*Anna Choi, Senior, Community and Environmental Planning*

*Mentor: Cynthia Updegrave, Community and Environmental Planning*

A popularly held belief is that Native American tribes lived in harmony with their natural environment prior to/during European settlement. It is also often assumed that, in contrast to European settlers, tribes rarely exploited their natural environment. These views frequently led to the idea that indigenous practices are a model for conservation. My research investigates the relationship between the Duwamish tribe and salmon. Did the Duwamish conserve salmon, and if so was it intentional or incidental? The two main criteria in defining conservation are based on the principles set forth by Smith and Wishnie in *Conservation and Subsistence in Small-Scale Societies*. These are 1) any practice that prevents future environmental damage or excessive resource use and 2) intentional design to do so. In addition, I am also investigating these questions through the archaeological and ethnographical lenses by examining artifact remains, spiritual beliefs, and economic contexts. My preliminary research indicates that Duwamish Indians conserved salmon by de facto. The tribe caught more salmon than needed for survival, but did not excessively waste salmon as a resource. The surplus salmon was traded and exchanged for extra individual items. Within the tribe, salmon was stored and distributed during ceremonies to display power and to reciprocate cultural customs. Furthermore, salmon habitats along the Duwamish River were left undisturbed by natives to avoid negative repercussions from evil spirits.

#### **New Urbanism Design and the Pedestrian Environment**

*Jianan Xin, Junior, Biology*

*Mentor: Gordon Bradley, College of Forest Resources*

In order to solve overwhelming problems of urban sprawl, architects and planners developed "new urbanism" as an effective land planning strategy to achieve healthy and sustainable urban development. New urbanism is guided by several principles, including walkability, mixed land use, diverse housing choices, and traditional neighborhood structure. This project explores the relationship between new urbanism and sustainability to gain greater understanding of these two concepts through a case study. The project consists of three parts. First, I will conduct a literature review regarding concepts, principles, benefits and drawbacks of new urbanism, and explore its relationship with sustainability. I will also conduct

interviews with local developers and residents to understand their perceptions of new urbanism and sustainability. Second, I use a case study using a local new urbanism community to determine how this design concept of new urbanism is put into practice. By measuring the new urbanism with community indicators, such as land-use diversity, pedestrian network coverage, and convenience shopping proximity using Geographic Information System (GIS) I will be able to determine if the new urbanism community has been implemented successfully in terms of sustainability and livability.

### **Influences on Women's Access to Nature in the Urban Environment**

*Celeste Gilman, Senior, Community and Environmental Planning*

*Mentor: Lynne Manzo, Landscape Architecture*

Extensive research in the social sciences over the last few decades has demonstrated the psychological benefits of access to nature. Yet, as more and more people live in cities, and as cities become larger and more dense, accessible nature becomes an amenity that must be consciously provided. Creation of parks and protection of critical habitat areas are two of many ways to establish natural areas in the urban landscape. However, existence does not equal accessibility. Natural areas in cities are not magically free from the social problems of the city in which they are imbedded. Fear of violent crime can create an invisible barrier that blocks people from accessing, and benefiting from, the natural areas where they live. This may be particularly true for women. This research focuses on the ways that fear of violent crime influences women's ability to freely access urban nature. This issue is explored through a critical analysis of written works, including design theories, scientific studies, and fictional literature.

### **Environmental Equity in Central District, South Park, and Rainier Valley**

*Claire West, Junior, Community and Environmental Planning*

*Scott Matetich, Junior, Community, Environment, and Planning*

*Jenafer Halpen, Senior, Community, Environment, and Planning*

*Ryan Healy, Junior, Community, Environment, and Planning*

*Mentor: Mark Purcell, College of Architecture and Urban Planning*

Recent immigration from all parts of the world is changing the ethnic landscape of American urban areas. Approximately 2,200 immigrants or refugees become permanent residents of the US daily, and a majority of these people settle in large metropolitan areas (Census 2000). Studies suggest that recent immigrant populations have proportionally higher birth rates than native-born

Americans and subsequently may have a greater need for using public open space (US Census Bureau). As cities become increasingly diverse, urban decision-makers need to respond to the new needs and requirements of its changing citizenry. The aim of this research is to explore the relationship between open space and park usage within racially diverse areas of Seattle. Specifically, we are interested in exploring Seattle Parks and Recreation's current park programming design, and how future park programs might best respond to immigrant needs. To complete our analysis we will use on-site observation and surveys to assess the uses, attitudes, and behaviors of ethnic groups in 4 selected parks throughout Seattle. We will use a statistical method to compare means and to determine who uses the parks and what they do in them. Due to seasonal considerations, the observations and surveys will be conducted and analyzed by early Spring 2004. One outcome of this analysis will be to provide information to Seattle Parks and Recreation about the particular programming needs of new immigrant families. This study could help inform the city of recent trends in park usage and park designs appropriate for its new citizens.

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## **SESSION 2K**

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### **THE GENETIC AND BIOCHEMICAL BASIS OF HUMAN DISEASE**

*Session Moderator: Wendy Raskind, Medicine, Genetics*  
*Session Assistant: Heather Hooper, Freshman, Pre-Major*

**Mary Gates Hall Room 389**

**\*Note: Abstracts in order of presentation.**

### **A Study of Agonist Induced CB1 Cannabinoid Receptor Internalization in Primary Hippocampal Cultures**

*Michael Myoga, Senior, Neurobiology*

*Howard Hughes Scholar, Mary Gates Scholar*

*Mentor: Ken Mackie, Anesthesiology*

The endocannabinoid system has been implicated in several central nervous system pathways, including those that underlie motor coordination, cognition, and memory. Many of the effects of endocannabinoids have been

attributed to CB1 cannabinoid receptor (CB1) mediated presynaptic inhibition of neuronal firing. These are the same receptors that are activated by other cannabinoid agonists, such as  $\Delta$ -9-THC, the primary psychoactive component of cannabis. Following sustained agonist treatment, CB1 receptors internalize via clathrin-coated pits. The present study investigated the potential involvement of G-protein receptor kinase 3 (GRK3) in CB1

internalization. We compared the time course and dose response of CB1 internalization in hippocampal neurons cultured from wild type and GRK3 knockout (GRK3<sup>-/-</sup>) mice. Our results suggest that the efficacy of agonist induced CB1 internalization is reduced in neurons lacking GRK3. These findings implicate GRK3 phosphorylation of CB1 as an important step in CB1 receptor internalization.

### **Characterization of Lamin A Disease Associated Mutations and Processing Defects**

*Samantha James, Senior, Cell and Molecular Biology, Philosophy*

*Mentor: Brian Kennedy, Biochemistry*

Lamin A is an intermediate filament protein that constitutes part of the nuclear lamina – a protein meshwork involved in maintaining nuclear structure. In addition to its role as a structural protein, Lamin A is thought to be involved in other aspects of nuclear function, in part because mutations in this gene have been associated with human tissue-specific diseases, such as muscular dystrophy, lipodystrophy, and diseases resembling premature aging. The molecular bases of the diseases are not known. Lamin A undergoes a series of processing events to reach its mature form. It is prenylated and methylated at the C-terminus, but then these modifications are removed with the last 15 amino acids. The function of this processing is also not known. To gain insights into the molecular bases of the diseases and the function of the processing, I set out to identify characteristics of the disease associated alleles as well as characteristics of mutant proteins defective in normal processing. I have made mutant forms of lamin A and examined the mutant proteins' ability to localize and affect general nuclear characteristics. Wild type lamin A localizes to distinct areas within the nucleus – the nuclear periphery and perinucleolar foci. Several of the disease causing mutations had localizations that differed from the wild type localization. Nuclear shape and the number of nucleoli also appear to be affected by certain mutant forms of the protein. Deviations from normal localization have also been noted in a mature version of lamin A requiring no processing, proteins defective in processing, and an alternative splice product of lamin A called lamin C. The data generated during this course of experimentation is beginning to shed light on the mechanisms of lamin localization and may lead to insights into the molecular basis of lamin-associated diseases.

### **PKC-gamma Gene Mutation Spectrum of SCA14**

*P.J. Cimino, Senior, Biochemistry, Neurobiology*

*Mary Gates Scholar, Space Grant Scholar*

*Mentor: Wendy Raskind, Medicine*

Spinocerebellar ataxias (SCAs) are a group of dominantly inherited neurological disorders manifested primarily as progressive degeneration of muscle movements. There are

more than twenty types of SCAs, which are classified based upon their individual chromosomal loci. Approximately half of the SCAs have had their responsible gene identified and all but two of the SCAs result from abnormal nucleotide repeat expansions in their respective genes. Linkage analysis followed by candidate gene screening allowed our lab to identify missense mutations, not repeat expansions, in the PKC-gamma gene as being responsible for SCA14. I have been screening more than 240 patients' DNA samples, in whom the SCA type is unknown, to look for the spectrum of mutations in this 18-exon gene that lead to SCA14. To date our lab has identified 5 missense mutations, 1 6 base pair deletion, and 1 probable splice site mutation. Eventually, this information will be combined with clinical evaluations and used for SCA14 phenotype/genotype correlations.

### **A Biochemical Analysis of the Dystroglycan Pathway**

*Elizabeth E. Gray, Junior, Biology*

*Mary Gates Scholar, Space Grant Scholar*

*Mentor: Hannele Ruohola-Baker, Biochemistry*

The Dystroglycan pathway consists of cellular machinery found in many cell types, including brain and muscle. It functions to allow communication between the extracellular matrix outside the cell and the cytoskeleton inside the cell. Perturbation of this pathway results in muscular dystrophies and brain malformations. Currently, the regulation of this pathway is not well characterized, and no cure exists for the disease. This connection between the Dystroglycan pathway and disease is the major motivation behind our research. Using *Drosophila melanogaster* as a model organism, we have demonstrated that the Dystroglycan pathway is vital for proper embryonic development and oogenesis. Many potential binding domains, including the SH2, SH3, and WW-domains, exist in the Dystroglycan C-terminus, which may function in providing structural integrity as well as signal transduction. This research aims to define the function of different interactions on this region to better understand the regulation of this pathway. *Specifically, deletion analysis has revealed that the Dystroglycan SH2, SH3, and WW domains play an essential role in this pathway.* Currently, we are examining the specific function of each Dystroglycan domain by analyzing the ability of various Dystroglycan deletion mutants, which specifically block interactions at the C-terminus, to rescue phenotypes. Rescue of specific phenotypes will allow us to elucidate the particular function of each binding domain.

### **Inactivation of Dystrophin in *Drosophila Melanogaster***

*Luis Tulloch, Senior, Biology, Biochemistry*

*Mentor: Hannele Ruohola-Baker, Biochemistry*

Our research uses *Drosophila melanogaster* as a model organism to further our comprehension of the molecular processes responsible for the various muscular dystrophies

that plague *Homo sapiens*. In particular, our research aims to inactivate Dystrophin (Dys), a crucial member of the Dystroglycan (Dg) intercellular complex responsible for the development of musculature in flies. Dys is inactivated via imprecise excision of EP(3)3397, a construct that contains *w+* and *lacZ*, markers used to trail EP(3)3397, located in the first intron of the first transcript of Dys, about 5000Kb from either contiguous exon. EP(3)3397 was excised via a cross to “2-3Sb (transposase) and excision mutants were balanced over TM3Sb, a common third chromosome balancer. Thus far, our research has generated 21 lines of excision mutants that are homozygous lethal and 19 lines of excision mutants that are homozygous semilethal. These various degrees of homozygous lethality imply an imprecise excision. To confirm this hypothesis, the next step is to cross these lines to DK3, an existing deficiency that inactivates a series of genes in the third chromosome, including Dys. The final steps will include isolation and sequencing of the mutant Dys gene (via PCR amplification of the region that contains Dys).

#### **Functional Analysis of the 152-156 Amino Acid Region of Yeast Cytosine Deaminase Using Alanine Scanning Mutagenesis**

*Kathleen Bongiovanni, Senior, Genetics, Biology, Washington State University*

*Mentor: Margaret E. Black, Pharmaceuticals, Washington State University*

Suicide gene therapy of cancer allows for the selective eradication of tumors while sparing normal tissue from damage. This process involves the introduction of a foreign gene into tumor cells followed by prodrug administration. The foreign gene encodes an enzyme that causes the prodrug to be converted into a toxic drug, killing the cancer cells. A major problem with this technique is low enzyme activity toward the prodrugs. In this project the enzyme yeast cytosine deaminase (yCD) is being explored for its possible application to suicide gene therapy. This enzyme is responsible for the deamination of cytosine and also has the ability to convert the drug 5-fluorocytosine (5FC) to 5-fluorouracil (a cytotoxic chemotherapeutic agent). In an attempt to increase the enzyme's activity toward 5-fluorocytosine, site directed mutagenesis was used to make individual alanine substitutions in residues 152-156 (generating mutants W152A, F153A, E154A, D155A and I156A). Plate complementation assays, used to determine yCD functionality, showed that both F153A and E154A retained the ability to metabolize cytosine. Assays utilizing 5FC as the sole pyrimidine source showed that the E154A mutant had increased drug sensitivity when compared to wildtype. This signifies that it has great potential in suicide gene therapy and is undergoing further investigation.

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## **SESSION 2L**

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### **USE OF MODEL SYSTEMS IN BIOLOGY**

*Session Moderator: Thomas Hinckley, Ecosystem Sciences Division, Forest Resources*

*Session Assistant: Kathleen Nguyen, Freshman, Academy for Young Scholars*

**Mary Gates Hall Room 295**

**\*Note: Abstracts in order of presentation.**

#### **Characterization of Active and Latent Heterotrophic Bacterial Communities on the Outer Coast of Vancouver Island**

*Colleen Evans, Senior, Oceanography*

*Mary Gates Scholar*

*Mentor: Richard Keil, School of Oceanography*

In Barkley and Clayoquot Sounds on the outer coast of Vancouver Island, British Columbia, we measured bacterial incorporation of the thymidine analog 5-bromo-2'-deoxyuridine (BrdU). Using immunochemical capture techniques and terminal restriction fragment length polymorphism (t-RFLP) analysis of DNA extracts, we determined the number of operational taxonomic units (OTUs) in a population and the proportion of the population that incorporates BrdU. We also measured bulk community growth rates using <sup>3</sup>H-thymidine incorporation. BrdU-containing DNA was found in, on average, half the community, indicating that the growing (BrdU incorporating) bacterial population is only a subset of the bulk population. Differences in bacterial community structure and growth were correlated with bacterial productivity and multiple water column properties. In both Clayoquot and Barkley Sounds, we found that the extent to which the active and bulk bacterial populations were similar increases with decreasing salinity (i.e. away from more marine waters and towards fresher waters). Additionally, in Clayoquot Sound, the active heterotrophic communities are distinct between different inlets while the bulk communities appear essentially equivalent. Characterizing the growing heterotrophic bacteria in Barkley and Clayoquot Sounds allows for a better understanding of the environmental, biological and physical conditions that influence the microbial loop.

#### **Genetic Diversity of *Synechococcus* in Puget Sound**

*Cheryl Williams, Senior, Oceanography*

*Mary Gates Scholar*

*Mentor: Gabrielle Rocap, Oceanography*

Phytoplankton, or photosynthetic, single celled, marine organisms, are the base of the marine food web.

Phytoplankton ecology must be understood in order to understand many marine trophic interactions, and they are also crucial to the carbon and nutrient cycles, which have large impacts on climate. Puget Sound hosts a wide range of phytoplankton from diatoms to cyanobacteria. My research focuses on the spatial variability of genetic diversity of the cyanobacteria genus, *Synechococcus*, in Puget Sound. Currently, there has been little, if any, research conducted on the genetics of this genus in Puget Sound. I am investigating the genetic diversity by comparing the ribosomal DNA sequences of *Synechococcus* from three regions of Puget Sound: Hood Canal, Main Basin, and the Strait of Juan de Fuca. I have isolated 64 colonies of genetically identical cells. Using polymerase chain reaction (PCR), the internal transcribed spacer (ITS) region of cyanobacteria was amplified from 46 of the isolates. Restriction-enzyme fragment length polymorphism (RFLP) was used to select 10 isolates to sequence. Consensus sequences have been obtained from 8 of these isolates. These sequences will be compared with known cyanobacterial strains using a phylogenetic tree to better understand the genetic diversity of *Synechococcus* in Puget Sound. The diversity, abundance, and seasonal patterns of phytoplankton is crucial in assessing the carbon and nutrient cycles, as well as the sustainability of all trophic levels above the primary producers in the ocean.

#### **Physiology of Arsenic Toxicity in a Unicellular Alga, *Acetabularia acetabulum***

*Nima Dejbod, Senior, Biochemistry*

*Howard Hughes Scholar, Mary Gates Scholar*

*Mentor: Dina Mandoli, Biology and Center for Developmental Biology*

*Acetabularia acetabulum* is an excellent aquatic unicell for studying arsenic toxicity 1) because its giant size facilitates monitoring subcellular sites of uptake and bioaccumulation of arsenicals and 2) because it both has a distinct phenotype in response to low, chronic exposures and dies when exposed to high concentrations of arsenicals. Here we determined the dose response over 12 orders of magnitude for toxic exposures to five arsenicals. The most toxic compound, monomethylarsonous acid [MMA(III)], caused death of populations of *A. acetabulum* at  $\geq 10^{-5}$  M and was ~280-fold more toxic than unmethylated or dimethylated forms. MMA(III) was also faster acting and killed to a greater extent than the other 4 arsenicals we tested [As(III), As(V), MMA(V) and DMA(V)]. Both sensitivity and hierarchy of toxicity of *A. acetabulum* were comparable to the responses of cultured human hepatocytes to these same five arsenicals. The absence of the nucleus increased sensitivity to MMA(III) by 2-fold. Juvenile and reproductive individuals were 10-fold more sensitive than late adults to MMA(III). The presence of chelating dithiols significantly delayed the onset of MMA(III)-induced death in *A. acetabulum*. MMA(III) was chemically stable in seawater, with a half-life of 35 days, enabling future studies

on chronic exposures in the non-toxic range. Data on transport within the thallus will be presented. Our data indicate that *A. acetabulum* is a promising aquatic unicellular model for defining mechanisms of arsenic metabolism and subcellular transport, and for developing and testing the efficacy of arsenic-binding compounds.

#### ***Agrobacterium*-mediated Transformation in *Acetabularia acetabulum***

*Amy McMahon, Senior, Cellular and Molecular Biology*

*Howard Hughes Scholar, Mary Gates Scholar*

*Mentor: Dina Mandoli, Department of Biology*

*Acetabularia acetabulum*, a giant (2-4 cm) unicellular alga, makes a complex thallus (“body plan”) with morphologically and physiologically distinct regions. For example, a cap-shaped structure is made at the apex for reproduction and branched hairs on the stalk may facilitate nutrient uptake. However, it is a powerful model because it is simple – it is unicellular and uninucleate for most of its lifecycle. To understand how *A. acetabulum* can execute its remarkable morphogenesis with just one nucleus we would like to visualize subcellular locations of specific cell components such as the cytoskeleton. *Agrobacterium* is widely used to transform organisms from vascular plants to humans. In this case, *Agrobacterium*-mediated transformation entails transferring foreign DNA from the bacteria into the nucleus of a host alga and requires co-incubation of the alga (a marine organism) with *Agrobacterium* (a fresh water soil microbe) in a common medium so that the transfer of DNA can occur. The haplophase is ideal for transformation because gametangia are mitotically active (required for transformation by *Agrobacterium*) and millions of different transformants can be obtained from one individual alga. To maximize percent transformation, we optimized survival of gametangia during each step prior to co-incubation. For mature gametangia, 93-98% survived removal of microbes with a protease, 95% survived mechanical isolation from the cap, and >85% of the gametangia survived the required 2 day incubation in distilled water. Data on selection of transformants with herbicides and screening for expression of GFP constructs will also be presented. Transformation with vectors expressing GFP fusion proteins will greatly facilitate studies of morphogenesis and development, including nuclear transport from the base to the apex of the cell during reproduction.

#### **Mechanisms for Leaf Growth in Arabidopsis**

*Jamie Lee Northern, Junior, Botany*

*Mentor: Liz Van Volkenburgh, Biology*

Very little is known about the biochemical mechanism for leaf expansion in the model organism Arabidopsis. The growth of leaves in plants is determined by genetic factors and refined by environmental conditions such as light,

water, and nutrient availability – all of which allow a plant to be flexible in ever-changing conditions. In order to understand the involvement particular ions, sugars, hormones and light have in controlling the response of Arabidopsis leaves to their environment, physiological experiments are being conducted to provide insight into the environmental regulation of Arabidopsis leaf growth. We find that light induces rapid growth in Arabidopsis leaves, and that this response to light is enhanced by the presence of exogenous potassium and sucrose. Dependence of light-induced growth on apoplastic acidification is being tested.

*“Research is at the core of university education. Without curiosity of the mind and the will to follow the calls of curiosity through research our lives would prove to be quite dull. For me, research experience has broadened my horizons and shown me how great education can truly be.”*  
- Jacob F. English, Senior, Political Science

*“My research has pushed my imagination and abilities farther than I thought ever possible.”*  
- Kam Yee, Junior, Interdisciplinary Arts and Sciences, Bothell Campus

*“I feel that undergraduate research has helped me clarify my personal goals and research interests. By actually doing something and not just studying it I feel better prepared to make decisions about the issues I will pursue later in life.”*  
- Jacqueline White, Junior, Environmental Studies

# PROCEEDINGS

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## INDEX

### A

Acuario, Adonis 7  
Adair, Randi 107  
Addelle, Tiffany Dierking 90  
Addison, Jason 99  
Ahmadi, Bobby 7  
Aldanese, Jonathan 7  
Aliwarga, Theresa 7  
Allen, Jeanne 8  
Altaras, Ariel 104  
Anderson, Anna 79  
Andrew, Trisha L. 85  
Anne, Erika Matthias 43  
Aravena, Christina 92  
Askren, Annamarie 8  
Axup, Jonathan 94

### B

Baker, Chris L. 9  
Ballinger, Brandon 9  
Barnea, Raz 80  
Baron, Mark 56  
Bazinet, Alissa 84  
Belew, Kathleen 112  
Bender, Rachel 9  
Bezold, Kristina 10  
Black, Toby 16  
Bleakly, Teresa N. 10  
Bongiovanni, Kathleen 117  
Boulware, Jeffrey 94  
Bowen, Sarah 40  
Bowers, Stuart 10  
Bradley, Kianna 114  
Brady, Kristen 11  
Braman, Alicia 11  
Bravo, Maria-Jose 11, 39  
Bridge, Carly 51  
Brigham, Ben 52  
Brittany-Bacha, Michele 84  
Brown, Crystal 78  
Bui, Kelly 110  
Burrirt, Eric J. 91  
Bush, Jane 83  
Bylenok, Laura 25  
Byrd II, Leslie Edward 11

### C

Cadag, Eithon 12, 65  
Carr, Rogan 12  
Carter, Jackie L. 106  
Casey, Linda 12  
Chan, Aron 13  
Chan, Christina 106  
Chan, Czarina 25  
Chan, Michelle 13  
Chang, Charles 13  
Chea, Helen K. 14  
Chekerylla, Andrew 14  
Chen, Steven 15  
Chin, Alice 15  
Chin, Irene 16  
Chisholm, Sarah L. 78  
Choi, Anna 114  
Chojnicki, Kirsten 100  
Cimino, P.J. 116  
Clevenger, Casey 76  
Coffey, Melissa 92  
Cope, Heather 105  
Cowell, Steven 52  
Cron, Lisabeth 16  
Crossman, Maria 16  
Crowder, Sarah L. 16  
Curran, Catherine 16  
Cutter, Jonathan 17

### D

Dahl, Elizabeth K. 95  
Dan, Vi Nguyen 87  
Danielson, Laura 71  
Davies, Maureen 17  
Day, Madalene 18  
Dearing, Jill 18  
Dee, Jeffrey 18  
Dejbod, Nima 118  
Devine, Jennifer 93  
Dewaraja, Asanka 19  
Ding, I-Kang 86  
Dinh, Jean 19  
Ditto, Logan 19  
Doan, Marisha 90  
Dolan, Eric 109  
Drullinger, Todd 20  
DuPuis, Meghan Maurus 44

Durkin, Colleen 82

## **E**

E-Sok, Andy Hong 107  
Ebel, Noelle 110  
Eckels, Dieter 107  
Edmon, Paul S. 20  
Edwards, Jeffrey 20  
Ellis, Rowan S. 112  
English, Jacob F. 113  
Ensor-Estes, Zaedryn 21  
Epilepsia, Aziel 21  
Erbad, Aiman 102  
Evans, Colleen 117

## **F**

Fairbourn, Celia 21  
Fashola, Oluwatope 21  
Ferretti, G'Nel 92  
Fincken, Karl 22  
Flemming, Audrey 22  
Ford, George 104  
Fortin, Anna L. 22  
Fox, Justin 99  
Frantz, Carie 23  
Frostad, Michael 23  
Fung, Tracy 23  
Fusch, Christina Jean 108

## **G**

Ghitis, Eliza 99  
Giansiracusa, Noah 24  
Gile, Ryan 39  
Gilman, Celeste 92, 115  
Gingrich, Stephen 24  
Goehring, Brent 24  
Golke, Neil 25  
Golob, Richard 25  
Gonzalez, Vincent 80  
Goodwin, Adam 54  
Govella, Kristi Elaine 80  
Graf, Erin 25  
Granger, Bram 17  
Grant, Anne 26  
Gray, Elizabeth E. 116  
Greaby, Robyn 95  
Green, Rula Gladden 26  
Greene, Nathaniel 26  
Greer, Yukari 91  
Griffiths, Jennifer 100  
Grogan, Meridith 27  
Grompe, Stephanie 105  
Groth, Curt 98  
Guerrette, Zach 17  
Gum, Jamie 83

Guter, Scott 92

## **H**

Halpen, Jenafer 115  
Hanes, Scott 27  
Hanni, Jeremy 52  
Hannon, Amanda 73  
Hanson, Clayton 113  
Harpold, Hana 27, 51  
Hash, Eileen 28  
Hatch, Marco 106  
Hatcher, Justin 28  
Haug, Brendan 109  
Healy, Ryan 115  
Hechter, Eliana 96  
Heeg, Elizabeth 88  
Held, Robert 28  
Henderson, Jenna 29  
Herem, Alicia 29  
Hill, Andrew 29  
Hiller, David 29  
Hobbs, Joseph M. 96  
Holman, Gareth 51, 105  
Hoover, Caroline 78  
Horm, David 51  
Hoyt, Amanda 30  
Hsu, Jessica 30  
Hsu, Jessie 31  
Hu, Junyuan 37  
Hudson, Amber 31  
Hughes, Sean 106  
Hultman, Eric 52  
Hungerford, Marc Eric 31  
Hurt, Justin P. 107  
Hyland, Jeremy 12

## **I**

Inoyama, Daigo 32  
Ireland, Kathy 17  
Isiordia, Alberto 98  
Iwaszuk, Trevor 16

## **J**

James, Jennifer L. 32  
James, Samantha 116  
Jenks, Kathryn 32  
Jensen, Doug 113  
Jihyun, Zena Kim 36  
John, Ethan 34  
Johnson, Ben P. 32  
Johnson, Charlyn 33  
Johnson, Eleda 95  
Johnson, Elizabeth 33  
Johnson, Lisa 33  
Johnston, Daniel 76

Johnston, Ingrid 34  
Jones, Andrea 34  
Jones, Merri 35

## **K**

Kam, Jason 19  
Kam, Jenny 35  
Katzaroff, Alexia 35  
Kellert, Brian 36  
Kelly, Devin 55  
Kenney, Caroline 47  
Kerr, Zachary 81  
Kian, Monya S. 110  
King, Andrew 92  
King, Michael 36  
Kirkham, Jared 103  
Kobayashi, Yuya 87  
Kooner, Preetma 37  
Krolikowski, Shane O. 37  
Kusunose, Jiro 37

## **L**

LaFrance, Laura Ann 107  
Lam, Ashley 12  
Lamm, Spencer D. 109  
Lang, Tess C. 38  
Larson, Sam 38  
Leach, Frederick R. 105  
Lee, Christal 38  
Lee, Christine 39  
Lee, Henry 39  
Lee, James 39  
Lee, Jennifer M. 40  
Lee, Teresa 103  
Leigh, Janis 40  
Lewis, Tiffany 40  
Li, Ian 42  
Li, Xi 41  
Liang, Shermi Y. 41  
Lin, Minhui 81  
Linville, Robert 41  
Liu, Jian 21  
Liu, Kenneth 41  
Logan, Kimberly 92  
Long, Ben 42  
Loo, Matthew 42  
Lu, Yi-Ching 43  
Lujan, Veronica 25, 81  
Lundgren, Ashley 43

## **M**

Mach, Megan 43  
Mano, Ryan 50  
Marchesini, Emily 17  
Martinez, Marleen M. 43

Mashadi-Hosseini, Afshin 103  
Matetich, Scott 115  
Matthews, Megan 107  
Mattson, Julia 44  
Maynor, Shannon K. 44  
McArdel, Shannon 45  
McCabe, Annette 79  
McCallum, Lindsey 45  
McClellan, Kyle 45  
McCloskey, Megan L. 46  
McGinnis, Leslie 108  
McKaskle, Tammy 51  
McKay, Melissa 46  
McMahon, Amy 46, 118  
Mejia, Pamela 84  
Mendex, Alexander 46  
Meyer, Edmund 47  
Mikkelsen, Ravi 59  
Miller, Andrew 47  
Miller, Autumn 111  
Mitts, Jared 89  
Mohadjer, Solmaz 48  
Morgan, Lindsay 100  
Morrisey, Evan 48  
Muerdter, Claire 48  
Mullen, Michelle 50  
Munro, Emily 108  
Mvukiyehe, Eric 114  
Myers, Jonathan P. 49  
Myhre, Sarah 49  
Myoga, Michael 115

## **N**

Neff, Emily 107  
Nelson, Justin 50  
Nesbitt, Jim 76  
Nevitt, Matthew 61  
Newkirk, Greg 50  
Ngo, Christina 82  
Nguyen, Hai 50  
Nguyen, Lisa 96  
Nissen, Stephanie 51  
Nivala, Michael 101  
Noguchi, Satoshi Mark 87  
Norman, Alex 101  
Northern, Jamie Lee 118

## **O**

O'Brien, Justin 77  
Okano, Ari 91  
Oleinik, John 51  
Ouellette, Cindra 51

## **P**

Palmer, Lauren 57

Pang, John 52  
Papiez, Chelsie 52  
Peinado, Erin 52  
Peplowski, Patrick N. 86  
Perron, Justin 52  
Pete, Nicole 83  
Peterson, David 53  
Phillips, Colin T. 53  
Piedalue, Amy 93  
Podhola, Dan 51  
Polakowski, Michael 53  
Poling, Victoria 54  
Popa, Simina 54  
Pratt, Andrea 54

## Q

Quist, Natalie 54

## R

Rahmedov, Ahror 55  
Ramirez, Suzanna 55  
Ramunno-Johnson, Damien 86  
Repetto, Andrea 55  
Rezvani, Brian 102  
Richardson, Joshua 111  
Rickey, Josh 56  
Riddle, Paul 56  
Roberts, Brock W. 56  
Roberts, John 88  
Roberts, John, S 88  
Robinson, Tammie 39  
Rodriguez, Virginia M. 57  
Rogers, Chad 57  
Rogers, Maximillian 82  
Rusk, Joshua 57

## S

Safariants, Rita 25  
Salehuddin, Adi 58  
Sam, Lee 59  
Samizay, Gazelle 58  
Sample, Alanson 72  
Schmeller, Joe 59  
Schmitt, Allison 59  
Schnackenberg, Thomas 60  
Schneider, Anna 60  
Schneider, Robert 17  
Schwed, Amber M. 97  
Scola, Lindsay 60  
Seater, David 60  
Sekharan, Monica 87  
Seliga, Michael 77  
Seymour, Anna Marie 91  
Shahani, Kabir 61  
Sharpe, Leilani 61

Sheldon, Lowell 76  
Shih, Yang-Luen 61  
Shreve, Ted 62  
Silvia, Jared 85  
Skeels, Meredith 16  
Skeels, Meredith M. 102  
Skinner, Samuel 62  
Slezicki, Katherine 79  
Slota, Diane 62  
Smith, Cable 62  
Smith, Shannon 89  
Sodeman, Robin 63  
Soto, Shannon K. 63  
Speaks, Derrick 98  
Spence, Diana 63  
Spradlin, Carrie 17  
Steedman, Mark 64  
Sternberg, Morgan 17, 111  
Steuben, Anneliese 93  
Stines, Jessica 92  
Stokke, Grant 112  
Stratis, Christina 64  
Su, Jonathan 64

## T

Tabert, Jason 65  
Tan, Jason 65  
Tasman., Joshua M. 88  
Tavana, Bahareh 66  
Taylor, James W. 66  
Teahan, Garrett 66  
Tengan, Brandon 61  
Thayer, Diana 66  
Thompson, Nathaniel 66  
Tisch, Lisa 67  
To, Tho 51  
Tonkonogui, Anna 67  
Tripathi, Mrityunjay 98  
Tselentis, Jason 76  
Tseng, Victor 67  
Tucker, Robert 67  
Tulloch, Luis 116  
Turner, Kevin R. 89  
Turner, T. N. 68

## V

Varg, Kirsten 68  
Velasco, Geoffrey 61

## W

Wang, Chenyang 68  
Wang, Feiya 69  
Wang, James 69  
Wang, Kai Z. 69  
Wang, Kaishi 59

Wang, Michael 97  
West, Claire 115  
Westley, Peter 90  
White, Caleb 101  
White, Derek 70  
White, Jacqueline M. 70  
White, Lisa 70  
Whiteside, Ursula S. 105  
Whitt, James D. 71  
Wiederholt, Kirstin 71  
Williams, Cheryl 117  
Wilson, Christina 71  
Wistort, Ryan 72  
Woelfel, Tiffany 72  
Wong, Darby 72  
Wong, Jamie 72  
Wood, Aaron 39

## **X**

Xin, Jianan 114  
Xin, Wang 54  
Xu, Huining 73

## **Y**

Yee, Kam 94  
Yi, Naomi S. 73  
Yirak, Kristopher 86  
Young, Kakani 94  
Young, Kakani K. 94  
Yuen, Jenny 73

## **Z**

Zeng, Liyun 74

*“Designing your own research project requires focus, creativity, persistence, lots of problem-solving, and the ability to see both the big picture and the tiny details. It is a wonderful challenge that makes use of all the general knowledge we have gotten at the university.”*

*- Jennifer Griffiths, Senior, Biology, Dance*

*“My research has been the best educational experience that I have ever taken part in. I have the opportunity to direct my own experiments and my research team is a supportive and caring group that I have built strong ties with. I encourage anyone who seeks to better their education to consider research because it has definitely made me a well rounded person with wonderful experiences to remember.”*

*- Jill Dearing, Junior, Chemistry*

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