

Seattle Pacific University

6th Annual

ERICKSON

UNDERGRADUATE

RESEARCH

CONFERENCE

CELEBRATING UNDERGRADUATE RESEARCH IN

Science

Technology

Engineering

and Mathematics

Friday, May 9, 2008

Otto Miller Hall, 3-9pm

SPONSORSHIP

The organizers of this year's conference would like to thank the following individuals and organizations for their generous donations.

- Primary funding for this years conference was provided by a generous donation from **David and Sandy Kvamme**
- Door prize kindly donated by **Microsoft Corporation**
- Continued support from the Lilly SERVE grant provided by the **Lilly Endowment, Inc.**
- Seattle Pacific University **College of Arts and Sciences**

ORAL PRESENTATIONS

Identification of Essential Genes in *Azotobacter vinelandii*

James Rosser, Kathryn Houmiel and Derek Wood

Azotobacter vinelandii is a Gram-negative soil-borne bacterium that fixes nitrogen aerobically. This bacterium also has a number of industrial applications including the production of pharmaceutical grade alginate and bioplastics. We recently completed sequencing the 5.36-Mb genome of *A. vinelandii* DJ. The availability of these sequence data allowed us to implement a novel high-throughput screen to investigate the function of proteins in this genome. Specifically, we have set a goal to identify essential genes under nitrogen-limiting conditions. Several previous studies have reported that *A. vinelandii* maintains between 40 and 80 identical copies of its genome per cell depending on growth conditions. Genetic studies in this organism have shown that mutations in essential genes are maintained in a heterogenomic state while mutations in non-essential genes will become homogenomic after chromosomal segregation. These observations form the basis for our screen. To address our goal, an 8000 member Tn5 mutant library has been constructed in *A. vinelandii* DJ. Using a two-step high throughput screen, we identified 1082 mutants in essential genes under nitrogen limiting conditions. Fifty of these mutants have been confirmed and the locations of the Tn5 inserts have been identified. The success of this assay indicates that essential genes can be identified under a variety of conditions that affect this model organism's biology.

Sudoku Trek: The Next Generation

Marshall Brown and Wai Lau

We set out to create an efficient algorithm that generates valid Sudoku grids of varying difficulty. In order to do this, we first developed a method of randomly generating the solution of an arbitrary Sudoku, and we then constructed an algorithm that creates a valid Sudoku puzzle, and another that solves the puzzles and assigns a level of difficulty based on how advanced the techniques are that are necessary to solve the puzzle. We made assumptions that allowed us to work with a subset of Sudoku puzzles that can be solved using seven well-known and popularly used Sudoku strategies. The way that we constructed these algorithms allows them to be extended by incorporating more advanced strategies. This permits for the creation of more difficult puzzles and a more extensive difficulty rating system. This system assigns weighted difficulty values whenever our algorithm uses a certain set of strategies to solve a puzzle. This allows us to keep a running total of these values and quickly assign a difficulty level to a given puzzle. Throughout our puzzle creating algorithm we run checks that guarantee that each puzzle has a unique solution, and is therefore a valid Sudoku.

Marginal Smoothing

Megan Wilson and Brian Gill

When sampling two populations and comparing their means, two tests are habitually used: the Two Sample t-test and the Wilcoxon Rank Sum test. This research investigated the possibility of smoothing the observations from the samples and performing a test on the smoothed distribution of observations. The research was performed through computer simulations and compared the tests' power and calculated significance level.

Using Distance Sampling to estimate the population of Black-tailed deer on Blakely Island

Luke D. Davies and Eric S. Long

Population studies are important to gauge the type of ecological pressure one group of organisms is placing on its environment. Population estimate of black-tailed deer on Blakely Island using Distance Sampling found population density of 39.4 deer/km². Deer are under low hunting pressure and no other type of predation. This density is much higher than mainland populations, but similar to other island populations that are not under predation.

Pedal Powered Generator for use in Rural Africa

Haley Krommenhoek, Tim Ogne, Michael Shi, Zach Williams and Kevin Bolding

Rural Africa lacks a readily available source of electricity. This affects many aspects of daily life: communication, education, and safety. A pedal powered generator is being developed to provide an inexpensive, renewable source of energy for personal use. The key features of this device are the ability to charge an internal or external battery and use the internal battery to power a variety of devices through both a 12 Volt DC output and a 230 Volt AC output. By building on the weaknesses of other available products, this device should be able to make a significant impact in rural Africa.

Interpolation Using Radial Basis Functions

Allen Flavell and Wai Lau

This presentation is an introduction and provides examples of the interpolation problem, radial basis functions, and solutions of the interpolation problem (including multidimensional and scattered data interpolation) using radial basis functions.

Mathematically Modeling the Human Knot Game

Christopher Hardy and Robbin O'Leary

This is a presentation of a senior project that mathematically investigates several questions about the human knot game, a popular icebreaker at camps and other social gatherings.

Fractals: Mathematical Beauty

Jennifer Combs and Russ Killingsworth

Fractals are beautiful - artistically and mathematically! Come discover the astounding topic of fractals including their history, the mathematics behind them, and a few of their applications.

Environmentally Controlled LED Lighting

Danielle Parris, Graham Schwinn, Phil Chase, Nathan Everett, Kevin Bolding and Elaine Scott

Senior electrical engineering project to design an environmentally sustainable, automatic LED lighting solution for home and business.

Water Electrostatic Generator

Sean Ong and Lane Seeley

An electrostatic generator that was invented in the late 19th century by Lord Kelvin is recreated and analyzed in detail using electrical measurements as well as high-speed video recordings. This device operates by collecting charged droplets of water to build up a high potential difference of up to 20,000 Volts, which can be used to create an electrical spark or run a small motor.

Smart Shower

Austin Stewart, Austin Clark, Jon Battershell, Nate Dupuis and Don Peter

Today's outdated shower controls leave us continually adjusting the shower knobs to maintain constant water temperature. The smart shower automatically regulates water temperature allowing people the ability to set and maintain a constant temperature. The unit automates temperature control using cold, hot, and mixed water temperature sensors, continuously adjusting the mixture to match personal preference and protect against drastic temperature spikes.

Estimating black-tailed deer population density on Blakely Island, WA, using capture-recapture models with data from motion-triggered cameras

Stephanie K. Irvin and Eric S. Long

Black-tailed deer (*Odocoileus hemionus columbians*) were captured and individually marked on Blakely Island, WA within a grid of 10 baited motion-triggered camera stations. Photographs taken over 5 weeks at the camera stations (>33,000 pictures) were analyzed using mark-resight approaches in Program MARK to estimate the population density of black-tailed deer.

POSTERS

Sequence Gap Filling of *A. rhizogenes* Chromosome 1

Michael Allen, Andrew Caldwell, Hilary Frank, Priyana Malik, Anthony Deboer, James Rosser, Katherine Houmiel and Derek Wood

The genome of *A. rhizogenes* A4 has been nearly entirely sequenced using 454 Life Sciences technology. However, over 100 gaps remain that need to be filled using traditional Sanger sequencing techniques. A4 contigs were aligned to the *A. radiobacter* K84 scaffold, and primers were designed based on known contig sequences. PCR amplification was used to amplify the gaps, and the amplified regions were sequenced and analyzed.

To be or not to be: A comparative study of factors that influence commitment to career choice among pre-health students

Steven Bair and Cindy Fitch

Choosing a career is a complex process. The current study is an attempt to translate previous findings regarding career development from general populations to students interested specifically in healthcare professions. Participants completed questionnaires that assessed factors of hypothesized importance in the career development process. We assessed differences between students who changed their career path and those that persisted and found that the latter have a wider breadth of previous career-related experience and more confident of their future success. Other significant findings also emerged. These results will facilitate future research and have implications for both career and academic advisors.

Concentration Demonstration Kit

Amber Lundgren, Elise Eccles, Erica Christiansen, Kenzie Brister and Don Peter

We are going to present our Junior Design Project, a Concentration Demonstration Kit. Our project consists of building and designing a relatively small and durable device capable of measuring the salinity of a solution. The kit will display a certain number of lights corresponding to the amount of conductivity of the solution. Our presentation will consist of the progress and completion we have made in the research, design and construction of the device.

Complementary Experimental and Computational Techniques to Investigate the Energetics of Symmetric Hot-Spot Tyrosine Residues in NKG2D

Andrew B. Caldwell and Benjamin J. McFarland

NKG2D is a strong activating receptor protein located on the surface of innate immune system cells. Its ligands, MHC class I-like proteins, are expressed on cells that are virally infected or undergoing tumorigenesis. Two tyrosine residues (Y152 and Y199) at each NKG2D-ligand binding interface were predicted by virtual alanine scanning analysis to play a central role in binding. We have mutated Y199 to tryptophan, phenylalanine, and serine by site-directed mutagenesis, which results in double mutants because NKG2D is a homodimer. Surface plasmon resonance (SPR) has been used to determine the binding constants and thermodynamics for the interactions of the double-mutant NKG2D proteins with three MIC ligands: MICA, MICB (an allele different at six binding-site residues), and the high-affinity variant MICA N69W/K152E/K154D. We have also conducted computational studies using Rosetta Design to model NKG2D residue 199 mutants (A,W,F,S), which allow us to compare computational results to experimental results, and by extension to estimate the energetic contributions of the individual half-site mutations to binding.

Synthesis of Tetramethylnorbornanone

Benjamin L. Burrone and Kevin L. Bartlett

Synthesis of tetramethylnorbornanone will hopefully allow measurement of the singlet-triplet gap of tetramethylenebenzene by negative ion photoelectron spectroscopy (NI-PES) on the radical anion formed by electron impact on the ketone. The literature synthesis requires an ozonolysis, for which we are attempting to find alternative reaction conditions. Synthesis begins with cyclopentadiene and acetone, and we report results for the first three steps in the synthesis.

Qualitative and quantitative analysis of intestinal parasites in the pot-bellied pig using comparative fecal analysis techniques.

Jena Goodman and Cynthia Bishop

Variability in parasite recovery has been suggested by using different fecal analysis techniques. Fresh fecal samples from a young, female pot-bellied pig were analysed using sodium nitrate and zinc sulfate floatation, saline direct smear, and Bauermann sedimentation techniques. Both qualitative and quantitative analyses were performed and evaluated for any statistical differences.

Safety and Efficacy of Selamectin in Budgerigars with an Atypical Knemidokoptes Infection

Elizabeth Rorabaugh and Cindy Bishop

Knemidokoptes mites can cause painful and unsightly scaling and feather loss in budgerigars, but current recommended treatments are either harmful to the birds themselves or difficult to apply. Selamectin can be applied topically, and has been proven safe in other animals. In this study, we examined the safety of Selamectin in a colony of healthy budgerigars, as well as the effectiveness of the drug in eradicating an atypically-expressed outbreak of Knemidokoptes among a second colony. Levels of parasitism and overall health were determined using fecal smears, skin scraping, and white blood cell counts.

Vacuum Tube Audio Amplifier

Eli Peter, Brad Rogers, Zeke Schellberg, Jordan Wirth and Don Peter

Vacuum tubes are often considered relics of electronics' past. Only musicians seem to know the true value of this old instrument. Vacuum tubes have a strange characteristic unmatched in the silicon realm, that is, their distortion is actually desirable. We wish to develop a device that will demonstrate this effect. In a two-fold process. First, the audio signal will be sent through a vacuum tube buffer, simply to take advantage of the distortion qualities of the device. Since this signal will be insufficient to drive a speaker, a second amplifier will be used to significantly increase the current output.

Establishing the Gateway System in *Agrobacterium tumefaciens*

Alan Lee, Kathryn Houmiel and Derek Wood

Agrobacterium tumefaciens C58 is a Gram-negative bacteria that is found in soil worldwide and is responsible for crown gall tumors. This bacteria causes disease in plants by transferring its own DNA into plant cells. Once in the plant cell, the transferred bacterial DNA will randomly insert itself into the plant's genome, resulting in a change in certain plant hormone production which then leads to the growth of tumors or galls. Sequenced by Wood *et. al.* in 2001, the genome of *Agrobacterium tumefaciens* has become of great interest as gene modification and replacement may provide *A. tumefaciens* versatility and efficiency as a biotechnology tool. With the use of the Gateway system developed by House *et. al.*, we are creating a construct that will increase the recombination efficiency of *A. tumefaciens*. The construct will provide us with a functional genomic toolbox that will allow us to modify, delete and tag genes to promote understanding of gene function. Through this tool, we hope to provide a complete Gateway set for this model organism that can be used by the larger research community to facilitate functional analysis of targeted gene products.

Identification of *Agrobacterium vitis* F2/5 Genes Required for the Elicitation of a Hypersensitive Response in Tobacco

Kimberly Lee Wellner, Kathryn Houmiel and Derek Wood

Agrobacterium vitis F2/5 is the causative agent of crown gall disease in grape vines. F2/5 induces a Hypersensitive Response (HR) when injected into tobacco plants. A hypersensitive response is an active response by the plant to a pathogen in an attempt to prevent the pathogen from spreading. HR is characterized by a local tissue collapse, followed by cell death around the infection site. *A. vitis* F2/5 has a tumor-inducing (Ti) plasmid, which transfers a segment of the T-DNA from the Ti plasmid into the plant's genes to cause the production of opines (an energy and carbon source) in crown gall tumors. Opines can be metabolized by the bacteria, but not by the plant cells. Julienne Durringer made an *A. vitis* F2/5 transposon mutant library by crossing *A. vitis* F2/5 Rif and *E. coli* BW20767/pRL27. Research was conducted to generate a consistent HR assay using the controls F2/5 and C58. The *A. vitis* F2/5 mutant library of 2500 mutants is currently being injected into tobacco plants to test for the loss of a hypersensitive response in order to identify genes involved in the elicitation of the HR. Research on the pathogenesis of *A. vitis* F2/5 contributes practical applications for antibacterial treatments and the prevention of crown gall disease, prevalent in agriculture today.

Sonar Distance Calculator

Yaochiem Chao, Brian Pflugrath, JoHannes Paul, Ben Walker and Don Peter

Our project involves the use of transducers to calculate the distance between two points underwater. By sending a pulse from one transducer, a counter will begin counting until it receives that pulse back. Using the speed of sound underwater and how long the process took, it will calculate the distance between the two transducers. This project potentially a lead-in to a senior design project which involves underwater GPS.

Intestinal Parasites in Black-tailed Deer on Blakely Island, WA

Kadie Singleton and Cindy Bishop

We studied the intestinal parasite load of Black-tailed deer on Blakely Island to find if the isolation and high density of the population affected the degree and type of infestation. No previous studies had been done regarding parasites and deer on Blakely Island, and so our objective was to begin identifying and quantifying the intestinal parasites. We worked along side another research team and collected fecal samples from 21 deer. The samples were analyzed using the floatation and direct smear techniques and examined under a microscope. We found to date that the most prevalent parasites are *Coccidia*, *Strongyle*, and *Moniezia*.

Estimated population size of *Lontra canadensis*: latrine census and seasonal variation on Blakely Island Washington.

Danielle DeVoe, Vanessa Miller, Timothy Nelson and Eric Long

The goal for this research was to get an estimated population size for river otters, *Lontra canadensis*, found around Blakely Island, San Juan, Washington. We also wanted to determine if there was significant variation in *L. canadensis* activity between seasons. We hiked along the accessible coast line of the island until we found a latrine site. Once the latrine site was authenticated as being from *L. canadensis*, the scat was categorized as fresh, moderate, or old. The scat was categorized and quantified for each latrine site. We also recorded the latitude and longitude of each latrine site. At areas with a high density of scat, we placed automatic motion censored cameras to get an idea of how many otters were present and the age. We found the location of latrines sites during three different seasons, summer, fall, and winter, to see how the population differed between the seasons and if activity varied between seasons.

Measuring recombination efficiency in *Agrobacterium tumefaciens*

Ashley Gregoire, Kathryn Houmiel and Derek Wood

The genome of *Agrobacterium tumefaciens* C58 was sequenced by Wood *et. al.* in 2001. This bacterium causes crown gall tumors on many wooded plants. This Gram-negative bacterium stimulates the formation of tumors by transferring parts of its T-DNA from the tumor-inducing (Ti) plasmid into the cell nucleus of the plant. We are developing constructs using the Gateway system developed by House *et. al.* in order to improve the recombination efficiency in *Agrobacterium*. This project establishes a functional genomics toolbox in *Agrobacterium* that will facilitate many genome-wide applications including the ability to delete genes and tag them for expression and immunological studies.

Pedal Powered Generator for use in Rural Africa

Haley Krommenhoek, Tim Ogne, Michael Shi, Zach Williams and Kevin Bolding

Rural Africa lacks a readily available source of electricity. This affects many aspects of daily life: communication, education, and safety. A pedal powered generator is being developed to provide an inexpensive, renewable source of energy for personal use. The key features of this device are the ability to charge an internal or external battery and use the internal battery to power a variety of devices through both a 12 Volt DC output and a 230 Volt AC output. By building on the weaknesses of other available products, this device should be able to make a significant impact in rural Africa.

Developing IT for Health Care in Africa

Zachary J. Ward and Phil Prins

Zach Ward has been working for the past couple of years developing a comprehensive data management system for use in African hospitals and community-based rehabilitation (CBR) programmes. A CBR-Management host database was successfully developed and implemented in 2007, and planning is currently underway for the algorithm development of software modules for specific diseases including HIV/AIDS, Cerebral Palsy, Hydrocephalus, and other Orthopaedic and Eye disabilities. The database has been developed in stages in Rwanda, Malawi, and Kenya and is currently undergoing a pilot programme at CCBRT in Dar es Salaam, Tanzania in conjunction with a Quality of Life assessment.

Biochemistry 4362: Adapting Crystallography-Grade Protein Preparation Techniques to a Teaching Laboratory.

W. Kalani Snyder and Benjamin J. McFarland

Teaching labs often face the challenge of exposing upper-division undergraduate students to applicable research techniques with restricted lab time. We adapted X-ray crystallography protein production protocols to the undergraduate laboratory. Lab groups are organized according to the architecture of the lab so that each bench-group of four is assigned a single protein. In this manner 8 different protein preps can be accomplished per term. In the first week, students mix their own culture media and lysis buffers. Then they express protein over an 8-hour period outside of class time. Cell lysis is accomplished through a combination of bead lysis and enzymatic lysis rather than through sonification of cells due to time and financial constraints. Additionally, inclusion bodies are washed through repeated pipetting rather than sonification, and then are refolded by six steps of stepwise dialysis during the week between lab periods. Proteins are purified using peristaltic pump column chromatography. Students run gels and set up sitting-drop crystallization trays to culminate the project. The entire process takes seven weeks of lab time, and has produced research-quality proteins for five years. This year enough protein was produced to provide concentrated, size-purified aliquots to collaborators for crystallization trials using the Mosquito crystallization robot (<http://www.ttplabtech.com/>).

Distribution in depth of eelgrass and ulvoid macroalgae in Puget Sound area

Jake Sharp and Timothy Nelson

The project involved looking at data from videotape of transects from the Puget Sound area and quantifying the presence or absence of *Zostera* (eelgrass) and Ulvoid Macroalgae. Distribution, depth, distance, and proportions of both organisms were recorded and analyzed for patterns of distribution in depth and area within the transects. The data has shown that there are complex interactions between the *zostera* and ulvoid that determine the density and number of their presence in a given local in a given year.

Garlic: To Smell or Not to Smell? The Question of the Mechanism for the Elimination of Diallyldisulfide Odor by Stainless Steel Surfaces

Leesa Dawnell Kurtz, Kevin L. Bartlett and Benjamin J. McFarland

Cooks are commonly advised to remove garlic smell from hands by rubbing stainless steel surfaces. We asked if there was a chemical, catalytic basis to this advice. We used the analytical chemistry method of headspace solid phase micro extraction in conjunction with GC-MS detection to investigate the results of contact between garlic and stainless steel. Garlic enzymatically forms large amounts of volatile diallyldisulfide when it is cut or crushed, producing the familiar pungent odor that remains on one's hands. Crushed garlic which was subjected to stainless steel did significantly have a reduced diallyldisulfide peak detected by HS-SPME/GC-MS, and two new product peaks, retained significantly longer by GC. The MS profiles of these peaks support a mechanism involving the dehydrogenation and cyclization of diallyldisulfide into 1,3-vinyl-1,2-dithiacyclohex-5-ene and 1,3-vinyl-1,2-dithiacyclohex-4-ene, which may be undetectable to the human nose.

Estimating Columbia black tailed deer (*Odocoileus hemionus columbianus*) activity patterns using motion triggered cameras on Blakely Island, WA.

Megan Friesen and Eric Long

Columbia black tailed deer (*Odocoileus hemionus columbianus*) are typically nocturnal as a mechanism of predator avoidance. It was predicted that populations that do not experience predator-prey interactions would have reduced nocturnal tendencies. Since deer on Blakely Island, WA are not subject to predation, a grid with ten motion detecting cameras was set up during the summer of 2007. Over the course of five weeks, 33, 721 images were captured. These data will be analyzed to determine the activity patterns of the deer population in a habitat lacking predator interactions.

Applying cation- π UV quenching techniques to MIC proteins

Patrick J. Nygren and Benjamin J. McFarland

As part of the human immune system response, when a cell is stressed by disease or cancer, a MIC protein (MICA or MICB) can be expressed on the cell surface. This protein is a ligand for a receptor protein on natural killer cells called NKG2D. When a natural killer cell binds to a diseased or tumor cell using the MIC-NKG2D complex, the diseased cell is destroyed. A region of local disorder was found by previous X-ray crystal structures of MICA, but the dynamic consequences of this local disorder are unclear. Here we propose a new method of structural research to investigate MICA and related mutants in solution. In this new technique, we titrate salt solutions into MICA and measure absorbance from 200-400 nm. The newly introduced cations can interact with pi-orbitals and may change the way aromatic amino acids absorb in this range. From this, we may gather independent structural information about protein dynamics. Once the data is collected with an Agilent 8453 spectrophotometer, second derivative UV spectra, spline-fitted with 99 interpolated data points, allows peak position determination with accuracy of up to ~ 0.01 nm. We are currently testing whether cations of various sizes (Na^+ , Li^+ , Cs^+) can discriminate degrees of disorder and estimate degree of aromatic residue exposure.

Energy Use Monitoring System

Stephanie Dost, Hanane Benanaya, Mark Seymour, Cody Vanderpol and Kevin Bolding

This senior Electrical Engineering design project is intended to create a device to monitor the energy use of Otto Miller. This device will have the capability of monitoring Otto Miller's gas and electricity consumption.

Party & Ambient Lighting (PAL) System

Brian Gong, Joshua Kanehen, Kaimana Fukuoka, Brent Weirsma and Kevin Bolding

This presentation will show the product of a yearlong series of courses, in which we designed, built, programmed and implemented a Microprocessor-Based Electronic system. The PAL System is a network of wireless LED lamps. Each unit is capable of displaying any of 16 default programs, or any of the user-created lighting displays. The changing light displays on these units are wirelessly controlled by an RF remote.

Benefits of XML

Nathan Elmenhurst and Elaine Weltz

The business benefits of XML and XSLT transformation in the marketing world.

CarbonCart.com

Reed Probus, Ryan Tilton and Phil Prins

CarbonCart.com is an online retail website based on the ASP.NET platform. Through a drop ship partnership with Amazon.com, CarbonCart carries Amazon.com's entire product catalogue. 100% of greenhouse gas emissions from shipments are offset through the support of renewable energy initiatives, reforestation, and energy efficiency credits. CarbonCart.com will begin taking orders in June 2008.