COLLEGE OF THE HOLY CROSS

Thirteenth Annual

Undergraduate Summer Research Symposium

September 8, 2006
Swords Atrium
2:00 – 4:00 pm

Sponsored by

Members of the Holy Cross Community,

Welcome to the 2006 Undergraduate Summer Research Symposium. Now in its thirteenth year, the symposium is a college-wide event that brings together faculty and students from all disciplines at Holy Cross and provides an opportunity to celebrate their accomplishments over the summer of 2006. It also provides an opportunity for students to witness the breadth of research possibilities on campus and to open a dialogue with a faculty member about conducting research during the upcoming year and summer. We hope you enjoy the impressive collection of research on display today.

Professor Paul Oxley
Professor Leon Claessens
2006 USRS Organizing Committee

We would like to recognize those whose contributions have made this research and this day possible, including:

The Richard B. Fisher Summer Research Grant
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Offices of the President, Provost and Dean
Office of the Science Coordinator
Office of Grants and Corporate and Foundation Giving
Departments of Biology, Chemistry, Economics, Mathematics and Computer Science, Physics, and Psychology

Posters

1. **Speech as a Mediator of Environmental Entrainment,** *Tracy Espiritu and Prof. Richard Schmidt, Department of Psychology, College of the Holy Cross*

2. **Wild Celery's Floating Bananas: Investigating seed dispersal mechanisms of *Vallisneria Americana*,** *A.C. Dempsey and B.D. Robbins, Ph.D., Landscape Ecology Program, Mote Marine Laboratory*

3. **Detecting Moving Objects: Effects of Various Angles and Speeds,** *M. Holloway and C. Royden, Department of Mathematics and Computer Science, College of the Holy Cross*

4. **The Effect of Minima on *Atta cephalotes* Loading Ratios,** *Christina Imrich, E. Brennan, and T. Ram, Organization for Tropical Studies, Duke University*

5. **Distinguishing Groups by Sight and by Taste,** *R. Laverdiere, Department of Mathematics, College of the Holy Cross*

6. **Corona Models Using Chandra X-Ray Data,** *A. Webster and T. Narita, Physics Department, College of the Holy Cross*

7. **Determining the Regulatory Region of Anti-HIV Cytidine Deaminase APOBEC3B ,** *Shannon McKernan and Ann M. Sheehy, Department of Biology, College of the Holy Cross*

8. **Protein Splicing of the *Pyrococcus abyssi* Lon Protease Intein,** *Melissa McGill, Kathryn O'Brien, and Prof. Kenneth Mills, Department of Chemistry, College of the Holy Cross*

9. **Attempts to Identify Genes Involved in Fe (III) Reduction in *Campylobacter jejuni*,** *Nicholas Faiella, Faculty Advisor: Prof. Madeline Vargas, Department of Biology, College of the Holy Cross*

10. **Isolation and Characterization of Iron-Reducing Bacteria from the Blackstone River,** *Lauren Rodda and Dr. Madeline Vargas, Department of Biology, College of the Holy Cross*

11. **Classification of Three-Dimensional Toric Codes,** *Alexander Simao, Jr. and John B. Little, Department of Mathematics and Computer Science, College of the Holy Cross*

12. **The Effect of Biglycan/ Fibromodulin Deficiency on Tendon Cell Fate,** *Natalie Sorbello, Yanming Bi, Tina Kilts, M.F. Young,' Molecular Biology of Bones and Teeth Unit, Craniofacial and Skeletal Diseases Branch, NIDCR, NIH, DHHS Bethesda, MD 20892, USA*

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29. **Estrogen Decreases Acoustic Startle Response and Prepulse Inhibition,** *L. Russell, D. Amante, T. Mahowald and D. Bitran, Department of Psychology, College of the Holy Cross*

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34. **Expression of a Single-chain Variable Fragment for Antibody Conformational Studies,** *Rory Ogden and Cathrine Southern, Department of Chemistry, College of the Holy Cross*

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40. **Locomotor rhythms of *Xenopus tropicalis* throughout**

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46. **Translational Research of Sarcoma and Melanoma,** *Dr. D. Slamon, Dr. W. Tap, M. Eckardt, J. Needle, A. Desai, K. Clarke, Department of Medicine, Division of Hematology Oncology, University of California, Los Angeles Medical Center*

47. **A Modular Approach to Mimicking Enzyme Active Sites,** *Mark Andrews and Professor J. Farrell, Department of Chemistry, College of the Holy Cross,*

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49. **Effects of ouabain on connexin 43 levels in MDCK cells,** *Chrissy Fanning and Dr. Mary Lee Ledbetter, Department of Biology, College of the Holy Cross*

50. **Synthetic Studies on the Higher Monosaccharide Octosyl Acid A,** *Neal A. Biddick and Kevin J. Quinn, Department of Chemistry, College of the Holy Cross*

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53. **Creating Confidence in Xenon Polarization Data,** *D. Muth and S.Ketel, Nuclear Physics Group, University of New Hampshire*

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Naco, M. Kneirim, P.J. Brennan, M.B. Koss, and T. M. Roach, Department of Physics, College of the Holy Cross

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59. **Removing Arsenic from Contaminated Drinking Water Through Adsorption to Iron Hydroxide,** *Laura Rose Condon and Dr. Jane M. Van Doren, Department of Chemistry, College of the Holy Cross*

60. **Implicit Learning in New World Primates,** *Matt Gagne and Katie Levesque, Charles Locurto , Department of Psychology, College of the Holy Cross*

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62. **A Comparison of Pituitary Volume (PV) in Growth Hormone Deficient (GHD), Idiopathic Short Stature (ISS) and Control Subjects,** *Daniel Ricotta, Kamolika Datta, Richard Noto, MD. Department Pediatrics, New York Medical College, Valhalla, NY*

63. **The Impact of Environmental Regulations on House Prices: An Examination of Wetlands Regulations,** *K. Kiel and C. Marieni, Department of Economics, College of the Holy Cross*

64. **Dancing Into March Madness: Is there a Major Conference Bias in the NCAA Men's Basketball Tournament?** *Victor A. Matheson, Paul Riley, Department of Economics, College of the Holy Cross,*

65. **Legalized Gambling: Does the Authorization of Casinos Affect Revenues from State Lotteries?** *N. Novarro and R. Galiano, Department of Economics, College of the Holy Cross*

66. **The Impact of Ticket Scalping On Performing Arts Markets,** *Professor Melissa Boyle, College of the Holy Cross, Professor Lesley Chiou, Occidental College, Steven Wych, Research Assistant, College of the Holy Cross*

67. **An Investigation of Excess Endowments at Private Liberal Arts Colleges,** *Karen Teitel, Asst. Professor and Ryan Hogan Class of 2008, Department of Economics and Accounting, College of the Holy Cross*

68. **Effects of Group Homes on Property Values in Framingham, Mass.,** *N. Sanchez and K. Beglane, Department of Economics, College of the Holy Cross*

69. **Exploring the Role of Syndecans in Neurofibromatosis Type 2,** *B. Keil and R. Bellin, Department of Biology, College of the Holy Cross*

Poster 1

Speech as a Mediator of Environmental Entrainment

Tracy Espiritu and Prof. Richard Schmidt
Department of Psychology, College of the Holy Cross

Previous research has shown that individuals become unintentionally coordinated when interacting with other people. One possible explanation of this interpersonal coordination is the existence of intrapersonal entrainment between speech rhythms and limb movements or postural sway: Because interactants speech is coordinated (e.g., in turn taking) and their speech is coordinated with their own limb movements, the limb movements of the two people become coordinated. The current studies seek to investigate the hypothesis that such intrapersonal coordination between speech and body movements underlies interpersonal coordination. Participants were asked to complete a rhythmic reading task, naming letters that appeared on a screen, while also swinging a handheld pendulum. The extent to which the wrist movements became coordinated with the presentations of the letters on the screen (reading rhythm) was analyzed using relative timing and cross correlation measures. I hypothesized that the wrist movements will entrain to the reading speed of the participants if more cognitive involvement is necessary to complete a task.

Financial support came from the Fischer Summer Research Fellowship through Holy Cross as well as the National Science Foundation.

Poster 2

Wild Celery's Floating Bananas: Investigating seed dispersal mechanisms of *Vallisneria Americana*

A.C. Dempsey and B.D. Robbins, Ph.D.
Landscape Ecology Program, Mote Marine Laboratory

The reproductive mechanism of the freshwater angiosperm *Vallisneria americana* (wild celery) has not been extensively studied. However, it is known that this plant has physiological characteristics that allow for highly specified seed dispersal mechanisms. *Vallisneria americana* seeds develop within a pod or banana that houses ~200 seeds. Bananas act as a dispersal vehicle, transporting seeds through the water column and may be inhibited by changing salinity levels in the water via tidal flux and/or freshwater input. Our objective was to investigate the physiological characteristics of *V. americana* bananas in relation to their buoyancy and seed dispersal ability with relation to salinity.

Mature bananas (n = 107) were harvested from a captive population of plants within Mote Marine Laboratory's research ponds. Each banana was measured recording length, width, and diameter, with position in the water column noted when harvested. Buoyancy was first recorded using freshwater based on physiological characteristics only. Bananas were placed at different salinity levels of 3%, 5%, 7%, and 10%.We found no pattern in the buoyancy of bananas regardless of salinity with some being negatively and others positively buoyant. In most cases, bananas were seen to be suspended in the water column at an angle. This angle was estimated for each banana and used to further evaluate salinity effects. We found that bananas are sensitive to changing salinity levels, but no trend could be seen between buoyancy and physiological characteristics.

We thank Mote Marine Laboratory, Charlotte Harbor National Estuary Program, and the South Florida Water Management District.

Poster 3

Detecting Moving Objects: Effects of Various Angles and Speeds

M. Holloway and C. Royden
Department of Mathematics and Computer Science, College of the Holy Cross

Detecting moving objects is a pivotal part of every person's motion through the world. Past research has discovered that the global pattern of the scene affects an observer's perception of his/her surroundings including moving objects. A radial pattern projects on the back of the retina as a person moves through a stationary scene. We have taken the research further to determine how a moving observer detects a moving object in the scene. We examined the angle at which the object travels, with relation to the scene, and the speed at which the object travels, relative to the scene. We ran experiments in which people viewed a computer simulation of motion toward a scene consisting of two transparent planes and a square object. Observers were asked to determine whether the object moved with respect to the planes, non-rigid, or not, rigid. The results show that observers are more likely to distinguish the object as moving when the object is moving at an angle opposite the radial pattern. Angles where the object appeared to moving in the same direction as the pattern, people perceived the object as part of the scene. In the second half of the experiment, observers were unable to distinguish the object from the scene when it moves at speeds close to those of the scene. Substantially large and small object speeds were overwhelmingly considered as non-rigid scenes. From these experiments, we conclude that the angle and speed at which the object travels affects an observer's perception and ability to pick out moving objects within a scene.

Supported by NSF grant #0343825

Poster 4

The Effect of Minima on *Atta cephalotes* Loading Ratios

Christina Imrich, E. Brennan, and T. Ram
Organization for Tropical Studies, Duke University

The presence of size polymorphism in fungus-cultivating leaf-cutter ants (Formicidae: Attini) has been the center of much research in the neotropics. Three main size classes exist: the maxima, or soldiers who guard the colony, the media, or workers who cut and transport leaf fragments, and the minima, the smallest class that tends fungal gardens. Given their large abundances, 79% of the colony population, we studied minima of *Atta cephalotes*, who hitchhike on the leaves of workers, in order to observe if minima mass has a significant effect on the load ratio of worker ants. Load ratios represent the mass an ant is transporting relative to its own body mass. We conducted our research at La Selva Biological Station in Costa Rica and focused our research on five minima categories, consisting of approximately 60 samples with workers carrying one minima per leaf, 60 with workers carrying two minima per leaf, and so on through five minima per leaf. We took the mass of each worker, minima, and leaf, along with a measurement of tibia length per worker. We also did a 30 minute observation to see how frequent our minima categories were. We found a difference in leaf mass carried by workers carrying five minima; workers carrying one through four minima carried similar leaf masses. There was also a difference in ant loading ratios when minima were included in calculations, supporting the idea that minima have an effect on workers. We agreed with previous research and also suggested that one role of minima is to clean leaves prior to cultivation to make harvesting more efficient. From this, we deduced that they are affecting colony productivity by reducing the quantity of leaves transported back to the nest, but increasing the quality of leaves by cleaning them.

Poster 5

Distinguishing Groups by Sight and by Taste

R. Laverdiere
Department of Mathematics, College of the Holy Cross

What's the difference between a chicken and a frog? Visually, it's easy to tell, but frog meat is often said to "taste like chicken." In other words, the use of sight allows discernment of a key distinction between frogs and chicken which is obscured by using only the sense of taste. A similar concept applies to mathematics: working through multiple paradigms allows one to grasp more fully certain characteristics of mathematical structures, which is especially important in determining whether or not two groups are "the same."

I have studied the orthogonal, special orthogonal, unitary, special unitary, and symplectic groups. Two groups will be considered to be "the same" if there exists an isomorphism (an operation-preserving bijection) between the groups. The goal of the project is to determine which of these various matrix groups are isomorphic, based on Morton L. Curtis' book, *Matrix Groups* (Springer, 1979).

The basic approach of the project is to characterize the groups from an algebraic and geometric perspective and then study invariants which are preserved by isomorphisms. Some invariants which will be be treated include the dimension, center, and maximal tori of the group. While the center of the group is a purely algebraic property, dimension is better understood if geometrically interpreted and studied from the point of view of differentiable manifolds. The use of both an algebraic and geometric perspective is analogous to the use of both sight and taste to distinguish the groups.

My research in the summer of 2006 was supported by NSF Grant No. DMS-0405529, Thomas E. Cecil, Principal Investigator.

Poster 6

Corona Models Using Chandra X-Ray Data

A. Webster and T. Narita
Physics Department, College of the Holy Cross

Analyzing the interaction between radiation and matter in space provides us with the most direct knowledge of the universe outside of our solar system. The interaction gives us information about the absorbing and emitting materials along our line of sight. Professor Narita and Professor Ross of the College of the Holy Cross collected data for two possible models the corona can be dispersed, called blanket and lamppost, for the FeXXV ion absorption spectra for the X-ray Binary XB 1916-053. To create the most accurate results we divided the accretion disk into multiple concentric annuli and found the equivalent width for each. From those we calculated the total equivalent width. To analyze the data from both methods, which include temperature, radius, and the three density fractions of the ions: H, FeXXV, and FeXXVI, I created a computer program that creates a curve of growth graph. After finding a correlating equivalent width for a predetermined temperature and column density, we compared it with the observed equivalent width from NASA's Chandra X-ray Observatory to see which is a more accurate physical simulation to use. We found that the blanket model results were closer to what Chandra observed than the lamppost model.

Poster 7

Determining the Regulatory Region of Anti-HIV Cytidine Deaminase APOBEC3B

Shannon McKernan and Ann M. Sheehy
Department of Biology, College of the Holy Cross

The APOBEC3 (apolipoprotein B mRNA editing enzyme catalytic polypeptide 3) family of proteins consists of cytidine deaminases (mutators of dC→dU) that have recently demonstrated involvement in an innate immune response against viruses. APOBEC3G (A3G), APOBEC3B (A3B) and APOBEC3F (A3F) all exhibit anti-HIV activity. While A3F and A3G are subject to HIV Vif (viral infectivity factor) mediated degradation, A3B appears to be at least partially resistant to this viral counterattact. Therefore, the upregulation of A3B is not vulnerable to HIV Vif degradation and may in turn cause an increase in A3B's anti-HIV properties. Thus, manipulating A3B has strong therapeutic potential in the treatment of HIV and possibly other viruses. In order to investigate this therapeutic possiblity, the regulatory elements to the A3B gene must first be identified. Thus, this project intends to identify the promoter region and any other regulatory regions of A3B.

Poster 8

Protein Splicing of the *Pyrococcus abyssi* Lon Protease Intein

Melissa McGill, Kathryn O'Brien, and Prof. Kenneth Mills
Department of Chemistry, College of the Holy Cross

The organism *Pyrococcus abyssi* is a thermophilic archaeon that contains a gene encoding a Lon protease and ATPase domain that is interrupted by an intein. Inteins facilitate protein splicing, a post-translational reaction in which the intein facilitates its own excision from flanking polypeptides called exteins. Proteases cleave peptides either ATP-dependently or independently. This protease is of interest because its ATPase domain is interrupted by an intein. We want to study the effect that the intein has on protease and ATPase activity.

We cloned the full gene sequence into an expression vector so we could study the splicing activity of the full protein. We also cloned only the intein into flanking polypeptides that express affinity domains so that we may study the splicing activity of the intein alone. We have discovered that the intein splices *in vivo* at room temperature.

We plan on studying the protease more specifically in the future using a variety of techniques. Site-directed mutagenesis will be used in order to disable the intein so that we can study the effect the intein has on protease activity. We plan to perform protease and phosphatase assays in order to study the protease's activity and to determine if the protease is ATP-dependent. We will study temperature dependence of the full-length protein as well as perform enzyme kinetics.

We thank the National Science Foundation for financial support.

Poster 9

Attempts to Identify Genes Involved in Fe (III) Reduction in *Campylobacter jejuni*

Nicholas Faiella
Faculty Advisor: Prof. Madeline Vargas, Department of Biology, College of the Holy Cross

Campylobacter jejuni is a Gram negative curved bacterium that is pathogenic. *C. jejuni* is capable of conducting a type of metabolism called iron reduction in which Fe (III) is used by the organism as an electron acceptor in the electron transfer chain. The goal of our research is to identify the genes involved in Fe (III) reduction by conducting random transposon mutagenesis through electrotransformation.

As a first step towards achieving this goal, *C.jejuni* cells were grown on Campylobacter blood agar plates. These cells were prepared for electroporation by washing twice with electroporation buffer. The randomly inserting vector EZ-Tn5 transposon DNA was added to prepared cells and electroporated. The electroporated cells were allowed to recover on Campylobacter blood agar plates. However, all attempts resulted in contaminated outgrowth samples. In all instances the prepared cells were contaminated.

We were also able to show that iron reduction is an inducible process. *C. jejuni* cells were grown on different types of media that contain different amounts of available iron. Cells were grown on Campylobacter blood agar plates (most iron), serum agar plates, and serum agar plates with 40mM iron chelator (least iron). Ferric reductase activity was measured with cell-free extracts collected from the different types of media. Cells grown on serum agar plates had 33.6% less specific activity than those grown on blood agar plates, and cells grown on serum agar plates with 40mM chelator had 59.2% less specific activity. Cell-free extracts were separated using a SDS 10% polyacrylamide gel and silver stained. However, preliminary results showed similar banding patterns.

Poster 10

Isolation and Characterization of Iron-Reducing Bacteria from the Blackstone River

Lauren Rodda and Dr. Madeline Vargas
Department of Biology, College of the Holy Cross

The purpose of our experiments was to isolate and identify iron-reducing bacteria populating the Blackstone River in Worcester, Massachusetts. For centuries the Blackstone was a dumpsite for industrial and human wastes. Despite the efforts of the UBWPAD treatment plant, the river still contains high levels of heavy metals and toxins, ~150mM of iron (Fe (II) and Fe (III) combined), making the water ideal for iron-reducing bacteria. These bacteria exercise dissimilatory iron reduction, which means they use Fe (III) as an electron acceptor. They couple reduction of Fe (III) to Fe (II) with oxidation of organic electron donors for energy.

We isolated and characterized one type of iron-reducer (and magnetite producer) from our Blackstone River samples. We grew the bacteria anaerobically on Lovely Fe Fresh Water media with 100mM Fe (III) plus lactate, acetate, or hydrogen (with yeast extract) for the electron donor and used Ferrozine assays to monitor Fe (II) concentration. The bacteria grew fastest with hydrogen or lactate, showing significant growth after 8d and peak growth at 14d with a Fe (II) concentration of 15-20mM. The bacteria are most likely mesophiles because they grew at both 21°C and 30°C, but better at the higher temperature. On solid media we isolated the iron-reducers, which grow in light purple, circular or irregular shaped colonies and are bacillli sometimes connected in chains. The bacteria can use any of the three electron donors and are facultative anaerobes, characteristic of iron-reducers, as they grow faster in aerobic conditions than in anaerobic environment. Two other strains of bacteria were also isolated. We await DNA sequencing for the bacteria.

Lauren Rodda thanks Dr. Madeline Vargas for this opportunity and we thank the Biology Department for financial support.

Poster 11

Classification of Three-Dimensional Toric Codes

Alexander Simao, Jr. and John B. Little
Department of Mathematics and Computer Science, College of the Holy Cross

Toric codes are a class of m-dimensional cyclic codes first defined by J. Hansen. They are created through evaluation of linear combinations of monomials corresponding to integer lattice points from a polytope P at the points of the m-dimensional torus over a finite field. This research focused upon the behavior of three-dimensional toric codes over various fields. We studied codes with small dimension to determine the best methods of building toric codes. Through the classification we also determined the best possible minimum distance for each set of parameters. The minimum distance, the smallest distance between two distinct words in the same code, is an important factor in determining the error-correction capacity of a given code. The minimum distances were then checked against recorded theoretical best value from published databases. This allows us to determine which toric codes can be useful in data transmission, and to use the codes with higher minimum distances for small dimension to determine the best patterns in building toric codes with larger dimension.

The emphasis of this presentation is to display the process above, and to focus upon one specific example that displays those characteristics. Through this example, a proof was also created to verify the minimum distance of the code, one which also rules out the possibility of creating a code with a larger minimum distance under the same length and dimension.

Poster 12

The Effect of Biglycan/ Fibromodulin Deficiency on Tendon Cell Fate

Natalie Sorbello, Yanming Bi, Tina Kilts, M.F. Young
Molecular Biology of Bones and Teeth Unit, Craniofacial and Skeletal Diseases Branch, NIDCR, NIH, DHHS Bethesda, MD 20892, USA

Healthy skeletal tissue makes proteins known as small-leucine rich proteoglycans (SLRP). Two types of SLRPs are known as biglycan (bgn) and fibromodulin (fmod). These are proteins that have been shown in past experiments to modulate the formation of collagen fibrils during collagen fibrillogenesis. The collagen fibrils are more clustered together and disorganized in Bgn/Fmod knockout (mice that do not have Bgn and Fmod) tendon compared to the wild-type. Bgn and Fmod also bind to growth factors such as TGF beta and BMP and may modulate their function. These two processes of 1) the formation of collagen fibrils and 2) modulating the function of growth factors are essential in the development of tissue repair.

Tendon from Bgn/Fmod knockout (KO) mice is weak and ossifies. We hypothesize that the tendon ossifies because the tendon has stem cells which are defective in the Bgn/Fmod KO. We predict that there is a deficiency in the pathway in the formation of tendon which is disrupted by the formation of bone. We propose bone cells are produced when tendon stem cells (TSC) bind to BMP. In order to test why this ossification process occurs, we performed procedures to test levels of Type I, II and III collagen in the tendon stem cells. Type I is a marker of bone, II, a marker of cartilage, and III, a marker of tendon. Osteopontin was also tested and is a well known marker of bone. As controls we used Gapdh and Beta Actin.

This study was supported in part by the National Institutes of Dental and Craniofacial Reasearch.

Poster 13

Correctional Global Assessment of Functioning

Dr Robert Trestman, Dr John Helfand, Cara Sullivan
Department of Psychiatry: University of Connecticut Health Center; Connecticut Correctional Mental Health Department; College of the Holy Cross

The Global Assessment of Function is a scale that has been widely used by the psychiatric community to determine an individual's general level of functioning. In fixed communities like correctional institutions, an individual's rate of functioning is skewed in comparison to the lay community. There has always been a need for a more appropriate scale with better accuracy for the correctional community. We researched aspects of correctional environments and learned how behaviors and motivations differ from those in the lay community. We have applied this research to form a correctional version of the GAF, a scale better suited for the peculiarities of correctional institutions. The version is still in its beginning phases and specificities of the anchors still need to be adjusted and tested in a correctional institution (the first study was planned to take place at Garner Correctional Institution in Newtown, Connecticut).

We have proposed several possible versions of the Correctional Global Assessment of Functioning to the head of the Connecticut's mental health department, Dr John Helfand.

We thank the University of Connecticut Health Center for financial support.

Poster 14

Synthesis of Inorganic Materials From Pyridine/Thiophene Hybrid Systems

D. LaVoie, J. Farrell, R.Pennell
Department of Chemistry, College of the Holy Cross

We are interested in synthesizing supramolecular arrays connected by transition metals. We have synthesized a series of pyridine/bithiophene ligands where the pyridine moiety binds to transition metals. The bithiophene portions of these ligands couple under oxidative conditions. We have prepared a series of metal complexes (Re(I) and Pt(II)) with multiple hybrid ligands. These monomers have been fully characterized by NMR, mass spectroscopy, Elemental Analysis, and X-ray crystallography. The monomers are soluble in a variety of organic solvents. Upon exposure to oxidative conditions (~1.0V versus ferrocene/ferrocinium), the bithiophene portions of the ligands couple to form conducting polymers on a variety of surfaces. We have grown polymers on platinum electrodes, stainless steel plates, and transparent ITO (indium tin oxide) covered glass plates. The polymers have been characterized by cyclic voltammatry, spectroelectrochemistry, and XPS. The films are polyelectrochromic, which allows one to control their color by applying different potentials. The materials have potential applications as sensors for small molecules.

Many thanks to the College of the Holy Cross for funding our research.

Poster 15

A Remote and Non-contact Measurement of the Blood Pulse Waveform with a Laser Doppler Vibrometer

Candida L. Desjardins and Dr. Lynn Antonelli
Naval Undersea Warfare Center Division Newport, Rhode Island

The use of lasers to remotely and non-invasively detect the blood pressure waveform of humans and animals will provide a powerful diagnostic tool. Currently, blood pressure measurement tools are not useful for burn and trauma victims, and animals require catheterization to acquire accurate blood pressure information. The purpose of the sensor method and apparatus invention is to remotely and non-invasively detect the blood pulse waveform of both animals and humans. This invention is used to monitor an animal or human's skin in proximity to an artery using laser radiation from a laser Doppler vibrometer (LDV). This system measures the velocity (or displacement) of the pulsatile motion of the skin, indicative of physiological parameters of the arterial motion in relation to the cardiac cycle. Tests have been conducted with an LDV that measures surface velocity, and a signal-processing unit, with enhanced detection obtained with optional hardware including a retro-reflector dot. The blood pulse waveform is obtained by integrating the velocity signal to get surface displacement using standard signal processing techniques. Continuous recording of the blood pulse waveform collects data containing information on cardiac health and can be analyzed to identify important events in the cardiac cycle, such as heart rate, and the timing of peak systole and of the dicrotic notch. The results presented will include plots of the blood pulse waveform measured at various arterial locations, and under different stress conditions. In addition, the blood pulse waveforms of smaller animals will be presented.

We thank the Office of Naval Research and the Naval Research Engineering Internship Program.

Poster 16

Phylogeny of *Scaphinotus petersi* in Southeastern Arizona Sky Islands

Abigail Ferrieri, Brian Matthews and Dr. Karen Ober
Department of Biology, College of the Holy Cross

Scaphinotus petersi is a flightless ground beetle in the Carabidae family. The major habitat of this species includes the complex of forested mountain ranges extending across southeastern Arizona and southwestern New Mexico known as the "Sky Islands". Since the last glaciation, these mountain ranges, many with peaks well over 5000 feet, have become relatively isolated from each other offering limited opportunities for genetic interchange between inhabiting populations and creating environments with high evolutionary potential for speciation and biological diversification. Presently, six sub-species of *S. petersi* have been identified on different isolated peaks of the "Sky Islands". We hypothesize that the habitat of S. *petersi* was once continuous thousands of years ago, but over time the retraction of this habitat due to glaciations forced these insects to interbreed and evolve in isolated environments resulting in their present-day diversification. Our approach targets three mitochondrial genes including, COI, ND5, and ND1, and one nuclear gene, ITS, for sequencing and amplification using PCR. DNA extracted from different sub-species collected during the 2006 summer in the sky islands will be used to construct a possible phylogeny for the evolution of *S. petersi*.

We would like to thank the Holy Cross Biology Department, The Fisher Undergraduate Research Program, and the Ober family for making this research possible.

Poster 17

Mimicking Metallo-proteins and Enzymes: New Aminoalcohol Ligands Using Mannich Condensations

J. Niconchuk, M. Andrews, C. Higham and J. Farrell
Department of Chemistry, College of the Holy Cross

We are using Mannich condensations to prepare a series of new aminoalcohol ligands. Mannich condensations are multi-component reactions that combine primary or secondary amines, formaldehyde, and in our case a disubstituted phenol to make new C-C and C-N bonds. After we build up a library of ligands, we will bind them to various biologically relevant metals (i.e. iron, zinc, and possibly cobalt) to explore the structure and reactivity of metallo enzyme and protein active sites.

Mannich condensations are known to be very condition-dependant and thus multiple combinations of temperature, reactant equivalence, and length of reaction were conducted. Our three reactants were a 2,4-disubstituted phenol, formaldehyde, and 1,3-diaminopropane. Three different 2,4-disubstituted phenols (di-methyl, di-*t*-butyl, and di-chloro) were used to control both the steric and the electronic properties of the resultant ligands. Using both the di-chlorophenol and the di-*t*-butylphenol, both the pure desired ligand and a pure pyrimidine product were isolated and characterized using proton and carbon NMR. Solubility was an issue in isolating further products and future work will be done using a different amine.

We thank the College of the Holy Cross for financial support.

Poster 18

Preparation and characterization of rhenium and molybdenum compounds with organic ligands containing amino acid derivatives. Crystal structure of Fc-CO-GABA(OMe).

F. Powers and R. Herrick
Department of Chemistry, College of the Holy Cross

In recent years the studies of the Tc^{99m} and Re^{188} isotopes have shown favorable decay properties for diagnostic imaging and therapeutic delivering purposes. Researchers in the relatively new field of bioorganometallic chemistry have been interested in synthesizing and analyzing different biological compounds that can be attached to organometallic reaction centers for medical purposes. A common synthetic approach is to attach an organic ligand to a central metal atom bonded to three carbonyl groups. The $[M(CO)_3]^+$ core acts as a protecting group and also stabilizes the compound.

We were able to synthesize and purify several novel organometallic compounds, consisting of amino acid derivatives and a pyridine ring, and were successful in attaching these ligands to a $[M(CO)_3]^+$ core. Syntheses were conducted in both organic solvents and in aqueous solution. The compounds were isolated, purified, and characterized by ^1H and ^{13}C NMR and IR spectroscopy. The most common starting material was $Re(CO)_5Br$ but other metal compounds such as $Re(CO)_5Cl$, $Mo(CO)_6$, $Mo(CO)_4(pip)_2$, and $Mn(CO)_5Br$ were also used. We worked mainly with the amino acids glutamine and asparagine due to their simplicity and because of the presence of the free amino side chain where biomolecules would be able to attach.

In addition to the amino acid derivative ligands, we were also successful in preparing new ferrocene compounds with amino acids. A crystal structure of one will be presented.

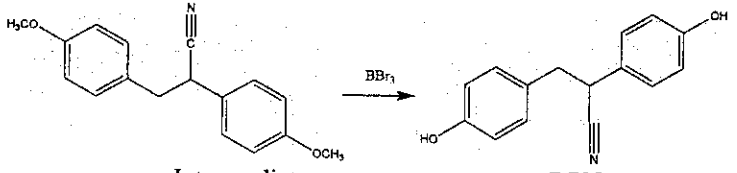
The authors wish to acknowledge the financial support of the Simeon J. Fortin Foundation.

Poster 19

Synthesis of the ER-beta Selective Agonist Diarylpropionitrile

Toni Mahowald, Daniel Bitran[1] and Richard Herrick[2]
Departments of Psychology[1] and Chemistry[2], College Holy Cross

Estrogen receptor beta (ER-beta) and ER-alpha are members of the nuclear receptor (NR) family that shows an evolutionary and functionally conserved structure. Other members of this family include the receptors for testosterone, progesterone, thyroid hormone, vitamins A and D. It has been hypothesized that the action of estrogen on either or both of these receptors can influence anxiety and reference memory. However, in several tests of anxiety and reference memory we found estrogen to have no effect. One possible explanation for these results is that the effects of ER-beta and ER-alpha activation are opposite, thus leading to a net lack of efficacy by estrogen administration. Diarylpropionitrile (DPN) is a full agonist at the ER-beta and has a 70-fold relative binding affinity for ER-beta over ER-alpha, which makes it a good option for exploring ER-beta's influences on reference memory and anxiety. It is much more cost effective to synthesize DPN than to purchase it, which prompted the development of this project. 4-(methoxyphenyl)-acetonitrile and 4-(methoxybenzyl)-chloride were combined with sodium hydroxide, tetrabutylammonium chloride and water to produce an intermediate. The intermediate's hydroxyl groups were then deprotected using boron tribromide. The resulting product was determined to be DPN by using proton and carbon NMR, and it purity was estimated to be about 90%. The DPN was then encapsulated for subcutaneous implantation into ovariectomized mice to be used in future tests of anxiety and reference memory.



Intermediate DPN

Poster 20

Ring-Opening Polymerization of Lactide to Form Polylactide

Jennifer Robert, Katherine Aubrecht, College of the Holy Cross

In this laboratory, a ring-opening polymerization of lactide catalyzed by tin(II) ethyl hexanoate ($Sn(Oct)_2$) and benzyl alcohol was conducted. In order to appropriate this experiment for a teaching laboratory, it was run under three varying sets of conditions, termed stringent, standard and sloppy. Stringent conditions resemble those of a structured research lab and involve advanced laboratory techniques. Standard conditions were developed to be similar to those in a typical teaching lab. To account for the less than proficient laboratory student, the sloppy conditions were analyzed, in which less care was taken in the overall procedure, in order to evaluate percent yield and percent conversion in comparison to the other, more carefully performed experiments. Results, analyzed by ^1H NMR and Gel Permeation Chromatography (GPC), showed that this laboratory is in fact successful when run under all three conditions. Furthermore, we monitored the progress of the polymerizations under all conditions by NMR analysis. The methine region of the polymer and monomer are clearly visible so that one can observe the progress of the polymerization.

Suitable for second semester organic chemistry students, this laboratory fits well into the section of the course concerning transesterifications. The polymerization completes in approximately one hour, so this experiment functions well in a typical four hour lab period. Additionally, the concepts of "green" chemistry can be introduced along with this lab because of polylactide as a biorenewable, biodegradable polymer commonly used in medical applications, and as a commodity polymer. Other issues that can be associated with this laboratory include the issues of polymer stereochemistry and molecular weights and molecular weight distribution.

Support from the Fisher and Fortin funds is gratefully acknowledged.

Poster 21

Polyelectrolyte Multilayer Coatings for Capillary Electrophoreis with one pH replacing another pH

J. O'Grady and K. Frederick
Department of Chemistry, College of the Holy Cross

Nanotechnologies are of prime interest in the research world including chemistry labs where microfluidics are paving the way for "Lab on a chip" devices. Capillary electrophoresis (CE) is one such microfluidic separation technique that has been shown to be effective at separating nanoliter samples of mixtures. A problem prominent in CE is analyte absorption to the capillary wall. One possible solution is coating the capillary with polyelectrolyte multilayers (PEM's). In this study alternating layers of oppositely charged polymers were applied to the inside of the capillary and changes in electroosmotic flow (EOF) were monitored in real time using a photobleached zone migration (PBZM) method. This differs from other studies as we were able to take real time measurements and did not have to rely on average flow calculations. Several different strong and weak polymers were used in different combinations to see the results with one pH solution being replaced by another pH solution in CE. All PEM coatings were effective at reducing EOF and hydrodynamic flow. Those combinations in which a strong polymer was the top layer of the coating were resistant to changes in pH over the range tested however when a weak polymer was the top layer, a change to lower pH resulted in a breakdown of the coating.

We would like to thank the Research Corporation, The National Science Foundation for funding, and The College of the Holy Cross Summer Science program for support for J.O'Grady.

Poster 22

Measuring Electroosmotic Flow in Ultratrol Coated Capillaries

K. Swords and K. Frederick
Department of Chemistry, College of the Holy Cross

Capillary electrophoretic separations are chronically plagued by separation irreproducibility which limits its use in industrial, pharmaceutical and environmental applications. One solution to this problem is to use capillaries which have been modified with a surface coating. For quality control purposes, each coated capillary needs to exhibit the same separation behavior. This work details a novel approach to measuring capillary to capillary coating performance using the flow profile observed during the coating procedure. A method, known as photobleached zone migration (PBZM) is employed to measure the electroosmotic flow (EOF) within a capillary.

Ultratrol is a commercially available coating material for CE capillaries. Since Ultratrol does not depend on buffer or pH, the EOF in CE can be studied without the influence of these factors. By studying the dynamics of EOF in UltraTrol coated capillaries, advancements are made in microfluidics, nanotechnology and in medicine. We were able to discover more about the EOF in UltraTrol coated capillaries by making short injections of differently charged fluorophores. By comparing the data from injections performed on bare capillaries to injections performed on capillaries coated with UltraTrol, we were able to conclude that a coating significantly influences the rate of the EOF. By further comparing different separations on different UltraTrol coated capillaries, it was noticed that even though the capillaries were coated in the same way, when the fluorophore injections were made, the separations were not uniform.

We would like to thank the National Science Foundation, Research Corporation, and the College of the Holy Cross for support of this work.

Poster 23

Using Thermo-responsive Guanosine Gels for Sample Pre-Concentration in Capillary Electophoresis

Antonela Dhamko and Dr. Kimberly A. Frederick
Department of Chemistry, College of the Holy Cross

The pre-concentration of proteins in dilute mixtures is very important for diagnostic applications. The screening of low-abundance proteins in medicine is necessary for detecting diseases in their early phase. Several techniques have been used by scientists in order to pre-concentrate samples of different kinds of analytes. However, none of these techniques are easy to use.

Our research project employs a technique that will be practical and very valuable in medicine. The technique that we are using involves: a thermo-responsive gel made of guanosine, 5'-guanosine monophosphate and KCl which are used to pre-concentrate and separate proteins in capillary electrophoresis separations. Guanosine gels are self-assembled structures of guanosine tetrads held together by hydrogen bonds and are stabilized even further by cations such as potassium. The stability of the self-assembled structures and the subsequent viscosity of the gels depend on the concentration of guanosine, the cation, the pH of the solution as well as the environmental temperature. During the summer we exploited the thermo-responsive behavior of the guanosine solutions in order to capture and concentrate insulin which is known to have an affinity for the G- gels. A plug of gel was injected into the end of the capillary and the protein was captured from a dilute solution. Then the temperature was adjusted until the gel became more fluid and protein was expected to separate and be detected down the capillary.

The authors wish to thank the National Science Foundation and the College of the Holy Cross for support of this work.

Poster 24

Structure-Function Analysis of APOBEC3G

E. Geoghegan and A. Sheehy
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The cytidine deaminase APOBEC3G (apolipoprotein B mRNA editing enzymatic catalytic polypeptide 3G) has been shown to function as part of the body's cellular innate immune response against viruses. Of great interest is APOBEC3G (A3G)'s ability to inhibit HIV. A3G suppresses HIV-1 by acting as a DNA mutator, which introduces a significant mutational load into the viral nucleic acid during the process of reverse transcription. HIV-1, however, encodes a viral protein known as virion infectivity factor (Vif), which effectively counteracts the anti-viral activity of A3G. A mutagenesis study of A3G may aid in characterizing this precise interplay between this cellular defense factor and Vif, and in turn, provide a more comprehensive understanding of A3G's function as an anti-viral and uncover novel anti-HIV strategies. A3G is a 384 amino acid protein that has two delineated active sites. Limited structure-function studies have been reported on A3G; these studies have primarily focused on the known active sites and the single amino acid critical to the A3G:Vif interaction. Site-directed mutagenesis of the active site domains revealed that the C terminal domain is essential for the DNA mutator activity, but both the N-terminal and C-terminal domains are important for antiviral activity. Other mutagenesis studies of A3G have yielded information about the role that specific amino acids play in the interaction between A3G and Vif. The purpose of this project is to expand the previous structure-function studies of A3G by performing an alanine-scan mutagenesis of the entire protein. Analyzing the ability of the mutant proteins to act as anti-virals in the setting of a viral infection should begin to provide important information on critical regions of the protein.

We thank Holy Cross College Biology Department and the Center for Aids Research for financial support.

Poster 25

Win-shift/Win-stay Acquisition and Tests of Working Memory in Mice

Megan Manco
Department of Psychology, College of the Holy Cross

The topic of this research concerned a comparison between the ability of animals to learn to avoid a previously rewarded location (win-shift) versus their ability to return to a previously rewarded location (win-stay). While there is considerable work on this problem in rodents, little has been discovered on the effects of these procedures on working memory. There is the suggestion in previous research using birds that animals prefer win-shift after short temporal delays between sample and comparison trials, but prefer win-stay after longer delays. After mice achieved an acquisition criterion under the win-shift or win-stay procedure, tests of working memory were conducted. These tests involved delays between sample and comparison trials that ranged from 5 s to 60 s. Results revealed the expected superiority of win-shift over win-stay during acquisition. Tests of working memory revealed a more complex picture of preference between win-shift and win-stay. We have designed further experimentation on this topic that will vary the motivational conditions under which mice learn either contingency.

I thank the College of the Holy Cross for financial support.

Poster 26

Examination of Tris-Pyridine Methoxymethane as a Ligand and the Study of Specific Biomolecules for Use in Radioimaging

C. Aquina and R. Herrick
Department of Chemistry, College of the Holy Cross

This research follows our goal of developing bifunctional chelating agents for use in diagnostic imaging. In this project, we studied tris-pyridine methoxymethane as a ligand and examined the properties of specific amino acids and fatty acids for use as biomolecules.

The tris-pyridine methoxymethane (tpmm) ligand was previously prepared by Prof. Don Jameson of Gettysburg College. The ligand was then bound to different metals, most notably rhenium and manganese which act as analogs for the radioisotope technetium-99. IR, ^{1}H NMR, and ^{13}C NMR spectra data were utilized for analysis of the compounds. A crystal structure was obtained for the compound $[Re(CO)_3(tpmm)]Br$.

In addition, specific amino acids and fatty acids of varying alkyl length were bound to a pyridine Schiff-base (pyca) ligand which formed a planar complex with either platinum or palladium. These compounds were used to examine the utility of fatty acids and amino acids as biomolecules. The structure, melting point, and IR, ^{1}H NMR, and ^{13}C NMR spectra data were examined for these compounds. Crystal structures were solved for $Pt[pyca(C_6H_{10}O)OMe]Cl_2$, and several derivatives will be presented.

We thank the Simeon J. Fortin Foundation and Holy Cross for their financial support.

Poster 27

Synthesis of Thermoresponsive Block Copolymers Clicked onto an Azide Functionalized BODIPY Dye.

Justin Caramiciu and Katherine Aubrecht
Department of Chemistry, College of the Holy Cross

The purpose of our work in this laboratory is to synthesize thermoresponsive block copolymers containing hydrophilic and hydrophobic portions that, under the appropriate conditions, form micellar aggregates. We plan to incorporate alkyne functionalized monomers into the hydrophobic block of the copolymers. A pendant alkyne will allow us to use a click reaction in the form of a 3+2 cyclo addition (Huisgen addition) to attach the BODIPY dye and crosslink the polymers.

We synthesized α-propargyl valerolactone by the alkylation of valerolactone enolate.We investigated the copolymerizations of α-propargyl valerolactone with lactide and ε-caprolactone using various catalysts, namely tin triflate and an organocatalyst.

We functionalized a BODIPY dye with an azide, which will allow us to covalently attach the dye to the alkyne functionalized block copolymer. This dye will serve as a fluorescent marker making it possible to view the block copolymer micelles under a confocal microscope.

We would like to thank the Connecticut Business and Industry Association and Pfizer Global Research and Development for financial support.

Poster 28

New Drugs to Fight Antibiotic-Resistant Bacteria

A.K. Knap, R. Frechette, A.C. King, L. Wu, and J.C. Fitzpatrick
MaxThera, Inc., Beverly, Massachusetts

The rapid emergence and spread of antibiotic-resistant bacteria has become a serious hazard in the realm of public health. Pathogenic bacteria cells can mutate to become resistant to antibiotics that are currently on the market to fight them. The occurrence of new drug-resistant bacteria isolates poses a threat to global health that will only proliferate as time continues. Thus, there is a great need for new drugs that can sufficiently treat patients infected with such drug-resistant pathogens. New antibiotics with novel chemical structures act on new targets and have the potential to conquer infections caused by drug-resistant bacterial pathogens.

With this approach, MaxThera, Inc. has identified a series of compounds, through previous high-throughput screening assays, that exhibit activity against essential target proteins that exist within a broad spectrum of bacterial pathogens. We are currently implementing validated testing methods, such as IC50 and MIC measurements, to further verify and characterize the activity of these compounds against purified targeted enzymes and whole bacteria cells. We are optimizing the compound structures of the leading effective series to create analogs that validate their activity. Our goal is to develop these series so as to maximize compound activity against the pathogens and minimize compound toxicity in animal and human cells.

We thank the National Institutes of Health (NIH) and specifically the National Institute of Allergy and Infectious Diseases (NIAID) for their financial support.

Poster 29

Estrogen Decreases Acoustic Startle Response and Prepulse Inhibition

L. Russell, D. Amante, T. Mahowald and D. Bitran
Department of Psychology, College of the Holy Cross

The acoustic startle response (ASR), a simple reflex contraction of the skeletal musculature in response to a sudden, intense acoustic stimulus, is utilized experimentally as both a construct for anxiety and a basis for measuring prepulse inhibition (PPI). PPI, the dampening of acoustic startle magnitude that occurs when a weak prepulse is delivered approximately 80 ms prior to the startle pulse, is found to be reduced in schizophrenia (Koch, 1998). It has also been noted that PPI is generally reduced in women and varies across the menstrual cycle, with PPI being reduced the most in the luteal phase when estrogen and progesterone levels are both high (Swerdlow, 1997; Jovanovic et. al, 2004). This study sought to analyze the effects of chronic estrogen administration on both threshold ASR and PPI. Ovariectomized mice were implanted with either 17β-estradiol (E_2) or placebo capsules that released 8 μg of over a 90-day period. Beginning two weeks after implantation, animals were tested in a threshold ASR paradigm followed by a PPI protocol. The threshold ASR paradigm revealed that E_2 decreased the startle response, but only to intermediate pulse intensities (103 and 113 dB), with no effect on lower (94 dB) or higher (123 dB) intensities. E_2 treatment also reduced the amount of PPI to lower intensity stimulus pulses (103 dB, when the prepulse was held constant at 10 kHz) and lower frequency prepulses (6 kHz, when the pulse was held constant at 123 dB). PPI is a measure of sensorimotor gating, a filtering mechanism that protects the brain from an overload of irrelevant information, thus allowing for coherent thought. Thus, it appears that sensorimotor gating is affected by chronic estrogen treatment, but only in response to low frequency prepulses and low intensity pulses. Although threshold ASR and PPI have been used as indirect measures of anxiety, the significance of these results to psychological constructs of anxiety remains to be determined.

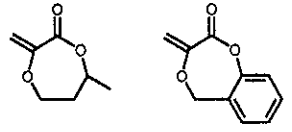
Poster 30

Synthesis of Monomers for Radical Ring Opening Polymerization

T. Vo and K. B Aubrecht
Department of Chemistry, College of the Holy Cross

Important polymers such as polyethylene oxide and polycaprolactone have proven ring opening polymerization to be a vital method of polymer production. Our goal to copolymerize monomers that undergo radical ring opening polymerization (RROP) with alkyl methyacrylates started with two cyclic monomer designs.

Monomer 1 Monomer 2



Both monomers rely on ring strain from a seven-membered ring to encourage the ring opening. The presence of both an electron donating and an electron withdrawing group helps to stabilize the free radical. The presence of a benzylic position also increases the stability of the radical and makes monomer two less prone to side reactions such as atom abstractions.

Synthesis of monomer **1** from 2-but-3-ene-oxy propanoic acid requires the formation of a seven-membered ring via an iodolactionization. Rather then using iodine as our source of I^+, bis-(2,4,6-trimethyl pyridine) iodine hexafluorophosphate was used to avoid an addition from iodine's reactive counter-ion. The 7-membered ring was formed successfully, though introduction of the exocyclic double bond still remains to be completed. Progress towards the synthesis of **2** has been made. The progress made was verified by ^1H and ^{13}C NMR. Future plans include completing the syntheses of both **1** and **2**, investigating their radical homopolymerization, and investigating their radical copolymerization with alkyl methyacrylates. Acknowledgement is made to the American Chemical Society Petroleum Research Fund for summer support.

Poster 31

Quantization of fluorophore distances using single-molecule FRET

D. Vafek and C. Southern
Department of Chemistry, College of the Holy Cross

Single-molecule Förster resonance energy transfer (FRET) has been used for over a decade to examine protein structure and dynamics. FRET is a useful technique to establish the distance between two fluorophores bound to a protein, due to the inverse relationship between the distance between fluorophores and the efficiency of non-radiative energy transfer occurring between them. We have used single-molecule FRET to examine the length of double-stranded DNA segments. 14- and 18-base pair segments labeled at one 5' end with Cy3, and the other 5' end with AlexaFluor 647 were examined. Double-stranded DNA has been studied previously using single-molecule FRET, allowing us to assess the capabilities of our apparatus based on the results obtained.

The 14-base-pair segment showed a maximum FRET efficiency of 0.58, whereas the 18-base pair segment resulted in a maximum FRET efficiency of 0.36. These results agree with the theoretical prediction that the efficiency is inversely related to the distance between the fluorophores. Additionally, the results obtained agree with those found in previous experiments, indicating that the apparatus is working as intended. In the future, we will move on to study the distances between various regions of antibody molecules.

We would like to thank the College of the Holy Cross Chemistry Department and the Richard B. Fisher Summer Research Grant for financial support.

Poster 32

The Detection of Moving Objects by Moving Observers

Edwin Marte and Professor Constance S. Royden
Department of Computer Science, College of the Holy Cross

To successfully move about the world, a person must detect moving objects in order to avoid them. In this study, we examined the effects of eccentricity and speed on moving object detection by a moving observer. Professor Royden developed a computational model that determines the direction of observer motion toward a stationary scene. The model is currently being extended to detect moving objects in the scene. To aid this model, psychophysical experiments were conducted to better understand how the human visual system detects moving objects. Observers viewed a radial flow field consistent with forward observer motion. In half of the trials, a target circle moved at an angular deviation from the rest. Observers were asked to determine whether this target circle was present. We previously found that the threshold for detecting a moving object depended on its eccentricity, or distance from the center of the radial pattern. However, we could not rule out image speed as a primary factor affecting thresholds. A large screen display was used in order to test whether the ability to detect a moving object varies with respect to its distance from the FOE at a larger range of speeds. We measured the thresholds for responses of target positions at 2.5, 5.0, and 10.0 deg from the FOE, and simulated observer speeds of 100, 200, 300 and 400 cm/sec.

Our results showed the thresholds for detecting the object decreasing with increasing speed and increasing eccentricity, which suggests that image speed may account for the change in thresholds, but it is possible that both speed and eccentricity play a role in the limits an observer, has on determining the presence of a moving object.

Supported by NSF grant #0343825

Poster 33

Study of Individual Differences in Mice

A. Delacruz, M. Gagne, K. Levesque, M. Manco, L. Nutile
Faculty Sponsor: Dr. Charles Locurto
Department of Psychology, College of the Holy Cross

Past research has provided reason to believe that humans share a common or general intelligence (g) that enables us to be successful at many different types of tasks. Very few researchers have asked the question of whether or not animals also possess a general intelligence factor. To determine if g exists for a nonhuman species we focused on studying individual differences in mice. Mice were run through a battery of cognitive tasks in order to see if a mouse that performed well on one task was also very successful at another task and visa versa. The tasks included elevated plus maze, open field, light/ dark, detour, four-arm, water escape, olfactory, and fear conditioning tests.

We thank the National Science Foundation for support.

Poster 34

Expression of a Single-chain Variable Fragment for Antibody Conformational Studies

Rory Ogden and Catherine Southern
Department of Chemistry, College of the Holy Cross

Every protein is individualistic, so finding an expression protocol that gives the optimized results requires experimenting with many parameters. We worked with a single-chain variable fragment (scFv) of the antibody 93F3. The unique features of this antibody fragment that assist in the process of expression in *E. coli* include a lacZ promoter, an OmpA leader for the light chain and a PelB leader for the heavy chain, and an amber stop codon. The nature of the 93F3 scFv makes it difficult to follow a standard protocol for protein expression in *E. coli* (strain: TOP 10F'). Therefore, we varied parameters such as time after induction, IPTG concentration, and temperature, all of which could affect the yield of soluble protein.

We observed no major impact on the expression of the 93F3 scFv in TOP 10F' *E. coli* as a result of varying these parameters; in addition, the level of protein expression was very poor. Therefore, we decided to express the 93F3 scFv in other strains of *E. coli*. We transformed the antibody fragment into BL21(DE3) competent cells, Rosetta-DE3-plyss cells, and BL21 codon plus DE3 RIPL competent cells. Only the Rosetta-DE3-plyss strain produced a measurable level of protein expression. This *E. coli* strain includes codons commonly found in human proteins, suggesting that a deficiency in these codons was the reason for poor protein production in the TOP 10F' cell line. The results obtained indicate that, upon optimization of the conditions for protein expression in the Rosetta strain, soluble 93F3 scFv will be obtained.

We thank the Camille and Henry Dreyfus Foundation and the College of the Holy Cross Chemistry Department for financial support

Poster 35

Synthesis and Characterization of Ferrocene Based Compounds

B. Franklin and R. Herrick
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Ferrocene is a well known compound that has been cited in many text books, journals and classrooms. It has been proven that attaching certain ligands to each ring provides interesting interactions. Using 1,1'-Ferrocene Dicarboxylic Acid, we attached cyclic and non-cyclic ligands to both rings and examined their specific interactions. Different methods of synthesis have produced varied results. Various tests show that the strength of the ligand to act as a nucleophile is correlated with the appropriate method of synthesis.

The poor nucleophilic ligands used were the cyclic compounds of pyrazole and 3,5-dimethyl pyrazole. Starting with the 1,1'-Ferrocene Dicarboxylic Acid we synthesized the acid chloride using thionyl chloride. This was followed by a room temperature stir with either pyrazole based ligand and triethylamine. Purification was attained through column chromatography. Numerous attempts to bind the pyrazole imine to metals failed. These trails led to the replacement of pyrazole with an amine. We also used the strong basicity of the amino group of various methyl ester protected amino acids. The later proved to be a more efficient synthesis. A simple stir of the di-acid, ligand, triethylamine and TBTU coupling agent carried out at room temperature yielded our product. The stir was followed by basic, acidic and water washes for purification. All products have given satisfactory results through NMR, IR and melting point tests.

Crystals have been attained for the Bis-Pyrazole compound. It shows hydrogen bonding among other interesting facts. Future crystallization tests of different compounds hope to reveal new and interesting facts. Further syntheses using these compounds as starting materials will be tested to examine other interactions.

This research was supported by a grant from Pfizer.

Poster 36

The Identification of a Moving Object by a Moving Observer

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Department of Computer Science, College of the Holy Cross

A person moving through the world must be able to detect and identify moving objects to avoid collisions. Previous studies dealt with simple detection of moving objects, rather than identification. In this study, we examined the problem of moving object identification by a moving observer. To accomplish this we conducted psychophysical experiments. Observers viewed a radial flow field, which is consistent with observer motion. In all the trials a target circle moved at an angular deviation from the rest of the circles in the field. Observers were then asked to use the mouse cursor and select the circle that they believed moved differently from the pattern. The angles of deviation tested were 8, 10, 15, 20, 25, 30, 35, and 40 degrees. Simulation lasted for durations of .25, .5, .75, or 1 sec. and contained 4, 9, 16, or 25 circles. The observers performed 16 blocks of trials, which were unique in trial duration and number or circles. Each block tested 8 conditions with a specific angle and ran each condition 10 times.

The results show that as the duration of each trial increased the thresholds of the observers tended to decrease. Observers had about the same accuracy when they viewed 9, 16, or 25 circles. However, observer accuracy was extremely low when they only viewed 4 circles. The results were very similar to those for simple object detection. Though these trends and numbers do not perfectly match, they are close enough to suggest that if an observer is able to detect motion, then they are also able to identify it.

Supported by NSF grant #0343825.

Poster 37

TASK-3 Expression in *Xenopus tropicalis* Eye

Marianne DiNapoli, Betsy Mills, and Dr. Cara Constance
Department of Biology, College of the Holy Cross

Circadian rhythms are endogenous timers that regulate biological activities in 24 hour intervals, including behavioral, physiological, and cellular processes. Circadian clocks are composed of three parts: the input which includes environmental detectors within cells, the rhythmic gene expression of the central oscillator, and the generation of rhythmic physiological and behavioral responses that comprise the output. Because the rhythmic gene expression occurs in the nucleus, circadian information must somehow leave the nucleus and signal information to other cells. It is known that potassium channels, which control ion flux through the membrane, are involved in rhythmic membrane conductance. The potassium leak channel TASK-3 is a good candidate for playing a central role in maintaining this rhythmicity because it is expressed in clock cells in mice, and it is voltage- and time- independent. We therefore investigated the possible role of TASK-3 in the clock photoreceptor neurons of the *Xenopus tropicalis* eye. We first determined from real time PCR experiments that TASK-3 is expressed in the *X. tropicalis* eye, and RT-PCR confirmed that it is localized to both the retina and the retinal pigment epithelium. We synthesized DIG-labeled RNA probes for TASK-3 and two genes that are expressed in the photoreceptor layer, the clock gene *period 1* and photopigment rhodopsin. We utilized *in situ* hybridization on cross-sections of *X. tropicalis* eye to localize *period 1*, rhodopsin, and TASK-3 expression, and our results confirmed that both rhodopsin and *period 1* were expressed in the photoreceptor layer. TASK-3 was expressed in all retinal cell layers, including the photoreceptors. This result suggests that TASK-3 may be important for normal retinal physiology.

We thank the Fight for Sight Foundation, the Fisher Foundation and the Holy Cross Biology Department for financial support.

Poster 38

Laser Modulation

Galo Lopez 07 and Prof. Timothy Roach
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In a Magneto Optical Trap (MOT) experiment we can cool down a cloud of atoms and confine them in a magnetic chamber. In order to cool down the atoms of an element such as Rubidium (Rb), one needs to make a laser that can emit light of the same energy as the electron energy level of the atom. Rb has two such energies so we need two laser frequencies. We produce these by microwave modulation of a single-frequency diode laser. Our main goal this summer was to see the effects on the frequencies of different variables in a 780 nm laser. Changing these variables such as the current and cavity length allowed us to discover a specific range where the laser was more stable and better suited to continue further experiments in the MOT.

Poster 39

Continuous Estrogen Exposure in Ovariectomized Mice Has No Effect in Three Tests of Anxiety-related Behavior

D. Amante, L. Russell, T. Mahowald, and D. Bitran
Department of Psychology, College of the Holy Cross

The discovery of two estrogen receptor (ER) subtypes, ERα and ERβ, has lead to a renewed interest in the role of estrogen on a number of behaviors, including those related to anxiety. Although estradiol (E_2) administration has been reported to have equivocal effects, recent studies have found that ERβ activation elicits an anxiolytic response in animal tests of anxiety. The present study examined the effects of E_2 in three different animal models of anxiety, thus serving as a preliminary investigation into the relative roles of the ER subtypes. Adult mice were ovariectomized and received capsules of placebo or E_2, that released E_2 at a rate of 8 μg day^{-1} over a 90-day period. Behavioral tests were conducted beginning two weeks after implantation, using the elevated plus-maze, the light-dark (L/D) transition, and the novel open-field for thigmotaxis. All tests involved the passive avoidance of an aversive stimulus: the open arms of the plus-maze, the light portion of the L/D test, and the central compartment of the open field. We found that E_2 had no effect on any measure of anxiety or general activity levels in any of these tests. It is possible that combined stimulation of ERα and ERβ with E_2 prevents the anxiolytic effect of ERβ stimulation that has been previously reported. This suggests that ERα stimulation may be anxiogenic, or that ERα activation prevents ERβ-induced effects. Future experiments are planned in which the effects of propylpyrazoletriol (PPT), a selective ERα ligand, will be compared to the effects of diarylpropionitrile (DPN), an ERβ-selective ligand, allowing us to distinguish the role of each receptor type on anxiety and activity levels.

We would like to thank Holy Cross for funding our research.

Poster 40

Locomotor rhythms of *Xenopus tropicalis* throughout development

Betsy Mills and Dr. Cara Constance
Department of Biology, College of the Holy Cross

Organisms have adapted to the daily environmental changes in temperature and light by regulating their internal biological processes such as cellular/molecular regulation of gene expression, physiological hormonal rhythms, and behavioral locomotor rhythms to correspond with these external rhythms. Circadian rhythms are generated by an endogenous 24 hour clock that can be entrained to environmental stimuli. Our goal was to characterize the behavioral locomotor rhythmicity of the frog, *Xenopus tropicalis*, through the different developmental stages of its life cycle, including tadpole stages, metamorphosis, and adult. Following entrainment in a 12 hr light:12 hr dark cycle (LD) prior to experimentation, an optical imaging system was used to monitor the swimming behavior of *X. tropicalis* while housed for 3-5 days in a humidified incubator at a constant temperature (25°C). 6 to 23 day old tadpoles have been tested in LD and in constant darkness (DD) using the visually undetectable wavelengths of light, 680nm and 770nm. Activity was monitored with and without the presence of food in the assay chamber. Tadpoles from 6-13 days old exhibit no discernable rhythms in any conditions. Tadpoles from 14-21 days old have peak activity at mid-day when monitored in LD, but continuous activity in DD. Metamorphosizing frogs in DD in 770nm light also exhibit continuous activity, however preliminary data suggests that juvenile frogs are rhythmic with peak activity at mid-day. We hypothesize that the continuous activity of filter-feeding *X. tropicalis* tadpoles is necessary to obtain adequate nutrition for metamorphosis to take place, while adult frogs are most active during times of day when their sources of prey are most accessible.

We would like to thank the Fight for Sight Foundation, the Fisher Foundation and the Holy Cross Biology Department for financial support.

Poster 41

Expression of a Single-chain Variable Fragment for Antibody Conformational Studies

L. Coletta and C. Southern
Department of Chemistry, College of the Holy Cross

Antibodies are the molecules responsible for eliciting the immune response in an organism which has been affected by some type of antigen, or foreign body. The antibody structure consists of two identical heavy and light chains, each with variable and constant regions. We have worked toward the generation of bivalent single-chain variable fragments, $(scFv)_2$, in order to study the preferential conformations of this antibody fragment using Förster Resonance Energy Transfer (FRET) at the single molecule level. In a single-chain variable fragment (scFv), the heavy and light variable fragments are linked by a flexible polypeptide chain. A bivalent scFv is created by joining two such scFvs with an additional polypeptide chain.

As a first step towards an $(scFv)_2$, we have used the polymerase chain reaction (PCR) to generate an scFv by joining the variable fragments of the antibody 93F3. We introduced a mutation into this scFv. This mutation is necessary in order to perform FRET experiments on the $(scFv)_2$, as it introduces a reactive cysteine residue that will allow the antibody fragment to be labeled with a dye molecule.

We would like to thank the College of the Holy Cross Chemistry Department and the Richard B. Fisher Summer Research Grant for financial support.

Poster 42

Studies of Electric and Magnetic Fields Required to Create Coherent Elliptical State Atoms

Robert Molt, and Professor Paul Oxley
Department of Physics, College of the Holy Cross

Highly excited coherent elliptical state (CES) lithium atoms have an atomic electron trajectory which can be controlled by external electric and magnetic fields. Studies of collisions between CES atoms and ions promise to provide insight into collision process that occur in plasmas. To create these atoms we require highly uniform electric and magnetic fields. We have made a theoretical study of an apparatus to generate a uniform electric field and made an experimental investigation of the properties of several candidate magnetic materials.

We studied the electric field uniformity of a series of parallel plates with holes in the center of each through which lithium atoms can pass. For each plate, we varied physical parameters such as size, separation distance, and voltage in order to obtain the largest region of field homogeneity. By using a fine copper mesh over the plate holes, and after optimization, we have surpassed our original design goal. Our fully optimized system shows an electric field uniformity of 0.1% over a diameter of 6.9mm. We also analyzed the effect on the electric field uniformity of small errors in construction.

We have measured the coercivity, hysteresis loss, and magnetic permeability of 416 and 410 stainless steels, and cold drawn mild steel in order to determine which material is most appropriate for our application. To do this, two coils (a primary and secondary) of copper wire were wound on a piece of each of the types of steel. The emf induced in the secondary coil when an AC current was passed through the primary coil allowed us to determine the permeability, hysteresis loss, and coercivity for each steel type. For each of these 3 parameters we found that 410 stainless steel outperformed both 416 stainless steel and cold drawn mild steel.

We wish to thank the Research Corporation and Holy Cross College for financial support.

Poster 43

Apparatus For Laser Excitation of Lithium Atoms

James Daly, Suzy Flaherty, and Professor Paul Oxley
Department of Physics, College of the Holy Cross

We have constructed and tested a vacuum system and a first prototype of a lithium oven. Lithium atoms from this oven will be excited to a high principal quantum number by a combination of three lasers. We have also built and tested the hardware needed to operate the first of these lasers. In the future we will study charge transfer (CT) collisions between excited lithium atoms and ions. Understanding CT collisions is important for determining the physical properties of fusion, astrophysical, and other types of plasmas.

Our vacuum system is assembled from standard conflat vacuum parts and from parts which we have designed and were built at Holy Cross. The vacuum environment is maintained by a diffusion pump which is simple to use, can reach very low pressures, and is inexpensive. When used in conjunction with a cold water trap our vacuum system remains relatively uncontaminated by oil used in the diffusion pump.

Our prototype lithium oven consists of a small steel tube filled with lithium and mounted inside our vacuum system. The oven is heated by high temperature cartridge heaters and must reach 500°C for a sufficiently intense stream of lithium vapor to be emitted from the tube. In our tests a maximum oven temperature of 450°C was reached before the heaters burnt out. We have recently created a new oven design using a tape heater and heat shield which will be tested in the near future.

The laser used in the first excitation step of lithium is a diode laser operating at 671nm. We have assembled the mechanical structure used to mount the diode laser and collimate its light output. Commercial electronics control the laser diode current and its temperature. Initial tests of the properties of the laser have been made.

We wish to thank the Research Corporation and Holy Cross College for financial support.

Poster 44

Evidence for Induction of Ferric Reductase and Other Proteins Involved in Dissimilatory Fe (III) Reduction in *Campylobacter Fetus*

Joseph Cummings, Dr. Madeline Vargas
College of the Holy Cross, Biology Department.

Campylobacter are all rod-shaped, gram negative bacteria that prefer microaerophilic environments. *Campylobacter fetus* is a bovine pathogen that lives in the host intestines and can cause diarrhea and other intestinal problems. Our previous studies have indicated that *C. fetus* is capable of using Fe (III) as the terminal electron acceptor in the electron transport chain as indicated by enzyme assays that monitor Fe (II) production. This enzyme, ferric reductase (FR), uses hydrogen gas as the preferred electron donor with specific activity, 146.81 mUnits/mg, an order of magnitude greater than activity with NADPH or NADH, 11.39 and 2.75 mUnits/mg respectively. New data indicates that specific activity of FR is induced depending upon the concentration of Fe (III) present in the media. Media rich with Fe (III) has greater FR specific activity than media with lower concentrations and this activity decreases further with the addition of an iron chelator, 146.81, 124.42, and 88.75 mUnits/mg respectively.

Due to the difference in activity, equal amounts of cell free extracts were separated via SDS-PAGE. Potential FR proteins were identified by band intensity. Some bands were darker in the samples grown on higher iron concentrations than the corresponding bands from samples grown on lower iron concentrations, and represent the candidate proteins for FR and electron transport proteins. These candidate proteins will be sent out for amino acid sequencing. Once known, the gene can be identified for targeted mutagenesis.

The energy flow in dissimilatory Fe (III) reduction was dissected through the used of respiratory chain inhibitors. Of the 5 inhibitors tested, cyanide, azide, PCMB, quinacrine, and rotenone, only the latter two inhibited the FR specific activity. This result shows that flavin proteins such as ferrodoxin and NADH dehydrogenase are involved in electron transport during hydrogen dependent Fe (III) respiration. However, ATPase and cytochrome A do not appear to be involved in hydrogen dependent Fe (III) respiration.

A special thanks to the Holy Cross Summer Research Program for providing our lab with funding and the opportunity to do this study.

Poster 45

Exploring the Structural Role of Syndecans in Cellular Attachments and Signaling

M. Frigault and R. Bellin
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Using syndecan-ectodomain specific antibody coated PDMS (polydimethylsiloxane) membranes, cell stretching and a Western blotting-bassed MAP kinase assay, we have previously shown that syndecans are involved in mechanotransduction, the process by which cells convert mechanical stimuli into a biochemical signal. Syndecans are transmembrane proteins that span the cellular membrane, enabling them to act as a conduit for cellular signaling. They are classified as heparan sulfate proteoglycans, and each includes a cytoplasmic domain that attaches to the cytoskeleton. Syndecans are also involved in the formation of cellular attachments through the formation of focal adhesions, intracellular structures that act as anchors to the extracellular matrix, facilitating the signaling pathway.

Having shown that syndecan specific cell stretching activates the MAPK pathway, our research has sought to study the structural wiring behind the signal process. Using laser scanning confocal microscopy, a protocol was devised to triple label syndecans, the focal adhesion protein vinculin, and the actin cytoskeleton. Initial experiments were successful in individually labeling all three structures of interest; however refinement of the fixation procedure is necessary for a successful triple labeling. This labeling protocol will be used to compare the structure of normal cellular attachments to syndecan-specific attachments. These experiments should help us understand the physical mechanism behind the observed signal transduction response to cell stretching.

This research supported by the Holy Cross Biology Department and the Fortin Charitable Trust.

Poster 46

Translational Research of Sarcoma and Melanoma

Dr. D. Slamon, Dr. W. Tap, M. Eckardt, J. Needle, A. Desai, K. Clarke
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Although advances in conventional cancer treatments have resulted in small incremental survival benefits for most common tumors, cancer researchers have long believed that the future of treatment rests in targeted therapies—"smart" drugs that, unlike the non-discriminating chemotherapy approach, take aim at the proteins, enzymes and pathways unique to cancer. At UCLA, under the management of Dr. Dennis Slamon, M.D., the lead investigational researcher that led to the use of Herceptin for breast cancer, and Dr. William Tap, M.D., we have been testing new forms of targeted chemotherapy against a range of different cancers. Drug Companies such as Bayer, Onyx, Astra Zeneca and Bristol-Myers Squibb have given us their newest drugs to perform phase I/II trials on many different types of cancer – from colon cancer, pancreatic cancer, and breast cancer all the way to sarcomas, melanomas, and many others.

The tests that we performed included dose response curves where we took different concentrations of the drug and drugged a known amount of cells and counted the cells remaining in the end to create an Ic50 for that drug that can then be used in lycates for when we ran our Western Blots. In addition to running Western Blots and dose response curves, we also ran Flow experiments where we did Cell Cycle Analysis and Apoptosis experiments. Once enough of our data was compiled, we moved the drug to be tested on rats for in vivo experiments, and then finally into clinical trials. Of course, this process from starting with the in vivo experiments takes years, so this presentation will mainly be centered along the primary lab tests.

We thank the drug companies, private donors, and UCLA for their financial support.

Poster 47

A Modular Approach to Mimicking Enzyme Active Sites

Mark Andrews and Professor J. Farrell
Department of Chemistry, College of the Holy Cross

A small molecule approach to investigating the activity of the active sites of enzymes is a useful tool in determining both the mechanism of catalysis, as well as the evolutionary origins of the enzyme's physical structure. We are looking specifically at the metallo-enzyme, protochatechuate 3,4 dioxygenase (PCD) which is responsible for bioremediation and carbon cycling in the environment. By using the Mannich condensation, we were able to prepare a variety of amino-alcohol ligands, each with different steric and electronic properties which will serve as amino acid analogs. These ligands were then bound to iron in a manner which resembles the actual active site of PCD.

We have solved three single X-ray diffraction crystal structures for iron compounds bound to these new ligands. In the future, we hope to continue to boost our synthetic approach to the ligands by increasing both variety and yield. We also hope to test these ligands for catalytic activity using methods such as UV-Vis and GC-MS.

We thank the College of the Holy Cross for financial support.

Poster 48

3-D Bone Scans and Paleontological Field Work

Scott Neabore and Ivan Vrcek
Department of Biology, College of the Holy Cross

By using a *Dr. Picza* 3-D scanner as well as a sophisticated software package called *Rapidform* we were able to scan the vertebral column and associated ribs from an alligator. The scanner has the ability to capture precise details of the bones including small grooves for muscle attachments and tiny nerve canals. The scanner scans the surface of the bone then rotates it 72°. This happens 5 times to create a 360° composite of the particular bone. These five scans must then be cleaned of any noise generated in the scanning process so that they can be merged together. For a complex bone such as a vertebra multiple scans are required. The finished product is a highly detailed 3-D representation of the original specimen. The software can be used for making very accurate measurements of the bones or comparing the differences between two different specimens.

The second half of our summer research consisted of doing fieldwork in Utah. We spent two weeks at the University of Utah Museum of Natural History working in the prep lab preparing fossil specimens. We also spent time in the collections department becoming more familiar with the morphology of the bones we would be collecting in the field. We then spent four weeks doing fieldwork in the cretaceous rock layers at Grand Staircase Escalante National Monument in southern Utah. Fieldwork included prospecting for new quarry sites, working in quarries uncovering bones, jacketing them, and removing them. Dinosaurs that we worked on included: Utah Ceratops, Tyrannosaurs, Parasarolophus, and Hadrosaur. We were able to gain an appreciation of the entire process associated with finding, collecting, preparing, and describing fossils.

Lab work funding was provided by the Holy Cross Biology Department. Our fieldwork was done through grants awarded to the University of Utah.

Poster 49

Effects of ouabain on connexin 43 levels in MDCK cells

Chrissy Fanning and Dr. Mary Lee Ledbetter
Department of Biology, College of the Holy Cross

Gap junctions are channels constructed of connexin proteins that allow inorganic ions and small water soluble molecules to pass directly from the cytoplasm of one cell to the cytoplasm of another. Most cells in animal tissue are in communication with their neighbors via gap junctions. The cardiac glycoside ouabain can inhibit the sodium-potassium pump of these cells, disrupting their ion gradients. This leads to decreased junction-mediated cell communication, but we do not understand how.

We measured distribution of connexin 43, the likely channel protein for that communication, without which communication could not take place. We used immunofluorescence to observe the distribution of connexin 43 in cultured Madin-Darby canine kidney (MDCK) cells. We perfected an immunofluorescence procedure to see the distribution of connexin among cells treated in various ways. We saw bright lines of connexin staining at borders of untreated cells, but little to no connexin staining was observed in cells treated with ouabain. The loss of connexin staining is reversible over time, however, if the ouabain is washed away. When the mineralocorticoid hormone aldosterone, which acts on kidneys to conserve sodium ions, is added simultaneously with ouabain, inhibition of communication is prevented and connexin staining is observed. These data further confirm that ouabain diminishes cell to cell communication by disrupting ion homeostasis, but when ion homeostasis is protected, ouabain has no inhibitory effect. Cells that were also treated with spironolactone or eplerenone, aldosterone receptor (AR) antagonists, did not show connexin staining. That suggests the mechanism of inhibition involves the AR, but it needs to be further investigated.

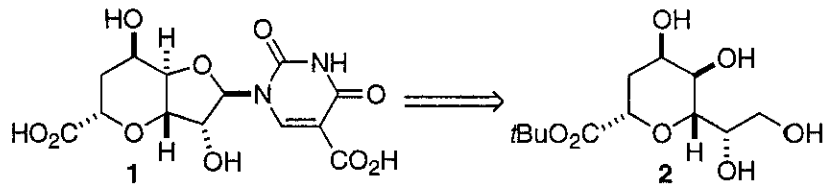
I thank the National Science Foundation and the Fisher Research Fund for support of this project.

Poster 50

Synthetic Studies on the Higher Monosaccharide Octosyl Acid A

Neal A. Biddick and Kevin J. Quinn
Department of Chemistry, College of the Holy Cross

Octosyl acid A (**1**) is a member of a class of natural products isolated from bacterial strains commonly referred to as higher monosaccharides. Members of this class of compounds display antitumor, antifungal, antiviral, and antibiotic activity. The interesting biology, structural complexity, and natural scarcity of octosyl acid A make it an ideal target for total synthesis.



We will describe the synthesis of tetraol **2**, which contains all of the necessary functionality for conversion to octosyl acid. Construction of the pyran ring of **2** was achieved by a novel [2,3]-sigmatropic rearrangemnt of a vinyl epoxide. Other key steps in the synthesis include Sharpless asymmetric epoxidation and double Sharpless asymmetric dihydroxylation. Completion of the synthesis of **1** requires selective oxidation of the lone primary hydroxyl of **2** and incorporation of the nucleoside base.

We thank the CBIA/Pfizer Fellowship Program for financial support.

Poster 51

Three Dimensional Scanning of Vertebrate Skeletal Material and Paleontological Fieldwork

Ivan Vrcek and Scott Neabore
Department of Biology, College of the Holy Cross

Our project consisted of two phases, three-dimensional scanning of living and fossil archosaurs, and paleontological fieldwork to locate and excavate fossil archosaurs of Late Cretaceous age (74mya). Three-dimensional scanning was accomplished by the use of a Roland laser scanner with Dr. Picza and Rapidform 2006 software suites. The scanner has 0.1milimeter resolution in x, y, and z directions, allowing the visualization of minuscule features such as sites of muscle attachment. Typically, several rounds of scanning are necessary to compose a complete digital image of the specimen. In addition, substantial cleaning and editing of the raw scan data is necessary to produce a useable image. We succeeded in scanning a large amount of an alligator axial skeleton as well as several avian bones. Future work will include the scanning of an ornithomimid dinosaur manus retrieved from Utah.

The second phase of our project was fieldwork at Grand Staircase-Escalante National Monument in Southern Utah. Fieldwork composed of prospecting for sites containing dinosaur bone material as well as quarrying and excavating specimens. Our field team including employees of the Utah Museum of Natural History discovered two sites of particular importance: Utahceratops Gettyae as well as what may be a completely new genus of ceratopsian dinosaur. Finally, we were loaned an Ornithomimid manus, the hand of a carnivorous ostrich-like theropod dinosaur, which we will prepare, scan with a Roland 3D laser scanner, describe, and publish during the coming academic year.

We would like to thank Dr. Scott Sampson, Michael Getty, and Mark Loewen from UNMH as well as Drs. Scott Edwards and James Hanken for loaning bird and alligator specimens from the Harvard Museum of Comparative Zoology.

Poster 52

Gap Junctional Communication in M1 Mouse Kidney Cell

Lindsey Konkel and Dr. Mary Lee Ledbetter
Department of Biology, College of the Holy Cross

Several types of mammalian cultured cells exhibit cell to cell communication through gap junctions, which are primarily composed of connexin proteins. However, previous dye transfer analyses conducted in the Ledbetter lab showed that M1 mouse kidney cells were not communicating through gap junctions. It was my goal to establish an electroporation procedure to deliver the gene encoding Connexin 43 across the cell membranes of the M1 cells to see if these cells would then incorporate Connexin 43 into their cell membranes and establish communication with each other through gap junctions. However, using dye transfer and immunofluorescence techniques, which were perfected on Madin Darby Canine Kidney (MDCK) cells in the Ledbetter lab this summer (see poster by Christine Fanning), we were able to see communication between the M1 cells that had reached a high level of confluency, in contrast to the previous observations. It then became my primary objective to try to understand if communication between these cells was density dependent, so I set up a series of experiments, performing dye transfer and immunofluorescence analysis on M1 cells at 25, 50, and 80 percent confluency; they appeared to be actively communicating and expressing Connexin 43 at all cell densities. Future studies on M1 cells will test whether they respond like MDCK cells to treatment with ouabain and/or aldosterone.

I thank the National Science Foundation and the Holy Cross Summer Research Program for support of this project.

Poster 53

Creating Confidence in Xenon Polarization Data

D. Muth and S.Ketel
Nuclear Physics Group, University of New Hampshire

The UNH Nuclear Physics Group and XeMed, LLC work to investigate the properties and utility of hyperpolarized xenon, particularly as a contrast agent in magnetic resonance imaging. Using lasers, our technology is able to achieve alignments of xenon nuclei nearly one hundred thousand times greater than proton alignments achieved in MRI magnets.

The goal of my research was to develop a systematic way to gage the accuracy of the Xenon polarization data created and to ensure that a superior standard was being achieved. The process involves the use of a LabVIEW program based on the facts that polarization of protons in water is known and polarization of Xe or He is unknown. Thus one can measure the magnetic field from both and compare to find the unknown polarization. We had seen unexplained variations in measurements using other NMR equipment so we created a new compact, single board polarization measurement circuit. We measured polarization under varied conditions such as with two different coils from protons at two different frequencies and achieved a satisfactory production level with extreme consistency.

After significant use of the programs created to acquire and analyze the signal data, I worked with the software engineer to identify and correct problems as well as develop a user's manual. The software is a set of VIs created with LabVIEW, each integrated with one another to provide the user with a myriad of options for receiving data and best utilizing it after acquisition. This manual is designed for a potential costumer in the medical profession. Xemed hopes to maintain this software as the single required interface for complete use of the Polarizer from start to finish. It is our goal to make all aspects of the Polarization process as simple, easy and accurate as possible.

We thank the National Institute of Health for their financial support.

Poster 54

Wind Effects in the Physics of Baseball

P. Brennan, M. Knierim, M. Koss, E. Naco, T. Roach and D. Wirth
Department of Physics, College of the Holy Cross

Current models for the trajectory of a baseball in flight include gravity, velocity, lift force, drag force, angle and wind. While these models seem quite accurate in terms of the conditions they describe, they are unrealistic. Their wind scenarios show wind blowing at the same speed at all points and heights. In a real world setting, we know this is not true. Therefore, we are creating new, more realistic wind models for baseball trajectory, using the famous Ted Williams "Red Seat" home run as a base. Our new models include plausible measurements of the initial conditions of the home run, both for the stadium in 1945 (when the home run was hit) and what the conditions would have to be in 2006 for the newly renovated Fenway Park. Furthermore, the models can now be altered to fit any stadium height and initial wind velocity.

We thank R. Miller and the Fisher Fellowship Foundation for their support in this project.

Poster 55

Worcester's Water: An Investigation of Coliform Content and Trihalomethane Formation in our Public Water Supply

M. McNamara, Dr. J.M. Van Doren, College of the Holy Cross,
J. Bonofiglio, Worcester Water Department
Department of Chemistry, College of the Holy Cross

My summer research involved two separate projects, both concerning Worcester's drinking water. The first project addressed the total coliform count in water; this count has displayed seasonal spikes in recent years. As an objective analyst, my goal was to determine the cause of these bacterial spikes using weekly chemical and physical water effluent data. Due to the locations and frequencies of these outbreaks, I determined it unlikely that their source was local. Rather, a combination of variables, most notably temperature and raw total coliform count, contributed to creating an environment favorable for bacterial growth throughout the water delivery system.

My second project focuses on trihalomethane formation in drinking water over time. Like most public water, Worcester's water is treated with chlorine. Residual chlorine and trace amounts of bromine react to form alkyl halides. It is hypothesized that an understanding of the kinetics of trihalomethanes' formation in water may enable its quantitation to be used as an indicator of stored water's age. This would be useful in future forensic analyses of water supply problems and in determining safe water storage times. The goal of my project is to investigate the kinetics of alkyl halide reactions in drinking water using GC-ECD analysis. Thus far, the method of extracting THMs from water has been optimized, efficient temperature ramping has been determined, and suitable calibration curves have been prepared.

I would like to thank the Fisher Fellowship Program and the Federal College Work-Study Program for their financial support.

Poster 56

Effects of Deviations in Baseballs Used

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The game of Baseball, America's pastime has been watched and passionately followed for over a century. Many amazing things have been seen from amazing pitchers to home-run record holders. No matter who it is, or what record is made, it all comes down to one thing, the ball. Balls vary from level to level. Variations are made for balls used in little leagues all the way up through balls used in College level baseball. The differences are small but the effects are surprising. The goal of my research is to demonstrate how tiny differences in seam heights affect distances traveled and the difference between an out and a home run, or a line drive and a bloop out.

I would Like to thank the Fisher Fellowship for its financial support, and Dick Miller for his support in construction

Poster 57

Synthetic Efforts Toward cis-Fused Bis(butyrolactone) Natural Products

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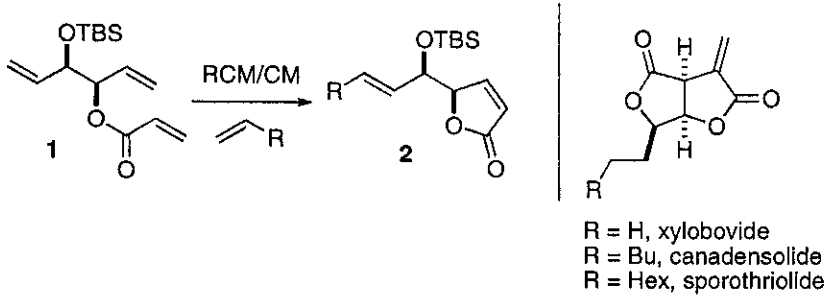
Xylobovide, canadensolide, and sporothriolide are members of a broad group of structurally related fungal metabolites with wide-ranging biological activities. We have developed a flexible strategy for the synthesis of butenolides 2 from triene 1 using a tandem ring-closing/cross metathesis reaction in which construction of a lactone ring and subsequent alkyl chain extension are achieved in a single pot. This tandem metathesis approach as well as efforts toward elaboration of butenolides 2 to xylobovide, canadensolide, and sporothriolide will be discussed.

We thank the American Chemical Society Petroleum Research Fund for financial support of this research.



Poster 58

Development of an Analytical Method for Jet Fuel Quality Analysis

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Departments of Chemistry& Mathematics and Computer Science
Dr. R. Morris and Dr. K. Johnson
Naval Research Lab

Fuel is one of the most important supplies for any military action. In order to check for degradation or contamination, each fuel must be fully characterized before it is used. When enemy fuel is recovered, it is necessary to identify which type of fuel it is. Current methods of fuel quality analysis in the field are slow and require large instruments that are not easily transported. Working together with the Naval Research Laboratory, we are trying to develop a single spectroscopic method that can characterize each fuel quickly and completely using only a small sample. Forty-six different fuel samples were examined using ATR-FTIR and FT-Raman spectroscopy. Studies were also performed to examine the influence resolution and signal averaging have on the accuracy of the fuel characterization. The corresponding data were analyzed by principal component analysis and partial least squares analysis.

Principal component analysis of FT-Raman and ATR-FTIR spectroscopic data can distinguish between fuel types. These data can also be used to accurately predict some critical properties of each fuel sample using partial least squares analysis of the spectroscopic data. However, other properties were not predicted well. Future work will focus on new strategies for property prediction and assessment of the applicability of our analytical method to a wider range of fuels.

We would like to thank the Fisher Fund and the Naval Research Lab for support.

Poster 59

Removing Arsenic from Contaminated Drinking Water Through Adsorption to Iron Hydroxide

Laura Rose Condon and Dr. Jane M. Van Doren
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Arsenic contaminated drinking water is moving to the forefront of environmental concerns nation wide and around the world. Contamination of groundwater occurs naturally through the decomposition of arsenic trapped bicarbonates and sulfides. Exposure to arsenic contaminated drinking water can lead to both acute and chronic effects, including many types of cancers.

Arsenic adsorption to iron hydroxide was studied as a possible remediation technique. Filters containing rusted iron nails and sand have been designed as an environmentally friendly and inexpensive way to remove arsenic from the drinking water. Two experiments were designed to study the adsorption process on a molecular level. The first experiment limits the amount of sites available for bonding by varying the amount of rust in each beaker. The second experiment limits the amount of arsenic molecules in solution available to bond to sites by varying the concentration of arsenic in each beaker. Arsenic III and arsenic V were separately tested for effective remediation. Our data suggests that both arsenic III and arsenic V follow the Langmuir model of adsorption, where only a monolayer is formed on the surface of the adsorbate. Arsenic III and arsenic V have very similar equilibrium constants and maximum amount of adsorption. Close inspection of the data suggests the mechanism may be different at very low concentrations. In future experiments, we will study the concentration dependence of the adsorption mechanism, and how arsenic III adsorption differs from arsenic V adsorption.

We thank the Fisher Grant for financial support.

Poster 60

Implicit Learning in New World Primates

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This experiment investigates the presence of implicit learning in Cotton-top tamarins (Saguinus Oedipus), a species of New World primate. Implicit learning occurs when a subject learns basic patterns or simple rules of grammar, after repeated exposure, without explicit knowledge of the new information. Previous studies have found that humans possess the ability to implicitly learn artificial grammar and patterns. By repeating a pattern and measuring the latency of the subjects' responses, where response latency decreases, it is concluded that the subjects learn the pattern, thus shortening response times. If no implicit learning took place, response times would remain roughly the same, meaning that the subject simply exhibited a basic operant response. After testing, the subjects in most cases are unaware that there is a pattern, despite their improved performance over time. This experiment was intended to find if New World primates have this learning ability as well. While humans can tell us what they have learned, this is not possible in non-humans, so the information must be acquired in a different way. To accomplish this, we first taught a Cotton-top tamarin how to interact with a touch screen computer. Through Pavlovian shaping, the subject learned to respond to a visual stimulus for a reward. Once the animal was habituated to the screen, the stimuli were presented in a five-cell repeating pattern. Rewards were given after the animal completed each full five stimuli pattern set. In the future, we plan to test a larger sample of subjects. This will include a comparison between the performance of young and old animals. We also hope to eventually test their ability to implicitly learn artificial grammar. Since humans have this capacity, it is believed that this is one of the precursors to human language. It would be an interesting finding if this ability is present in primates as well.

Support: NSF (grants BCS-0116089 and IBN-0344514 and the Fisher grant.

Poster 61

Tandem Reactions as a Strategy for Natural Product Synthesis

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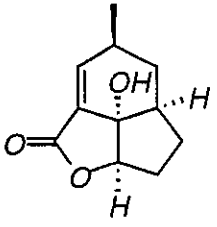
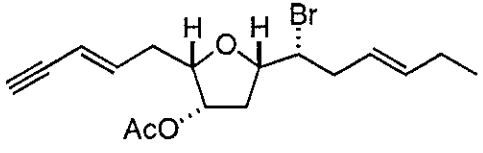
A tandem reaction is one in which several bonds are formed in sequence without isolating intermediates, changing reaction conditions, or adding reagents. Nature commonly makes use of such processes in biosynthesis, and applications of tandem reaction sequences in synthetic organic chemistry have become increasingly popular due to their efficiency and elegance. We are exploring the use of tandem reaction strategies in the syntheses of the natural products galiellalactone and kumausyne.



galiellalactone



kumausyne

In the case of the synthesis of kumausyne, we will discuss how olefin metathesis provides a versatile route to stereodefined dioxabicycles that contain the proper relative stereochemistry of our desired natural product. We will also outline our approach to the synthesis of galiellalactone using a tandem enyne metathesis/intramolecular Diels-Alder sequence.

We would like to thank the Fisher Fellowship Program and the Research Corporation for financial support of this research.

Poster 62

A Comparison of Pituitary Volume (PV) in Growth Hormone Deficient (GHD), Idiopathic Short Stature (ISS) and Control Subjects

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A retrospective study of MRI with contrast of the brain with particular attention to the pituitary gland was undertaken to determine and compare the pituitary size in patients diagnosed with Growth Hormone Deficiency (GHD) (GH< 10 ng/dL on stimulation), Idiopathic Short Stature (ISS) and normal controls.

Subjects were separated by diagnosis, sex and pubertal status. For this study, pre-pubertal females and males were defined as age $\leq$11 years and age $\leq$12 years, respectively. The mean age for GHD, ISS and controls were 11.9$\pm$2.0, 12.7$\pm$3.2 and 9.8$\pm$4.7 years respectively. The populations were composed of 12 females and 57 males for the GHD group, 9 females and 20 males for the ISS group, and 38 males and 28 females for controls in this study. Patients with major MRI abnormalities were eliminated from this study.

GHD subjects exhibit the smallest Pituitary Volume, while ISS subjects have intermediate volume; it is not surprising that GHD patients have diminished PV since they have diminished GH secretion on stimulation. Although ISS subjects were able to demonstrate normal acute GH secretory response, their smaller PVs and possibly diminished somatotropes may reflect diminished chronic GH secretion versus normals. The GHD patients did not show the expected PV increase during adolescence, whereas the other two groups had expected greater difference. This may represent diminished somatotrope reserve or diminished pubertal development versus control and ISS patients.

In conclusion, our study demonstrates significant deficiencies in PV among children with GHD and ISS versus control subjects. Pituitary volume may reflect integrated GH secretion over long periods of time suggesting that it may be a better reflection of growth capacity than provocative stimulation testing.

Poster 63

The Impact of Environmental Regulations on House Prices: An Examination of Wetlands Regulations

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Federal regulations are put in place to protect and preserve the country's wetlands. Previous literature has shown that wetlands regulations decrease the value of properties with wetlands since limits are placed on the development of these properties. This limited development provides benefits to neighboring properties, however, which may be reflected in higher values of properties contingent to wetlands. In order to understand the full impact of wetlands regulations on property values, this study examines both their effects on prices of properties with wetlands, as well as their effects on prices of properties with wetland neighbors.

This research was supported by a grant to Holy Cross from the May and Stanley Smith Charitable Trust and a College of the Holy Cross Research and Publication Grant.

Poster 64

Dancing Into March Madness: Is there a Major Conference Bias in the NCAA Men's Basketball Tournament?

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The National Collegiate Athletic Association (NCAA) Men's Basketball Tournament is one of the most popular and profitable sporting events of the year. Each year controversy surrounds the tournament in regards to the possibility of a major conference bias from the tournament selection committee. This study examines the debate using tournament data from 1986-2006. Results from two separate tests, one comparing seeding to margin of victory, and the other comparing seeding to win percentage, show that the committee does not systematically discriminate either for or against teams from smaller conferences.

This research was supported by a grant to Holy Cross from the May and Stanley Smith Charitable Trust.

Poster 65

Legalized Gambling: Does the Authorization of Casinos Affect Revenues from State Lotteries?

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Lotteries and casinos have become widespread in the United States over the past few decades. This study explores how casino gambling affects state lottery revenues. An easy rough estimate would compare state lottery revenues to the change in casino revenues. However, unlike state-run lotteries, many casinos are owned by Native American tribes and are not required to report their revenues. In order to get a proxy for the size of casino gambling in each state, we have begun compiling a master list of all casinos in the United States. This master list, when complete, will include the number of slot machines and opening date of each casino. In addition earlier literature has not adequately controlled for the effects on lottery revenues of casinos that open in a neighboring state. Within the United States it is very easy to cross state lines to gamble. In order to account for this, we compiled thirty years of data containing the population in each of the bordering counties of all 50 states. We will use this to control for the population of people coming into a state to gamble when a lottery or casino is introduced.

This research was supported by a grant to Holy Cross from the May and Stanley Smith Charitable Trust.

Poster 66

The Impact of Ticket Scalping On Performing Arts Markets

Professor Melissa Boyle, College of the Holy Cross
Professor Lesley Chiou, Occidental College
Steven Wych, Research Assistant, College of the Holy Cross

Intuition and traditional economics suggest that any transaction involving two voluntary parties is beneficial. However, theoretical economics suggests that the effect of ticket scalpers is unclear. Scalpers may benefit the market by reallocating tickets to consumers who value them the most, and by acting as insurance for producers who otherwise might not have been able to sell as many tickets. On the other hand, scalpers may harm the market by usurping profits that would have been reinvested in production had they gone to the producers. These opposing theories, as they relate to the performing arts, remain untested empirically. This research addresses this issue by examining the impact of state-level scalping laws on production and consumption in performing arts markets. Using regression analysis, variations in state laws are used to estimate the effect of such laws on consumption and production of plays, musicals, operas, and dance performances. Preliminary results indicate that while state scalping laws do not influence attendance in the performing arts, producers do generate more shows in states that prohibit scalping on the site of the event.

We thank the May and Stanley Smith Charitable Trust for financial support.

Poster 67

An Investigation of Excess Endowments at Private Liberal Arts Colleges

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Endowments are used to both finance current operations and to grow the college or university for the future. In addition to operating incentives to maintain or grow endowments, there are external pressures from sources such as the annual U.S. News and World Reports ranking of colleges and universities. A higher endowment per student results in a higher ranking. The internal and external pressures for endowment growth may result in excess endowments at the expense of benefits for students or capital expenditures. Recent research finds that excess endowments are associated with excessive managerial pay and reduced expenditures on the production of the good or service (Core et al. 2006). In addition, Ehrenberg and Smith (2003) find that richer colleges and universities, as measured by the endowment per student ratio, devote a larger share of alumni giving to further building of endowments versus current operations and capital expenditures.

We plan to apply the excess endowment model developed by Fisman and Hubbard (2002) and used by Core et al (2006) to private liberal arts colleges to investigate potential agency problems of excess endowments. This research may explain the behavior found by Ehrenberg and Smith (2003). It also may highlight some of the perverse effects of external pressures to build endowments created by college and university ranking systems. We will also investigate some potential mitigating factors present in private liberal arts colleges such as Boards of Trustees and any religious affiliations.

We thank the May and Stanley Smith Charitable Trust and the Charles and Rosanna Batchelor (Ford) Foundation for their support.

Poster 68

Effects of Group Homes on Property Values in Framingham, Mass.

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Framingham has many times more group homes than comparable towns and cities in the Commonwealth of Massachusetts and residents of this town have strongly voiced their opposition to the siting of group homes in their neighborhood fearing a drop in property values and lower quality of life. Past studies that have used homes up to two miles away from a group home have shown that there is no effect on property values. This study will use only homes that are a very short distance away from group homes and may show that there is indeed a decrease in property value or a significantly larger number of sales than would be expected in the sample size.

This research was supported by a grant to Holy Cross from the May and Stanley Smith Charitable Trust.

Poster 69

Exploring the Role of Syndecans in Neurofibromatosis Type 2

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Mutations in the NF2 tumor suppressor gene cause Neurofibromatosis Type 2 (NF2), a tumor disorder affecting the central nervous system. The product of the NF2 gene is merlin, a member of the ERM (ezrin, radaxin, moesin) subgroup of the 4.1 Band protein family, which is a collection of proteins that link cell membrane proteins so the cytoskeleton. Although it has been determined that merlin binds with several membrane associated proteins, exactly how the protein functions as a tumor suppressor is not well understood. We propose that syndecans, a family of transmembrane proteoglycans, may play an important role in the activity of merlin by holding it at the cell membrane.

This summer we designed two different co-immunoprecipitation experiments to test the *in vitro* as well as the *in vivo* interaction between merlin and syndecan-1. For the *in vitro* overlay experiment, I began a cloning project to produce fusion proteins containing the cytoplasmic domain of syndecan-1. For a few weeks, my progress was hindered by low yields of vector, which was most likely due to a bacteriophage contamination in the lab. However, I eventually prepped the vector successfully, and I will continue to work on this project throughout the school year.

The *in vivo* experiment involved transfecting COS-7 monkey kidney cells with both FLAG-tagged merlin and syndecan-1, applying the cell lysate supernatant to a FLAG-tag affinity column, and probing for the proteins in the column elutant by Western blotting. Unfortunately, I discovered that neither FLAG-merlin nor syndecan-1 was present in the supernatant applied to the column. In future experiments, I will try to adjust the lysis buffer conditions so that both proteins remain soluble in the lysate supernatant.

This research supported by the Holy Cross Biology Department and the Fortin Charitable Trust