

# WEST MICHIGAN REGIONAL UNDERGRADUATE SCIENCE RESEARCH CONFERENCE

## ABSTRACT BOOKLET

Saturday, November 16, 2013

*Organizing Institutions:*

*Aquinas College*

*Calvin College*

*Grand Valley State University*

*Hope College*

*Van Andel Institute Graduate School*



Van Andel Institute®

333 Bostwick Avenue, NE  
Grand Rapids, MI 49503  
[www.vai.org](http://www.vai.org)

**WEST MICHIGAN REGIONAL UNDERGRADUATE  
SCIENCE RESEARCH CONFERENCE**

Saturday, November 16, 2013

**SCHEDULE OF EVENTS**

- 8:30 ARRIVAL AND POSTER SETUP** *Cook-Hauenstein Hall*
- 9:00 WELCOME** *Tomatis Auditorium*  
Steve Triezenberg, Ph.D.  
President and Dean of Van Andel Institute Graduate School
- 9:15 KEYNOTE ADDRESS** *Tomatis Auditorium*  
Scott Barolo, Ph.D.  
Associate Professor of Cell & Development Biology  
Director, Cell and Development Biology Graduate Program  
Associate Director, Cellular and Molecular Biology Training Program  
University of Michigan Medical School  
*"Working out the logic of gene regulation: a collaboration with undergraduate and graduate researchers"*
- 10:00 POSTER SESSION I** *Cook-Hauenstein Hall*  
*Presenters at even-numbered posters*  
Refreshments served
- 11:15 FACULTY TALKS** *Tomatis Auditorium*  
Virginia McDonough, Ph.D.  
Associate Professor of Biology  
Hope College  
*"How do cells know what they eat? Molecular recognition of dietary lipids by cells"*  
  
Douglas A. Vander Griend, Ph.D.  
Professor of Chemistry  
Calvin College  
*"Equilibrium snapshots of supramolecular assembly"*
- 12:00 LUNCH** *Cook-Hauenstein Hall*
- 1:00 POSTER SESSION II** *Cook-Hauenstein Hall*  
*Presenters at odd-numbered posters*
- 2:15 FACULTY TALKS** *Tomatis Auditorium*  
Richard Vallery, Ph.D.  
Professor of Physics and Department of Physics Chair  
Grand Valley State University  
*"Probing matter with antimatter: Using positrons to study materials at the nanoscale"*  
  
Jeremy Van Raamsdonk, Ph.D.  
Assistant Professor and Head of the Laboratory of Aging and Neurodegenerative Disease  
Van Andel Research Institute  
*"Using small worms to answer big questions: insights from C. elegans on the aging process"*
- 3:00 CONCLUSION**

## RECRUITER INFORMATION

### **Aquinas College**

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The logo for Aquinas College features the words "AQUINAS" and "COLLEGE" stacked vertically in a serif font. The "A" in "AQUINAS" is stylized with a red underline that extends to the right.

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The logo for Ferris State University consists of a stylized graphic on the left, composed of a red and yellow shape resembling a flame or a 'V', followed by the words "FERRIS STATE UNIVERSITY" in a red serif font.

### **Grand Valley State University**

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The logo for Grand Valley State University features a blue circular emblem containing a stylized 'V' shape. Below the emblem, the words "GRAND VALLEY STATE UNIVERSITY" are written in a large, bold, serif font, with "www.gvsu.edu" in a smaller font underneath.

## RECRUITER INFORMATION

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## WEST MICHIGAN REGIONAL UNDERGRADUATE SCIENCE RESEARCH CONFERENCE

### Acknowledgements

Costs for the 2013 West Michigan Regional Undergraduate Science Research Conference are underwritten by the following organizing institutions: Aquinas College, Calvin College, Grand Valley State University, Hope College, and Van Andel Institute Graduate School.

The organizing committee for this conference includes:

Dr. Jennifer Hess, Aquinas College  
Dr. Keith Grasman, Calvin College  
Dr. Mark Staves, Grand Valley State University  
Dr. Greg Fraley, Hope College  
Dr. Nick Duesbery, Van Andel Research Institute  
Dr. Xiaohong Li, Van Andel Research Institute

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Catering services are being provided by Eurest Dining Services.

Facilities services are being provided by Van Andel Institute.

## Keynote Speaker

**Scott Barolo, Ph.D.**

**Associate Professor of Cell & Development Biology  
Director, Cell and Development Biology Graduate Program  
Associate Director, Cellular and Molecular Biology Training Program  
University of Michigan Medical School**

*“Working out the logic of gene regulation: a collaboration with undergraduate and graduate researchers”*

DNA sequences called **enhancers** control where, when, and how strongly genes are expressed. They may be located near the genes they regulate, or very far away—even on the far side of other genes. Enhancers contain binding sites for **transcription factors**—proteins that bind to specific DNA sequences and help to turn genes on or off.

Very basic questions about biological patterning information and enhancer logic remain unanswered. These gaps in our knowledge are best illustrated by the fact that “synthetic” versions of well-characterized enhancers (that is, combinations of the known transcription factor binding sites) nearly always fail to drive gene expression in animals. It seems that we still don’t understand how enhancers work, or how they evolve to produce new patterns. My lab is using transgenic, genetic, biochemical, evolutionary, and bioinformatics approaches to study these questions, and we're finding some pretty surprising answers.

## Abstracts of Faculty Research Talks

**Virginia McDonough, Ph.D., Associate Professor of Biology, Hope College**

*“How do cells know what they eat? Molecular recognition of dietary lipids by cells”*

Cells have exquisite molecular systems that respond to the presence or absence of nutrients available to them from the environment. In the case of fatty acids, cells can distinguish saturated from unsaturated, differing chain lengths, cis from trans double bonds, and even the position of the double bond in the fatty acyl chain. One can hypothesize that proteins could provide that level of identity through direct interaction with the fatty acid, or, that the cell can detect, in some manner, the physical changes the fed fatty acid species imparts to the membrane. In my lab, using molecular biological and biochemical methods in the model organism *Saccharomyces cerevisiae*, we are investigating how cells can “sense” the molecular species of fatty acid, and then transmit that information for gene expression changes.

**Douglas A. Vander Griend, Ph.D., Professor of Chemistry, Calvin College**

*“Equilibrium snapshots of supramolecular assembly”*

When in a 1:1 mole ratio, copper(I) cations assemble with a special *bis*-bidentate ligand, L, in dichloromethane to form a  $[\text{Cu}_4\text{L}_4]^{4+}$  supramolecular square. Spectrophotometric titration of ligand with the metal cation yields raw absorbance data that can be modelled in order to elucidate equilibrium snapshots of the entire assembly and disassembly process, including detailed thermodynamic information on the step-wise reactions. Not only will this talk feature the possibilities of controlling supramolecular architectures, but it will also show you how to learn more from spectroscopic data than you may have thought possible.

## Abstracts of Faculty Research Talks

**Richard Vallery, Ph.D., Professor of Physics and Department of Physics Chair, Grand Valley State University**

*“Probing matter with antimatter: Using positrons to study materials at the nanoscale”*

Novel materials enable advances in many high tech areas such as medicine, information technology, and energy storage. In many cases the macroscopic properties of these materials are determined by engineering the composition at the nanoscale. To understand fundamental makeup of the materials in turn, requires new probes to characterize the structure at these very small length scales. Positronium, the hydrogen-like bound state of an electron and a positron is a very sensitive probe of void structure of matter at scales down to 3 nm. Positronium Annihilation Lifetime Spectroscopy (PALS) is a unique metrology which studies the annihilation of positronium, whose mass is completely converted into energy as governed by Einstein’s famous equation  $E = mc^2$ , to characterize the pores/voids in materials.

**Jeremy Van Raamsdonk, Ph.D., Assistant Professor and Head of the Laboratory of Aging and Neurodegenerative Disease, Van Andel Research Institute**

*“Using small worms to answer big questions: insights from *C. elegans* on the aging process”*

Traditionally, aging was thought to result from a stochastic process of damage accumulation. However, it is now known that genes strongly influence longevity. This paradigm shift began in 1993 when the first lifespan-extending gene was discovered using a microscopic worm called *Caenorhabditis elegans*. This gene was called *daf-2* and it encodes the insulin-IGF-1 receptor, which is involved in a nutrient signaling pathway. Since that time, genes in this same nutrient signaling pathway were shown to increase lifespan in yeast, flies and mice. In addition, genetic variants in this pathway are also associated with long life in humans. Based on demonstrated evidence of conservation across species of lifespan extending mechanisms, it has been possible to study aging in model organisms with the ultimate goal of promoting healthy aging in humans. Much of this work has been done in the worm *C. elegans* because of its advantageous features as a genetic model organism. In fact there have now been hundreds of genes identified in the worm that have the ability to increase lifespan. Thus, by using a simple model organism it has been possible to gain valuable insights into the human aging process.

## Poster Presentations

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### 1. Laura Blohm & Adamove Osho, Calvin College

Biochemistry

(Co-Author: Dr. Larry Louters)

#### *“Activity of Tea Extracts & (-)-Catechin on GluT1 Transport”*

GluT1 is a membrane transporter that is present in all mammalian cells. Its major function is to transport glucose across the cell membrane for use within the cell. Green tea is thought to have glycemic effects. One of the active ingredients in tea is (-)-Catechin. Glucose uptake assays were performed to determine if green tea extracts affect transport activity of GluT1, to investigate the effects of (-)-catechin on glucose uptake in L929 fibroblast cells, and to determine the effects of (-)-catechin with pH. It was found that green tea extracts and (-)-Catechin, which is an active ingredient in green tea, activates the uptake of glucose by the transporter GluT1. Green tea extracts activate GluT1 rapidly, with full activation achieved by 10 minutes. The rate of recovery from activation with green tea extracts is slow. (-)-Catechin has an additive effect on pH at 6 and 7, but at 8 it is already fully activated.

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### 2. Ola-Oluwakiti Alabi, Calvin College

Biochemistry

(Co-Authors: Sam Kerk, Kathryn Wrobel, Riemer Praamsma, Dr. Eric Arnoys, Dr. Larry Louters)

#### *“The Effect of Quercetin on GluT1 Activity”*

GluT1 is a ubiquitous glucose transporter embedded in the plasma membranes of many cells. As one of several isoforms in the GluT family, this protein is responsible for the basal uptake of glucose into the cell. Data shows that the enzyme kinetics of GluT1 can be altered when cells are treated with specific compounds. Quercetin is a naturally occurring flavanoid found in numerous fruits, herbs, and vegetables. This compound has previously been used in traditional medicine as a treatment for diabetes. Our investigations indicate that quercetin acutely inhibits the uptake of glucose in cells, a result that may prove useful in developing treatments for cancer and diabetes.

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### 3. Amanda Bolles, Kalamazoo College

Biochemistry

(Co-Author: Dr. Laura L. Furge)

#### *“5-Fluoro-2-[4-[(2-phenyl-1H-imidazol-5-yl)methyl]-1-piperazinyl]pyrimidine is a Mechanism Based Inactivator of Cytochrome P450 3A4”*

Human cytochrome P450 3A4 (CYP3A4) is responsible for the metabolism of over fifty percent of pharmaceutical drugs on the market today. Inhibition of CYP3A4 can lead to adverse drug-drug interactions. 5-Fluoro-2-[4-[(2-phenyl-1H-imidazol-5-yl)methyl]-1-piperazinyl]pyrimidine (SCH66712) has been previously identified as a mechanism based inactivator (MBI) of CYP2D6 and preliminary data also suggested it could be an inactivator of CYP3A4 (Palamanda et al., 2001 Drug Metab. Dispos. 29, 863–867). In the current study SCH66712 was shown as an MBI of CYP3A4. Inhibition of CYP3A4 by SCH66712 was determined to be concentration-, time- and NADPH-dependent. In addition, inactivation of CYP3A4 by SCH66712 was shown to be unaffected by the presence of radical scavengers and autoxidation protectants. SCH66712 displays type II binding and a spectral binding constant (K<sub>s</sub>) of 0.0152 + 0.0003 μM. Binding stoichiometry of SCH66712 to CYP3A4 was shown to be ~2.5:1. The partition ratio was determined to be 11, suggesting SCH66712 is a potent MBI of CYP3A4.

*“Resveratrol Affects Localization of VACM-1/cul5 in Endothelial Cells”*

Vasopressin-Activated Calcium Mobilizing (VACM-1) protein (or cul-5) inhibits the cellular proliferation in endothelial and breast cancer cell lines. These effects are further controlled by its posttranslational modifications by Nedd8 protein (neddylation). In previous work, the treatment of resveratrol (trans-3,5,4'-trihydroxystilbene), a natural compound found in red wine, grapes, berries, and other fruits, has been found to reduce neddylation of VACM-1/cul5 in Rat Endothelial Cells (RAMEC) and inhibited cellular growth. Treatment with Nedd8-Aldehyde has been shown to prevent deneddylation of other cullins. The aim of this study was to determine if VACM-1/cul5 dependent inhibition of cell growth by resveratrol and 17 $\beta$ -Estradiol involve the neddylation process. Immunohistochemistry assays were used to find the intracellular localization of VACM-1/cul5 and Neddylated VACM-1/cul5 proteins in RAMEC at specific times after treatment. Our results indicated that resveratrol decreased NEDD8 protein and increased expression of VACM-1/cul5. 17 $\beta$ -Estradiol reduced levels of VACM-1/cul5 in RAMEC. Further, treatment with Nedd8 Aldehyde prevented nuclear localization of VACM-1/cul5. Together these results suggest that the antiproliferative effect of resveratrol may involve the control of VACM-1/cul5 neddylation.

(Co-Authors: Jozlyn R. Clasman, Joshua M. Mitchell, Kip-Chumba J. Kaitany, Neil V. Klinger, Cynthia M. June, Robert A. Bonomo, Rachel A. Powers and David A. Leonard)

*“Understanding the Structural Basis of Activity Against Aztreonam and Expanded-Spectrum Cephalosporins for Two Clinically-Derived Carbapenem-Hydrolyzing Class D  $\beta$ -Lactamases in Acinetobacter spp.”*

Background: The carbapenem-hydrolyzing class D  $\beta$ -lactamases (CHDLs), OXA-23 and OXA-24, have emerged world-wide as causative agents for  $\beta$ -lactam antibiotic resistance in *Acinetobacter* spp. Many variants of these enzymes have appeared clinically, including OXA-160 and OXA-225, both of which contain a single structurally homologous P $\rightarrow$ S substitution in OXA-24 and OXA-23 respectively. Interestingly, the presence of blaOXA-160 in *A. baumannii* increases resistance to aztreonam compared to blaOXA-24 while maintaining resistance to carbapenems and penicillins. Our goal is to decipher the structural basis of this novel specificity in these two CHDLs. Methods: We purified OXA-160 and OXA-225 and used steady-state kinetic analysis to compare the substrate profiles of these variants to their parental enzymes, OXA-24 and OXA-23. We next determined the structures of OXA-160 with aztreonam, ceftazidime and cefotaxime bound, and compared those structures with apo OXA-160 and OXA-24/cefotaxime. Results: The P $\rightarrow$ S substitution in OXA-23 and OXA-24 (creating OXA-225 and OXA-160) enhanced kcat/KM for aztreonam, ceftazidime, and cefotaxime. These enhanced activities are the result of much lower KM values, suggesting that the P $\rightarrow$ S substitution enhances the binding affinity of these drugs. Atomic structure analyses suggests that the R1 oxyimino side-chain of these drugs clashes sterically with the  $\beta$ 5- $\beta$ 6 loop and the omega loop of OXA-24. The P $\rightarrow$ S substitution of OXA-160 results in a deviation of the  $\beta$ 5- $\beta$ 6 loop, relieving the steric clash with the R1 side-chain carboxypropanyl group of aztreonam and ceftazidime.

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**6. Christine Ikponmwonba, Calvin College****Biochemistry**

(Co-Author: Dr. Eric Arnoys)

*“Cloning and Sequencing of Point Mutants”*

Glut 1 is one of the isoforms of glucose transporters. It is a membrane bound transporter found in most eukaryotes. Its role in glucose metabolism is to contribute mainly to basal uptake of glucose. New recoveries have shown evidence that drugs gotten from Glut1 might be used to treat diabetes and cancer. Monitoring the activity of Glut1 protein through mutagenesis and cloning can lead to new discoveries.

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**7. Sam Kerk, Calvin College****Biochemistry**

(Co-Authors: Ola Alabi, Kathryn Wrobel, Riemer Praamsma)

*“Characterization of glucose uptake in human kidney cells”*

GLUT1 is a universally expressed facilitative transporter responsible for basal glucose uptake in mammalian cells. This study examines the expression and function of GluT1 in human kidney-2 (HK2) cells. HK2 cells are somewhat unique because, in addition to GluT1, a passive glucose transporter, they also express sodium-glucose linked transporters (SGLT), an active glucose transporter. In kidney cancers, glucose uptake is significantly increased, but it is not known if the increase uptake is due to an increase in GLUT1 activity or SGLT activity or both. Therefore, the purpose of this study is to begin to characterize glucose uptake in HK2 cells.

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**8. SeongEun Kim, Calvin College****Biochemistry**

(Co-Author: Prof. Douglas A. Vander Griend)

*“The self-assembly of a supramolecular cube”*

The self-assembly of the supramolecular cube  $[M_8Lnaph_{12}]_{16+}$  in dimethylformamide has been studied via spectroscopic titration, SivvuTM and mass spectrometry. The UV-Vis absorbance curves of 41 solutions of  $Ni(BF_4)_2 \cdot 6H_2O$  with zero to three equivalents of Lnaph (two chelating pyrazolyl-pyridine units connected to an aromatic spacer 1,5-diynaphthalene) were measured at three different temperatures (295 K, 305 K, and 323 K). The mathematical structure of each isothermal data set indicates there are at least nine species for the formation and denaturation of the cube. Modeling each data set according to a common set of chemical equilibrium leads to the identification of these species:  $[Ni]^{2+}$ ,  $[Ni_2(Lnaph)]^{4+}$ ,  $[Ni_3(Lnaph)_2]^{6+}$ ,  $[Ni(Lnaph)]^{2+}$ ,  $[Ni_8(Lnaph)_{12}]_{16+}$ (cube),  $[Ni_7(Lnaph)_{11}]_{14+}$ ,  $[Ni_4(Lnaph)_7]^{8+}$ ,  $[Ni_2(Lnaph)_5]^{4+}$ ,  $[Ni(Lnaph)_3]^{2+}$ . Free energy values,  $\Delta G^\circ$ , for the set of reactions were obtained, which were all negative. However, the driven force for the cube assembly was unidentified due to inconsistent trend in  $\Delta G^\circ$  value for four sets of reactions from one temperature to another. Mass spectrometry was performed on solutions of  $Ni(BF_4)_2 \cdot 6H_2O$  and Lnaph in acetonitrile in order to determine the exact size and mass of the species in solution. The species identified by mass spectrometry are:  $[Ni]^{2+}$ ,  $[Ni(Lnaph)]^{2+}$ ,  $[Ni(Lnaph)_2]^{2+}$ ,  $[Ni(Lnaph)_3]^{2+}$ ,  $[Ni_2(Lnaph)]^{4+}$ ,  $[Ni_2(Lnaph)_2]^{4+}$ ,  $[Ni_2(Lnaph)_3]^{4+}$ ,  $[Ni_2(Lnaph)_5]^{4+}$ ,  $[Ni_3(Lnaph)_2]^{6+}$ ,  $[Ni_3(Lnaph)_3]^{6+}$ ,  $[Ni_3(Lnaph)_4]^{6+}$ ,  $[Ni_4(Lnaph)_3]^{8+}$ ,  $[Ni_5(Lnaph)_{11}]^{10+}$ ,  $[Ni_6(Lnaph)_{12}]^{12+}$ ,  $[Ni_7(Lnaph)_7]^{14+}$ ,  $[Ni_7(Lnaph)_{10}]^{14+}$ ,  $[Ni_7(Lnaph)_{11}]^{14+}$ ,  $[Ni_7(Lnaph)_{12}]^{14+}$ ,  $[Ni_8(Lnaph)_9]^{16+}$ ,  $[Ni_8(Lnaph)_{10}]^{16+}$ ,  $[Ni_8(Lnaph)_{11}]^{16+}$ ,  $[Ni_8(Lnaph)_{12}]^{16+}$ . Mass spectrometry has helped to corroborate the species that were used in SivvuTM, but  $[Ni_4(Lnaph)_7]^{8+}$  is still unaccounted for.

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**9. Nicole Ladd, Hope College****Biochemistry**

(Co-Authors: Elizabeth Unterbrink, Sara Lang, Anne Georges, Cassandra Cramer, Leah Chase)

*“Identification of Endocytic Motifs in the C-Terminus of xCT”*

The purpose of this study is to identify the trafficking mechanisms within the amino acid sequence of system xc-, a heterodimeric amino acid transporter belonging to the SLC7 gene family. System xc- has been shown to facilitate the exchange of intracellular glutamate for extracellular cystine. Cystine, when internalized, is quickly reduced to cysteine, the limiting factor for glutathione production. It has been demonstrated that glutathione is necessary to reduce oxidative stress produced by common metabolic reactions. Accumulation of excess oxidative stress can lead to cell death and is common in the brain because of its high level of metabolic activity, making it particularly susceptible to neurological degenerative diseases such as Parkinson’s and Alzheimer’s. Thus, it is important to study the putative amino acid trafficking motifs of xCT, the heavy chain subunit of system xc-. To achieve these means, the creation of xCT mutants, Western blotting, immunocytochemistry as well as other procedures are necessary. Six mutants were created and studied, three truncations of xCT and three point mutations of lysine to arginine. These allowed for the identification of putative tyrosine-based motifs, dileucine motifs, and lysine ubiquitination sites which are important endocytic signals for the internalization of xCT from the membrane. This work has the potential to provide the necessary knowledge to create disease models for neurodegenerative disorders.

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**10. Abigail Leistra, Calvin College****Biochemistry**

(Co-Authors: Amanda Witte, Jong Hyun Han, Seok Ki Choi, Kumar Sinniah)

*“An AFM Force Pulling Study of Riboflavin Receptor Targeting Nanoparticles”*

Riboflavin ligands present an alternative pathway for targeted drug delivery as riboflavin receptors are over-expressed in breast and prostate cancer cells. We have examined a riboflavin-conjugated PAMAM dendrimer (generation 5) for targeting riboflavin binding protein (RFBP), which acts as a model protein for the riboflavin receptor. A single molecule force spectroscopy study using Atomic Force Microscopy (AFM) was performed to examine the binding interactions between riboflavin-conjugated dendrimers and RFBP. Using multiple theoretical models, the apparent kinetic and thermodynamic parameters for the riboflavin-conjugated dendrimer system were estimated.

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**11. Nicole Michmerhuizen, Calvin College****Biochemistry**

(Co-Authors: Margaret A. Van Winkle, Kumar Sinniah)

*“A Microcalorimetry Study of the Interaction between Insulin and G-Quadruplex DNA”*

The formation of guanine (G)-quadruplex structures in the guanine-rich tandem repeats of the insulin-linked polymorphic region (ILPR) have potential effects on transcription of the insulin gene. Recent studies demonstrate that the ILPR G-quadruplexes can bind to insulin. The energetics of the binding between insulin and the G-quadruplexes formed by the most common ILPR repeat sequence have also been characterized in prior work. We have studied the proton transfer involved in the interaction between insulin and this DNA sequence by conducting isothermal titration calorimetry (ITC) experiments in various buffers and analyzing the observed enthalpy change. The transcriptional activity of a number

of ILPR repeat sequences, including the consensus sequence, have been measured previously. Transcriptional activity for less common repeats is significantly lower than that of the consensus sequence but can be increased substantially by varying only one or two nucleotides. To determine the potential role of G-quadruplex formation and stability in regulating transcription, we have studied the second and third most common ILPR repeats as well as their variant sequences that exhibit increased transcriptional activity. ITC was used to characterize the energetics of the binding interaction between insulin and each of the four ILPR repeat sequences. The bulk thermodynamic measurements performed at various temperatures from 20 - 37 degrees Celsius provide insight into these biomolecular interactions.

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**12. Auguste Niyibizi, Calvin College**

**Biochemistry**

*“Using Raman and Fourier Transform Infrared Spectroscopy to Obtain Quantitative and Qualitative Data on Polystyrene and Polycarbonate Films”*

Light is a unique tool which can be used to characterize matter. Optical techniques are able to provide a great deal of information without affecting an analyte. Fourier Transform (FT)-infrared (IR), and more recently Raman spectroscopy, are two common methods used to conduct optical analyses. While IR and Raman spectroscopies vary in application, they are complementary to each other, and together can provide detailed molecular information. We use these techniques to determine a correlation between the peak intensities and the percent composition of polymer films. The Lambert Beer equation  $A = \epsilon bc$  demonstrates IR absorption and concentration are directly proportional to each other, while Raman peak intensity is proportional to the concentration of the active species. In IR spectroscopy, a linear correlation is present with different film concentrations of polystyrene but not with polycarbonate; however, there is a linear correlation with the Raman peak height and the percent polycarbonate. Optical profilometry was used to acquire polycarbonate film thickness.

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**13. Amanda Porter, Hope College**

**Biochemistry**

(Co-Authors: Sarah Colton, Chelsea Campbell, Elizabeth Gerometta, Rachel Haas, Abigail Lindberg, Sara Gallemore, Advisers: Drs. Gregory S. Fraley, Aaron A. Best, & Susan M. Fraley)

*“Gut bacterial ecology of developing Pekin ducks in the food industry”*

Riemerella anatipestifer (RA), also known as Pasteurella anatipestifer and Moraxella anatipestifer, is a bacterial pathogen causing septicemia in Pekin ducks. This disease generates substantial economic losses for poultry duck producers in the food industry. Little is known about the pathogenesis or the source of this pathogen in ducks. To determine if RA is a natural part of the gut ecology within ducks, we collected the contents of the paired cecae in ducks over a six-week period, isolated the total bacterial DNA from the samples, and analyzed for the presence of RA, E. coli, and Salmonella using PCR. Data shows the absence of RA in samples in the cecae of ducks from hatch to market weight. Given the lack of current knowledge regarding the gut ecology of Pekin ducks we submitted the isolated bacterial DNA for total community ecological analyses, using next generation sequencing technology to sequence bacterial 16S rRNA taxonomic markers. Initial analyses revealed as many as 35,000 bacterial taxa present in the gut of developing Pekin ducks. Interestingly, we observed a complete shift in gut bacterial taxonomic composition through the full grow-out age of 35 days. Varying conditions in which poultry are raised may influence baseline gut health, raising questioning implications for public food safety and poultry welfare that must still be evaluated.

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**14. Riemer Praamsma, Calvin College****Biochemistry**

(Co-Author: Professor Eric Arnoys)

*“Mechanistic Study of Glucose Transporter 1”*

GLUT1, a ubiquitous glucose membrane transporter protein, has cancer and diabetic implications due to the high activity of GLUT1 in cancer cells and the need for increased glucose uptake for diabetic patients. Activation and inactivation motifs of GLUT1 were studied using Gibson syntheses to perform specific GLUT1 mutants, radioactive Glucose uptake assays, and western blotting. Evidence suggesting both oligomerization and lipid raft association was found.

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**15. Hollister Swanson, Grand Valley State University****Biochemistry**

(Co-Authors: Hollister C. Swanson, Rachel A. Powers, and Bradley J. Wallar)

*“X-ray crystal structure of the extended-spectrum class C Beta-lactamase, ADC-7, in apo form and in complex with a boronic acid transition state analog”*

Resistance to beta-lactam antibiotics in the pathogenic bacteria, *Acinetobacter baumannii*, presents one of the greatest challenges to current antimicrobial chemotherapy. Majority of resistance is due to expression of class C  $\beta$ -lactamase enzymes, known as *Acinetobacter*-Derived Cephalosporinases (ADCs). The enzyme ADC-7 is a broad-spectrum class C beta-lactamase, capable of deactivating multiple types of antibiotics. Boronic acid transition state inhibitors (BATSI) are compounds able to inhibit by reversibly binding to class C beta-lactamases. Enzyme kinetic studies of one BATSI, designated S02030, demonstrated a greater affinity for binding than a common cephalosporin substrate. After expression and purification of ADC-7, the first known X-ray crystal structure of ADC-7 with inhibitor complex was solved at 2.03 Å resolution. The ADC-7/S02030 complex provides insight into ADC enzymes structure and offers a novel starting point for the structure-based optimization of beta-lactamase inhibitors.

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**16. Jared Weidman, Calvin College****Biochemistry**

(Co-Author: Roger L. DeKock)

*“Core Electron Ionization and the Periodic Table”*

Moseley's Law,  $\sqrt{\Delta E} = k_1(Z - k_2)$ , empirically describes the direct correlation between an element's atomic number (Z) and the energy of its emitted X-ray ( $\Delta E$ ). We employed two quantum mechanical methods to calculate the electronic energies of the reactant and product species involved in the X-ray emission. This was done for elements B – Ar in order to model Moseley's Law. In doing this, we seek to theoretically interpret the value of the constant  $k_2$ , which Moseley empirically found to be nearly equal to 1 for the  $K\alpha$  emission. Our computational data shows excellent agreement with experiment. Interpretation of our theoretical results shows that the fact that the value of  $k_2$  is nearly equal to 1 is purely coincidental.

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**17. Kathryn Wrobel, Calvin College****Biochemistry**

(Co-Authors: Ola Alabi, Sam Kerk, Riemer Praamsma; Dr. Eric Arnoys, Dr. Larry Louters, Dr. Brendan Looyenga)

*“The Effect of pH on GluT1 Activity”*

GluT1 is a trans-membrane protein that is ubiquitous in mammalian cells which transports glucose into cells through facilitated diffusion. The study of GluT1 has cancer and diabetes applications. The ability to deactivate highly activated GluT1 in cancer cells and ability to activate glucose transport in diabetic cells is the goal of GluT1 research.

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**18. Taylor Hegg, Calvin College****Biochemistry**

(Co-Authors: Brett DeVries, Matthew Hollowell, Emily Golz, David Benson)

*“Detection and Quantification of Tyrosine-Cysteine Crosslinks”*

Gel electrophoresis has shown that cysteine dioxygenase (CDO) has roughly 50% yield of the post translational modification resulting from a crosslink between tyrosine and cysteine (Tyr-Cys). However, this method is imprecise, plus or minus 20%. A more precise detection method is needed in order to more accurately measure the percent-crosslinking in a protein. Fluorescence was investigated and found to be much more sensitive and precise. The fluorescence assay developed here based on the absorption characteristics the crosslink, which absorbs at 317nm at pH 10. (2-hydroxy)thioanisole was used as a model compound and external standard for Tyr-Cys fluorescence. Standard curves were plotted at pH 10 and pH 7 for this compound; the difference of these two should remove background tryptophan fluorescence. Similar curves were plotted for each of the proteins under study. The slopes of the difference curves were then compared to the slope of the difference curve of the standard compound in order to see the percent crosslinking in the protein. This assay gives a much more precise value of crosslinking in a protein than the traditional method of gel electrophoresis, which examines the multiple bands of a protein due to crosslinked and uncrosslinked sample.

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**19. Andrew Roth, Calvin College****BioMolecular Science**

(Co-Authors: Andrew G. Roth, Taylor H. Hegg, Emily K. Golz, Brett T. De Vries, Matthew T. Hollowell, David E. Benson)

*“Quantified Correlation of Activity and Tyr-Cys Crosslink in Cysteine Dioxygenase by NMR”*

Cysteine Dioxygenase regulates cellular levels of cysteine by enzymatically oxidizing cysteine to cysteine sulfinic acid (CSA). Improper activity of cysteine dioxygenase has been linked to a variety of neurological and nutritional disorders. Enzymatic turnover is putatively accompanied by a post-translational modification; a covalent linkage between a tyrosine and cysteine sidechain that is referred to as a Tyr-Cys crosslink. Tyr-Cys might function as a cofactor, as in galactose oxidase, to increase the rate of CSA formation, but has not been definitively established. We developed an assay using 1H-NMR to measure CDO activity over time. Different preparations of recombinant cysteine dioxygenase provide different rates of CSA production, due to exogenous iron ions that produce cystine. Cystine detection is difficult using the typical fluorescence-detected HPLC assays for CSA conversion but is able to be detected using 1H-NMR. Between 2.70ppm- 3.50ppm, where the methylene protons of all three reactants and

products are in resonance, peak integration of each molecule, relative to an internal standard, provided the amount of cysteine converted to CSA and the amount of cysteine non-specifically oxidized to cystine. To confirm the formation of the Tyr-Cys crosslink 1H, 13C-HSQC NMR spectra was recorded to show an asymmetric tyrosine resonance similar to a synthetic standard. Within the aromatic region of a 2D spectrum a resonance shift will occur when the Tyr-Cys crosslink forms bringing peaks into an open spectral window for easy analysis.

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**20. Alex Zuhl, Grand Valley State University**  
(Co-Author: Matthew E. Hart)

**Biochemistry**

*“Progress towards the synthesis of N-[2-(2-aminoethyl) phenyl]-N'-phenyl urea and like TAAR activating derivatives”*

The thyroid excretes tyrosine based hormones that have a pivotal role in organism development and metabolism. The principle thyroid hormone (TH) produced by the thyroid is thyroxine, which exists actively in vivo as the metabolic stimulator triiodothyronine. 3-iodothyronamine (T1AM) is a recently discovered derivative of TH that acts as a potent agonist of the trace amine associated receptor (TAAR1), a subclass of the G-coupled protein receptor, but with inverse physiological effects of TH. Previous studies have shown T1AM evokes rapid biochemical responses in mice such as hypothermia and cardiac depression, demonstrating the possibility of a regulatory relationship between TH and T1AM. Further exploration of this regulatory mechanism encompasses the systematic examination of the chemical structure activity relationship of T1AM. Incorporation of a urea system in place of the ether linkage in T1AM has led to potent TAAR1 activation. The goal of this project is to expand on this structure activity relationship by specifically examining ortho substituted aromatic systems in addition to a urea linkage. Herein is reported progress towards the synthesis of a novel T1AM derivative N-[2-(2-aminoethyl) phenyl]-N'-phenyl urea as a principle compound for the generation of similar analogues.

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**21. Yesenia Aguilar, Kalamazoo College**  
(Co-Authors: Jiaqiong Wang, Damien Pearse)

**Biology**

*“Functional and Histological outcome of Bilateral Cervical Spinal Cord Contusion Injury in Fischer Rats”*

Cervical contusion trauma is the most common form of spinal cord injury (SCI) from which only an approximate 10% of individuals regain motor function. Pathology of SCI often leads to full quadriplegia or paraplegia due to secondary injury following initial trauma resulting from compression or contusion of the cord. The exploration and use of experimental cervical SCI models have been limited. Thus, the current study developed a reproducible rat model of contusive cervical (C5) SCI using the Infinite Horizons (IH) Impactor to induce graded severities. Adult female Fischer rats (180-200g) received C5 laminectomy only (sham group) or laminectomy plus graded contusion injury (150, 200, or 250 kiloDyn(kDyn)). Animals were assessed one week and two weeks post cervical SCI with a battery of functional test: Basso-Beattie-Bresnahan (BBB) open field locomotion score, IBB forelimb scale, gridwalk and catwalk test, hanging and gripping strength tasks, and by histological analysis of the injury. Forelimb function was evaluated via the Irvine, Beatties, and Bresnahan (IBB) test, weight-supported hanging test and forelimb gripping strength test. Hindlimb function was assessed with the Basso, Beattie and Bresnahan (BBB) open field locomotor test. Additionally, gridwalk and catwalk tests evaluated both forelimb and hindlimb function. The pathological change of the injured spinal cord was assessed by Luxol Fast Blue (LFB) - Hemotoxylin and Eosin –(H&E) Staining. Injured animals demonstrated loss in gray

matter at the lesion and hindlimb and forelimb dysfunction, analogous to severity of SCI. Thus, forelimb and hindlimb locomotor deficits observed in this bilateral cervical SCI model are similar to patients with cervical SCI, suggesting the utilization of this model for future investigations of the pathophysiological mechanisms and potential therapeutic approaches for SCI repair.

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**22. Kendra Antonides, Calvin College**

**Biology**

(Co-Authors: Prof. Rob Keys, Prof. Sam Riffle, Fred Van Dyke)

*“What is the relationship between sculpin abundance and water quality in streams in northwestern Michigan?”*

The U.S. Forest Service designated mottled sculpins as an indicator species – one whose presence suggests high stream quality. However, due to the lack of documentation on the range of sculpins, my study investigated the distribution of sculpin in Kalkaska, Antrim and Crawford County, MI. I hypothesized that sculpin abundance was negatively correlated with stream temperature. Sculpins are increasingly threatened due to human encroachment and physical or chemical stream alterations. Therefore, we considered the study of sculpins as central and pertinent to assessing the health of local ecosystems. However, I found no relationship between sculpin abundance and abiotic factors at the conclusion of my study. This suggests the need for further investigation into the status and relevance of sculpin as indicator species.

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**23. Chelsea Campbell, Hope College**

**Biology**

(Co-Authors: Campbell, Chelsea L., Sarah Colton, Meredith Rice, Mike Turk, Susan M. Fraley and Gregory S. Fraley)

*“The effect of different wavelengths of light on development and behavior of grow-out Pekin ducks”*

Research has shown that red light conditions improve growth and decrease aggressive behaviors in chickens and turkeys, although more recent study suggests that blue-green light may improve production of broilers. Research has not been conducted to examine whether different wavelengths of light could improve production of meat in the Pekin duck. To determine this, we raised Pekin ducks under aviary conditions that were standard to commercial barns. We had three different pens under which the ducks were kept: red light (approximately 780nm), blue light (approximately 450nm) and white light, which were all standardized to have a peak wavelength at  $1.6 \times 10^3$  photons/m<sup>2</sup>/sec. Ducks were given ad libitum access to water and commercial duck diet, were housed on pine shavings. Ducks were housed at a density of 0.43m<sup>2</sup> per duck. Ducks were evaluated weekly for body weight and body condition and a subjective measure of the duck’s anxiety levels was taken. We found that ducks housed under blue light were significantly lighter at each age until processing (35 days). Ducks in the blue pen also showed increased anxiety, increased motor activity and were subjectively flightier. There were no differences in any measure between the red and white pens. These data suggests that unlike the chicken, blue lights may be inappropriate for commercially raising Pekin ducks.

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**24. Alexandria Clark, Hope College****Biology**

*“Herbivore response to naturalized tall fescue and its endophytic fungus”*

Varieties of endophytic fungi have been known to increase its host grass's resistance to drought, photosynthetic efficiency, and resistance to herbivores. However, it is common for these grasses to produce alkaloids that cause toxicosis in cattle and other organisms of higher trophic levels. We tested the performance and preference of *Rhopalosiphum padi* (cherry-oat aphid) after feeding on grasses of various levels of infection hailing from three locations as well as grasses with different endophyte hybrids. We found that the aphids built larger populations on naturally and mechanically uninfected grasses as well as on grass infected with sexual endophytes than on other hybrids or the infected fescue. There was also no preference between grasses of different collection sites. We conclude that *R. padi* is sensitive to the presence of endophytic fungi.

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**25. Emily Fuller, Calvin College****Biology**

*“Water Quality Assessment of Bear Creek. Kent County, MI*

This research was completed in coordination with GLISTEN, Cannon Township Watershed Council & Calvin College. The research provided a comprehensive analysis of Bear Creek's water quality; taking into account the physical, biological and chemical parameters that influence the stream. This research project included the data collection and analysis of benthic macroinvertebrate populations, dissolved oxygen content, chemical ion concentrations in the creek and more in order to provide a comprehensive assessment of the health of Bear Creek and the surrounding watershed.

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**26. Nkrumah Grant, Grand Valley State University****Biology**

(Co-Authors: Nkrumah Grant, Nick Smith, William Schroeder, Robert Smart, Roderick Morgan)

*“GV-2 - A Novel Anthranilic Acid Derived Therapeutic to treat MRSA and other Antibiotic Resistant Microorganisms and its Inhibitory Interaction with Human Serum Albumin”*

Implementation of antibiotics to treat bacterial infections began during World War II. Since then, a number of antibiotic resistance microorganisms have emerged, one of these being Methicillin Resistant *Staphylococcus aureus* (MRSA). This resistance can be accredited to multiple factors, but the greatest contributor is the similarity in the chemical composition of the commonly prescribed antibiotics used to treat MRSA. MRSA is the most frequent health acquired infection in the United States and to combat this growing problem, we have developed a novel class of antibiotics derived from anthranilic acids that show antibacterial activity against MRSA. Our derivatives record a minimum inhibitory concentration (MIC) of 2-64  $\mu\text{g/ml}$ , however when in the presence of human serum protein (HSP) this value increases, decreasing their effectiveness. We have identified a component of HSP, albumin, that causes the increase in MIC, and have characterized the intermolecular interactions allowing this to occur. Using this information we are currently synthesizing new derivatives with a low binding affinity for albumin, or when bound that do not lose antibacterial activity.

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**27. Marvin Harbour, Michigan State University**  
(Co-Authors: Schuyler Pike and Norbert Kaminski)

**Biology**

*“Engineering of a Dual Promoter Construct to Quantitatively Evaluate TCDD-Induced”*

2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) is a halogenated aromatic hydrocarbon and a persistent environmental toxicant known to produce marked immunosuppression in virtually all animal species where it has been tested. Specifically in B cells, it impairs IgM secretion and B cell to plasma cell differentiation. In the cell, it is a high affinity ligand for the cytosolic aryl hydrocarbon receptor (AhR). Upon entry into the cell, TCDD forms a multiunit complex, translocates to the nucleus, and binds to dioxin response elements (DREs) in the regulatory regions of multiple genes such as cytochrome P450 1B1 (Cyp1B1), cytochrome P450 1A1, and IgH. In this study, we designed and are constructing two dual promoter plasmids that will allow for the unprecedented simultaneous measurement and correlation of TCDD:AhR to DRE binding with B cell functional parameters such as IgM production and B cell to plasma cell differentiation. This dual construct promoter will be inserted into B cells via a lenti viral system. The final plasmids will contain GFP under the control of the human B cell CD19 promoter and either a luciferase or a RFP under the control of a shortened human Cyp1B1 promoter (with five DREs), and a woodchuck hepatitis virus posttranscriptional regulatory element (WPRE), which increases the stability of mRNA. Thus far, the GC-rich CYP1B1-promoter has been amplified using betaine with “Slowdown” PCR while WPRE was amplified using a standard PCR protocol. These two cassettes were transferred 5’ and 3’, respectively, of luciferase in a reporter plasmid. Subsequently, the Cyp1B1-luciferase-WPRE cassette was amplified and ligated behind the CD19-GFP in a lentiviral transfection system host plasmid generating the dual reporter construct, pLexDC-L. Further work will exchange the luciferase cassette in pLexDC-L with an RFP cassette making pLexDC-R. This work is supported in part by NIH ES002520 and 5R25HL103156

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**28. Esther Hui, Calvin College**  
(Co-Authors: Anthony Tam, Lam Fung Kwok, YS Chan, Daisy SK Shum)

**Biology**

*“Production of Purified Chondroitinase ABC II in use for Studies of Spinal Cord Nerve Regeneration”*

The up-regulation of chondroitin sulfate proteoglycan (CSPG) after spinal cord injury forms a molecular barrier which restricts axonal regeneration and prevents functional recovery (Chau et al., 2003). It has been suggested that chondroitinase ABC (ChABC), a crude enzyme obtained from *Proteus vulgaris*, can digest the chondroitin sulfate. Therefore, the infusion of ChABC to the host side of the interface would aid axonal regrowth in severed nerves (Chau et al., 2003). There are two types of ChABC: type I and II. ChABC II’s digestion rate is quite low (Hamai et al, 1997). Protein modification is needed to maximize the digestion efficiency of ChABC II. Yet, we do not know its exact structure. We can identify its structure through the process of crystallization and X-ray crystallography. To do so, we will need a large concentration of ChABC II, in its purest form. The goal of this study is to develop methods of ChABC II purification and concentration, so crystallization and protein engineering can be done in the future.

*“Analysis of Marine Bivalve along the Coast of Thailand for Toxoplasma gondii: Comparison between methods to optimize the detection sensitivity in the standardisation phase using cockles (Anadara granosa)”*

Toxoplasmosis, a parasitic infection due to the protozoan called *Toxoplasma gondii*, is considered one of the most common diseases around the world. It affects up to one-third of the world’s human population and may further cause abortion and other congenital diseases. Between 1998 to 2004, the number of sea otters in California was found to be declining as a result from this parasitic infection. One of the main assumptions was that they were infected through contaminated food sources such as bivalves. In this study, we performed a comparison between two methods in order to optimize the standardization phase for the analysis of *T. gondii* contamination in bivalves along the coast of Thailand. The two methods, pepsin digestion and fat extraction by ethyl acetate, were used to investigate cockles’ (*Anadara granosa*) tissues specified as gills and digestive tracts. By using B1 and SAG1 primers, the detection sensitivities toward the parasite for both methods were obtained through real time polymerase chain reaction (qPCR) and compared by conducting a t-test. Matrix spikes of *T. gondii* DNA into the cockles’ gills and digestive tracts were applied to both methods for more accurate outcomes. The pepsin digestion method was found to be the better option as it can detect as few as two *T. gondii* parasites. By resulting in the high sensitivity for the standardization phase, the optimized method can be used for a further analysis of the research. The result from this research can be used to conclude whether bivalves are the real vehicles for the parasite to infect human and other vertebrates.

(Co-Author: Dr. Dave Warners)

*“Restoring Native Habitats to Urban Landscapes”*

Our society's obsession with the manicured lawn has resulted in a loss of native plant species and the organisms they host, increased soil compaction and water runoff, heavy fossil fuel inputs for lawn chemicals and maintenance efforts, and other associated costs to creation. Our project utilized different soil preparations to find how best to restore an area of lawn to native habitat, more specifically to shortgrass prairie. We hope the results of our project will be used in future restoration projects on our campus.

(Co-Authors: Jenna Kennedy, Dean Pettinga, and Darren S. Proppe)

*“The Effect of Anthropogenic Noise on Songbird Response to an Avian Predator”*

Songbird communication is negatively affected by anthropogenic noise. Because songbirds use sound not only for communication but also identifying threats while foraging it is likely that their foraging would also be affected by noise. Our objective was to test how anthropogenic noise affects birds’ foraging patterns and ultimately, the likelihood of predation and survivorship. Seven common and easily identifiable songbird species were tested at feeding locations throughout west Michigan. Speakers placed 10m from the bird feeder played a repeating recording of ambient road noise for 25 seconds

followed by 25 seconds of silence. A Cooper's hawk call was played on demand at amplitudes simulating a hawk call at 10, 40, and 70m from the feeder. All calls were played during noise playback and quiet. Bird behaviors were assessed in person and via video recording. Behaviors were placed into predetermined category based on level of alarm to come up with an overall numerical behavioral score. Number of pecks was also observed and analyzed. Song birds showed significantly higher levels of response to Cooper's hawk calls at closer simulated distances, and fewer pecks. Significantly higher behavioral scores were calculated in response to hawk calls played in quiet conditions compared to scores in the presence of ambient noise, and the number of pecks during these two treatments approached significance. The interaction between distance and treatment (noise/quiet) was not significant for behavioral scores or number of pecks. Our results suggest that anthropogenic noise may reduce the awareness of songbirds to potential predators, and thus, may reduce their fitness.

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**32. Evan Kowalski, Aquinas College**  
(Co-Author: Dr. Jeffrey McKelvey)

**Biology**

*"Factors influencing foraging of native woodpeckers for emerald ash borer"*

he emerald ash borer (EAB) (*Agrilus planipennis*) is a significant threat to ash trees in the Midwest Ecoregion. Native avian predators may play a role in the containment of this pest, and this study attempted to ascertain which factors most influence native woodpeckers foraging on EAB. We found that ash species and EAB larval density were most influential. White Ashes averaged  $18.2 \pm 24.3$  woodpecker attacks/m<sup>2</sup> of trunk (n=106), while the mean value for Green Ashes was  $9.1 \pm 12.9$  attacks/m<sup>2</sup> (n=49). Pearson's correlations showed that higher densities of D-exit holes positively correlated [ $r(153) = 0.526, p < 0.0001$ ] with the number of woodpecker attacks/m<sup>2</sup> of trunk, and Cramér's V associations (mean =  $0.407 \pm 0.017$ ) indicated that woodpeckers tend to forage on ashes with more pronounced canopy dieback. We conclude that while woodpeckers do prey on EAB larvae, they may not reduce the spread of infestation, as they forage mainly in stands that are already heavily infested with EAB.

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**33. Dorteia Leisman, Calvin College**  
(Co-Author: Dr. David Warners)

**Biology**

*"Flat Iron Lake Preserve Phenology and Floral Inventory"*

This summer was year six in a long-term phenology project at Flat Iron Lake Preserve in Greenville, Michigan studying how the flowering period of native wildflowers is being affected both by year-to-year weather patterns and overall climate change. The preserve consists of roughly five different habitats: a restored prairie, a sizeable forest, two swamps, and an east lot of successional old field. In its entirety, the preserve provides a home to over two hundred different wildflower species. For ten weeks, I made weekly rounds to inspect each area and document any changes in vegetation. New blooms were identified, recorded, and then monitored until close. A comparison of my results (2013) with data from 2012 and 2010 reveals that weather patterns do affect the flowering period of most species. In 2012, West Michigan experienced an unusually warm spring, record high temperatures, and little rainfall. However, this year it remained cold throughout most of the spring, and the summer was mild with near normal rainfall. Comparing the data, the vast majority of plants began to flower later in 2013 than in 2012. Further analysis showed that some species (e.g. Solomon's Seal) seem more resistant to weather fluctuations whereas others (e.g. White Avens) fluctuated markedly from year to year. From this study

and subsequent work in the future, we hope to see how seasonal fluctuations may be altered by larger climate change influences, and how these may effect ecosystem dynamics over time.

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**34. Sara Leonard, Grand Valley State University**

**Biology**

(Co-Authors: Jessica Meppelink, Joseph Jacquot, Paul Keenlance, Doug Graham, Sara Leonard)

*“Got Worms? Distribution and prevalence of Baylisascaris procyonis in raccoon populations throughout Allegan and Barry Counties in Michigan”*

Baylisascaris procyonis (raccoon roundworm) is a species of ascarid worm that lives within the intestinal tract of the common raccoon (*Procyon lotor*). Raccoons typically defecate in communal areas, called latrines. Millions of *B. procyonis* eggs can accumulate at latrine sites and can remain infective for years. Many animals, including humans, can serve as intermediate hosts for raccoon roundworm. Ingestion of the eggs can result in ocular, neural or visceral migrans which can lead to brain damage and, in some cases, death. Our goal was to determine the distribution and prevalence of raccoon roundworm in Allegan and Barry Counties in Michigan. We sampled scat from latrine sites and also necropsied raccoon road kill to look for the presence of *B. procyonis*. A total of 191 fecal samples and fifteen dead raccoons were collected from Allegan and Barry Counties. A 5.1% prevalence rate was found for Barry County and a 5.5% prevalence rate was found for Allegan County. These prevalence rates are fairly low; however, we did note that there was spatial variability between our sample locations. The necropsy results yielded a prevalence rate of 33%, indicating there may be a seasonal component for when the adult worms shed their eggs. Also shedding of eggs in many helminthes can be intermittent and inconsistent from day to day, so one scat pile from a single raccoon may have a lot of eggs and the next may not. There can also be pre-patent infestations – raccoons infected with *B. procyonis* that are not yet mature enough to produce eggs – or the number of worms in an individual may be low, reducing the likelihood of finding eggs in any one scat sample. Thus there could be false negatives from the fecal samples, a possible explanation for our differing prevalence rates.

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**35. Mary Mathyer, Kalamazoo College**

**Biology**

(Co-Authors: Brandon K. Swan, Ramunas Stepanauskas)

*“Carbon and Nitrogen Cycling by Nitrospina in the Dark Ocean”*

The dark ocean is thought to harbor chemolithoautotrophic microbes that fix inorganic carbon and use inorganic sources of energy, but the specific participants carrying out these processes are vastly unknown. Members of the nitrite-oxidizing bacteria group *Nitrospina* sp. are an abundant dark ocean microbe who may function as chemolithoautotrophs, as suggested by an evolutionarily related surface bacteria *Nitrospina gracilis*. Using single cell genomics, we obtained three *Nitrospina* sp. whole genome sequences and identified genes supporting the reductive tricarboxylic acid cycle, providing an inorganic carbon assimilation pathway, and the nitrite oxidation pathway, which provides an inorganic source of energy. *Nitrospina* sp. also contained genes that hydrolyze urea, a metabolic pathway absent in other nitrite-oxidizing bacteria. Comparisons of genome sequence abundances within several ocean metagenomes revealed a global distribution of *Nitrospina* sp. in the dark ocean. This was further supported by phylogenetic clustering of several key metabolic genes identified within both *Nitrospina* sp. and metagenomes. Molecular evidence suggests that *Nitrospina* sp. within the dark ocean may have a chemolithoautotrophic lifestyle, and thus play a key role in ocean carbon and nitrogen cycles.

*“Unionids: their current status in Cedar Creek and their association with benthic macroinvertebrates”*

In North America, it is estimated that 72 percent of the nearly 300 species of freshwater mussels (unionids) are in danger of extinction and only 23 percent are considered stable (Williams et al.1993). No other group of animals in North America is in such grave danger. They are one of the most endangered groups of animals on Earth, yet surprisingly little is known about their life history, habitat needs, or even how to distinguish different species. Our project investigated the status of the unionid community in a 3rd order Michigan stream and examined their relationship with aquatic macroinvertebrates. We sampled randomly chosen transects within 2 separate 100 meter reaches that spanned the natural gradient of Cedar Creek to compare unionid and macroinvertebrate biodiversity, density, and species richness. At each site, we sampled macroinvertebrates, unionid mussels, and environmental variables such as visually estimating % substrate composition. At each site, a Hess Net was used to sample benthic macroinvertebrates, and eight, 0.25m<sup>2</sup> quadrats were surveyed for unionids in the area directly surrounding the Hess Net (2m<sup>2</sup> per site total)(n=144). We also recorded other environmental variables such as water temperature, velocity, total dissolved solids (TDS), rate of organic transport at the top of each reach, pH, and specific conductivity. None of these variables, with the exception of velocity ( p=0.002)—which was faster in areas with greater mussel density—were significantly correlated with mussel-macroinvertebrate assemblages. All sampling was done during the summer and within a 6 week interval. Macroinvertebrate density was significantly higher in sample sites where higher mussel densities were present than in sites where mussel densities were low/absent. Mussel density was positively correlated with macroinvertebrate density across the randomly chosen 18 sites (p=0.004, R<sup>2</sup>=0.405). We found that the substrate composition that was correlated with the higher mussel densities had an average substrate size of 3.1cm and consisted of a mixture of gravel, cobble, sand, and Vallisneria, with gravel being the dominant substrate. Sample sites that had little or no mussels present had one or two dominate types of substrate, such as sand, silt, or cobble. The data suggest that substrate is a strong determinant of mussel assemblages and as the natural gradient in substrate becomes more homogeneous, mussel abundance and diversity declined.

*“A comparative analysis of the tibia of Paralouatta varonai, an extinct Cuban primate”*

Primates inhabited the Caribbean islands for millions of years, from at least the Miocene up until several thousand years ago. One genus, Paralouatta, was endemic to the island of Cuba. The fossils of Paralouatta varonai, one of the two known species of that genus, have been well described, including evidence for possible semiterrestriality in the skeletal remains. Currently, all known New World monkeys are arboreal, spending almost all of their time in trees. This work offers additional comparative analyses of the fossilized tibia of Paralouatta varonai, specifically looking at the distal articular surfaces to determine the locomotion of the extinct platyrrhine along with the relation of Paralouatta to the extant platyrrhine families. We used geometric morphometrics in order to collect three-dimensional shape data to carry out a number of statistical analyses. Principal component analyses were carried out on all individuals as well as on all extant taxa means and individual fossils. Our sample consisted of 166

individuals, 160 of which were extant taxa from 14 primate families. The remaining 6 were platyrrhine fossils. The PCAs performed showed *Paralouatta* to be most closely related to the atelids; the family of New World monkeys that includes the howler, spider, and woolly monkeys. Locomotor inferences are still unclear, as the distal tibia of *Paralouatta* does not fit tightly with the arboreal or terrestrial primates used in this analysis but does exhibit a mix of characters that are associated with the ankle morphology of terrestrial and arboreal suspensory primates.

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**38. Marie Mustert, Calvin College**

**Biology**

(Co-Authors: Marie Mustert, Daniel Michele)

*“The Use of Induced Pluripotent Stem Cells for a Genetic Model of Muscular Dystrophy”*

The muscular dystrophies are a group of diseases that are characterized by a defect in the post-translational processing of the protein dystroglycan, which is essential for muscular function. Along with the gene that encodes dystroglycan, there are eleven other known genes that encode proteins involved in the function of the dystrophin-glycoprotein complex (DGC). The lack of function of this complex is associated with several types of muscular dystrophy, such as Duchenne muscular dystrophy and the limb-girdle muscular dystrophies. The development of induced pluripotent stem cells (iPSC) has presented a potential model for the diseases, and would provide means for development of patient specific treatment. In order to utilize iPSCs for this purpose, the behavior of the cells throughout their differentiation process should be characterized. iPSCs isolated at different points of maturation were used to identify gene and protein expression, as well as the glycosylation behavior of the DGC, throughout the differentiation process. iPSCs lacked expression of dystrophin N-terminus and glycosylation of dystroglycan, leading to a loss of laminin binding and function of the DGC. As cells were differentiated into cardiomyocytes, the function of the complex was similar to normal muscle cells, implying that iPSCs are an acceptable model for patient phenotypes and provide potential for therapeutic screening.

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**39. Margot Oliver, Calvin College**

**Biology**

(Co-Authors: Emily Diekema and Dr. Amy Wilstermann)

*“Growth Characteristics of *Lactobacillus iners* that Promote Persistence in Bacterial Vaginosis”*

Bacterial Vaginosis (BV) is the most common vaginal infection presented in medical practice. It is associated with a variety of negative effects regarding reproduction including premature rupture of fetal membranes (PROM). Our research focuses on the shift between healthy and BV conditions. This shift is characterized by an increase in pH and a loss of the typically dominant *Lactobacilli*, with the exception of *L. iners*. Growth characteristics of the four most common *Lactobacillus* species, *L. gasseri*, *L. jensenii*, *L. crispatus*, and *L. iners*, were analyzed. Factors tested included environmental pH and interaction with the BV-associated bacterium *Gardnerella vaginalis*. The growth of *L. iners* was inhibited by the low pH associated with healthy environments but not by the presence of *G. vaginalis*. The inverse was found to be true for *L. gasseri* and *L. jensenii*. *L. crispatus* was found to be inhibited by both a low pH and factors produced by *G. vaginalis*.

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**40. Tim Olson, Grand Valley State University****Biology**

(Co-Authors: Dr. Eric Snyder and Tim Olson)

*“A Longitudinal Stream Health Study of Pine Creek in western Ottawa County, MI”*

This study focused on quantifying the general health of Pine Creek in western Ottawa County, MI, during June and July 2013. We were interested in a longitudinal (head-waters to mouth) assessment of stream ecological health, especially given that we use this stream to plant the juvenile Chinook salmon that are raised in our classroom during the winter. We focused our assessment on three stream attributes; the macroinvertebrate community, temperature regime, and riparian and in-stream habitat complexity. Data was collected at 5 locations. Collections made with kick nets showed that the macro-invertebrate communities for all sites in Pine Creek were within the acceptable range according to a suite of metrics calculated following procedures used by the Michigan Department of Natural Resources (Procedure 51). Specifically, we found that taxa richness ranged from 4 to 12 and sites tended to be dominated by isopods, amphipods or chironomids (midges). Artificial substrate samplers (Hester Dendy's, 3 per site) were used to quantitatively sample macroinvertebrates and results indicated a significant decline in community health from up- to down-stream, a pattern opposite of riparian condition. We hypothesize that cumulative impacts from farming, golf-course runoff, and urbanization account for this pattern. The average temperature data collected at sites 2 and 5 ranged between 17.250C and 18.200C. These temperatures are known to be in the upper range for juvenile salmon survival but research shows that the salmon should have migrated downstream earlier in the spring. Habitat assessments for each site ranged from a marginal rating at site 1 to good ratings throughout the rest of the sites. This research represents a base-line that establishes ecosystem health and will hopefully be reproduced by classroom students during different times of the year and for multiple years to come. Thus as conditions change- hopefully for the better- we can track and quantify this change through time.

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**41. Jonathan Knott & Paige Stephens, Calvin College****Biology**

(Co-Authors: Herb Fynewever and David Koetje)

*“Teaching Ecology and Evolution Through the Lens of Vision and Change”*

In 2011, a team of faculty from Calvin College initiated a reform of their undergraduate biology curriculum. The NSF document, Vision and Change in Undergraduate Biology Education, provided six core competencies to be covered in undergraduate biology. These include the ability to: apply the process of science, use quantitative reasoning, use modeling and simulation, tap into the interdisciplinary nature of science, communicate and collaborate with other disciplines, and understand the relationship between science and society. During the summer of 2012, two Biology students modified Biology 224: Cellular and Genetic Systems lab to fit a research-based model for understanding cellular biology. This past summer, two students, Jonathan Knott and Paige Stephens, under the supervision of faculty members David Koetje and Herb Fynewever, redesigned a three-module laboratory portion for Biology 225: Ecological and Evolutionary Systems. It includes an in-depth examination of the aster plant genus *Symphyotrichum*, a phylogenetic assessment of the Salmonidae family in Lake Michigan, and a quantitative and qualitative analysis of hominid evolution. Each of these three research-based modules integrate the six core competencies of Vision and Change to better prepare students for future application in scientific fields. As these changes are implemented in the fall of 2013, student gains will be analyzed via formal and informal assessment to compare with results of previous years.

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**42. Dean Pettinga, Calvin College****Biology**

(Co-Authors: Dean Pettinga, Jenna Kennedy, Darren Proppe PhD, Dave Warners PhD)

*“Monitoring the Plaster Creek Watershed”*

Plaster Creek is one of the most polluted waterways in Michigan. In 2001 and 2005 the Michigan Dept. of Environmental Quality deemed the creek unfit for partial body contact due to dangerously high levels of E. coli. The watershed also struggles with storm-water retention, facing huge storm surges, especially due to the urban and suburban land use of the region. The Plaster Creek Stewards received a grant from the Michigan Department of Environmental quality for the installation of several bio-swales to improve the water retention. Discharge measurements were collected for these locations to compare the drainage before and after landscaping. Additionally, E. coli measurements were taken in order to locate the greatest E. coli-loading regions of the watershed. These data will be used to inform and target further best management practices in the watershed.

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**43. Rachel Polet, Calvin College****Biology**

(Co-Authors: Jacob Jensen, Nathan Johnson, Curtis Wilkerson)

*“Investigating the synthesis of xylan for the development of biofuel crops”*

The development of biofuels could potentially reduce dependence on foreign oil and the impact of global warming. In order to make the production of biofuels economically feasible, it is important that components of plant cell walls are broken down quickly and easily. A large component of cell walls is hemicellulose, a branching polymer which is thought to help cellulose maintain the plant's structure. Hemicellulose is ubiquitous among plant cell walls and is commonly found in the form of xylan. Manipulating the biosynthetic pathway of xylan could lead to the ability to increase energy density in biofuel crops and improve their digestibility. In order to do this, it essential to understand how different promoters and transcription factors interact. The identity and targets of many master regulators and transcription factors have already been identified but many more are yet unknown. The transcription factor (TF), BLH6, and TF KNAT7 are involved in the expression of the xylan synthesis gene, IRX10. BLH6 belongs to a family of 11 proteins. By testing the rest of the proteins for their ability to work with KNAT7 in the activation of the GH10 promoter, we can hopefully further our understanding of the xylan biosynthetic pathway. Plasmids containing the BLH synthesis genes were created by cloning from cDNA stocks and harvesting plasmids via maxi preps. Protoplasts were be obtained from 3-week-old Arabidopsis plants and transformed with the plasmids. Transactivation assays were then used to determine if the GH10 promoter had been activated.

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**44. Lindsay Rupp, Siena Heights University****Biology***“Barred Owl Pellets”*

Since owls swallow their prey whole, they regurgitate a pellet containing the indigestible parts of the prey such as bones, fur and claws. The purpose of this study was to look at the correlation between the phases of the moon and what/how much barred owls (*Strix varia*) eat by examining the contents the pellets found at the Chippewa Nature Center at the time of the full and new moon. I tested the hypothesis that barred owls eat a larger quantity of prey and a greater variety prey during the new

moon. Owl pellets were collected May-August 2013 during a five day span coinciding with the specific phases of the lunar cycle with the day of the full or new moon being the third day of collection. Pellets were then dried and dissected and the bones were identified to species level. After analyzing the data, temperature was found to have a stronger influence on the owl's diet rather than the phase of the lunar cycle.

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**45. Allyson Schenk, Hope College**

**Biology**

(Co-Authors: Allyson N. Schenk, Alexis Meelker, Amanda L. Porter, Chelsea Campbell, Susan M. Fraley, & Gregory S. Fraley)

*"A Comparison of Water Lines vs. Water Troughs in an Aviary Setting: Environmental, Behavioral, Body Condition, and Production Data in Pekin Ducks"*

The use of water lines vs. water troughs has been a controversial issue for many years, but there has yet to be a study that analyzes which water source is better for maintaining duck welfare. The current study was done on a small scale to explore the effects of both watering methods on Pekin ducks during a 5-week period.

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**46. Clara Schriemer, Hope College**

**Biology**

(Co-Authors: Clara Schriemer, Marshall Willey, Mathew Ochs, Lauren Bedard, and Virginia McDonough)

*"Differential regulatory response for the  $\Delta 9$  desaturase in *Saccharomyces cerevisiae* based on fatty acid species and intracellular amount"*

The OLE1 gene in *Saccharomyces cerevisiae* encodes the  $\Delta 9$  desaturase, which inserts a double bond in saturated fatty acids to create unsaturated fatty acids (UFAs). OLE1 expression is controlled in part through the transcriptional regulators Mga2p and Spt23p in response to supply of UFAs. We investigated whether the regulation was uniform in response to different UFAs and at different concentrations. We found that in wild type cells, reporter gene assays show a stronger decrease in expression of OLE1 when fed 16:1  $\Delta 9$  or 18:2  $\Delta 9$ , 12 as opposed to 18:1  $\Delta 9$  or 17:1  $\Delta 10$ . Concentration of the fed fatty acid also impacted the regulation of OLE1 with higher levels of each UFA impacting expression to a greater degree. Fatty acid profiles of wild type cells show cells accumulate a higher concentration of 16:1  $\Delta 9$  and 18:2  $\Delta 9$ , 12 than fed 18:1  $\Delta 9$  or 17:1  $\Delta 10$ . This leads to the conclusion that the expression of OLE1 is dependent both on properties of fed fatty acids and the amount in the cell. While our initial hypothesis was that OLE1 is regulated in response to membrane fluidity, subsequent work does not support that idea. We have found that conditions that would affect membrane fluidity (besides UFA species and amount), such as growth temperature and saturated or trans fatty acid supplementation do not regulate OLE1 in the direction predicted by fluidity changes. Recently our lab has isolated a mutant that is deficient in regulation of OLE1, called nro1 (no regulation of OLE1). The signaling mechanism for the NRO1 protein's action is unknown. Growth tests using the OLE1 promoter-reporter gene construct suggest that Nro1p responds more strongly to the fatty acids 16:1  $\Delta 9$  and 18:2  $\Delta 9$ , 12, than 18:1  $\Delta 9$  and 17:1  $\Delta 10$ . However, in nro1 cells, there was diminished regulation of expression in response to feeding any of the tested UFAs. This leads to the possibility that there may be more than one regulatory system controlling expression of OLE1 in response to UFA feeding, and that the NRO1 gene product may be a common point in each system.

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**47. Jonathan Shoaff, Cornerstone University****Biology**

(Co-Author: David C. Mahan)

*“Dam Removal and Macroinvertebrate Response”*

On 6 October, 2012 the Brown Bridge dam electronic dewatering system on the Boardman River breached as engineers were draining it for proper deconstruction. This failure caused a mass flooding of water and sediment downstream covering downstream substrate with sediment. The drawdown should have taken 20 days but because of complications of the failure it drained in hours. The dam was being drawn down due to aging infrastructure and the cost of repairs was not economically feasible. The objective of this study was to determine if there was a difference between the upstream and downstream sites in respect to their condition and recovery after the discharge by looking at macroinvertebrates that inhabit each community as indicators of stream quality. Using Simpson’s Index of Diversity and EPT/C comparison we analyzed and determined that there was no major difference between the two sample sites and our hypothesis that there would be site differences in macroinvertebrates was rejected.

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**48. Monica Langeland & Stacy Hooker, Calvin College****Biology**

(Co-Authors: Sylvia Fuhrman, Stacy Hooker, Keith Grasman)

*“Great Lakes Restoration Initiative: Reassessment of Wildlife Reproduction and Health Impairments in the Saginaw Bay and River Raisin Areas of Concern”*

This assessment investigated contaminant effects on reproduction and immunological health of fish-eating birds in the Saginaw Bay and Raisin River Areas of Concern (AOCs). Saginaw Bay studies were conducted during 2010-13 at two herring gull colonies (Confined Disposal Facility (CDF) and Little Charity Island), two Caspian tern colonies (CDF and Charity Reef) and one black-crowned night heron colony (CDF). River Raisin herring gulls were studied at the Detroit Edison Monroe Power Plant on the western shore of Lake Erie. Reference sites were located in the lower St. Mary’s River on the Pipe Island Twins (gulls), Two Tree Island (terns) and Northern Lake Huron’s Chantry Island (herons). Gull nests were marked during egg-laying, and embryonic viability was assessed during late egg incubation. Embryonic nonviability rates in gulls at both AOCs (multiyear means of 4.3% (CDF), 7.6% (L. Charity), and 7.3% (Monroe)) generally were higher than at reference sites (<2-4%). Infertility and embryonic mortality contributed to nonviability at all sites. Caspian tern chicks, a state threatened species, in Saginaw Bay had poor to marginal survival. Chicks at Monroe experienced poor survival during 2010-12, with complete reproductive failure during 2010. Mean phytohemagglutinin skin responses for T-cell mediated immunity were suppressed dramatically compared to reference sites in young gulls (50-57%), terns (48-51%), and herons (39%) in the Saginaw Bay AOC. This response was suppressed 57-65% in gulls at the River Raisin AOC. Ongoing immunological, developmental, and reproductive impairments in birds at these AOCs are consistent with previous studies on the effects of persistent pollutants, such as PCBs, in Great Lakes wildlife.

*“Endophytic Response to Methyl Jasmonate and Loline Quantification”*

Tall fescue (*Schedonorus phoenix*) is a grass found throughout much of the world, and is known to harbor the fungal endophyte *Neotyphodium coenophialum*. The fungus forms a mutualistic relationship with the host, providing stress tolerance. The agronomic cultivar Kentucky-31 is used for much of the endophytic-host research, as opposed to a naturalized grass. Seeds were obtained from Gotland, Finland in order to study the effect of a naturalized cultivar and its response methyl jasmonate (MJ). It is common to use mechanically uninfected (ME-) seeds to act as naturally endophyte-negative (E-) seeds. The purpose of testing naturalized tall fescue expanded to using naturally E- and ME- seeds. Plants were exposed to MJ by gaseous diffusion within a controlled environmental chamber, and response was assessed with an aphid (*R. padi*) bioassay. As in Simons et al. (2008), MJ decreased the resistance of endophyte-infected grasses. Further, there was no difference among ME- and naturally E-, suggesting that both types are viable for experimental use. Constitutive production of toxic chemicals to herbivores is one of the key components of herbivore resistance. Damage to the plant or fungus induces increased alkaloid production. Samples of KY-31 from a previous damage-treatment experiment were used to quantify lolines. Data show that loline levels peak when the plant is cut where the fungus resides, suggesting that it is damage to the endophyte that induces increased alkaloid production.

(Co-Authors: Dr. Robert Keys, Mentor)

*“Using electronic field recordings to increase the detectability of bird species at point count sites”*

Each year thousands of auditory breeding bird point count surveys are conducted by field technicians (both volunteer and professional) to monitor the state of bird populations across North America. This data is then used to help manage and steward bird communities across the continent. The greatest limitation to this survey technique is the validity of the collected data based on the ability of the observers. This study sought to continue the monitoring of breeding bird populations at the Pierce Cedar Creek Institute while at the same time using an observer-electronic field recording combination to determine if the accuracy of identifications and/or actual counts can be increased by having field observers compare their point count observations against electronic field recordings made at the same time the point count is being conducted. We hypothesized that observer accuracy and identification would become more acute by listening to and comparing field observer point count data with electronic field recordings as the field season progresses.

(Co-Author: Randall DeJong)

*“In-Depth Analysis of Bacteriophage Esperanza”*

The bacterial communities in the gut of the *Biomphalaria glabrata* snail were characterized and examined for bacteriophages (viruses that infect bacteria). Phages are thought to play an important role in the bacterial communities of many different organisms, however few studies have examined the relationship between phages and the bacterial communities of invertebrates. The *Biomphalaria glabrata*

snail was selected because of its impact on humans; *Biomphalaria glabrata* snails often act as intermediate hosts for human infectious parasites. Esperanza is a bacteriophage isolated from *Citrobacter* and *Enterobacter* bacterial hosts from the gut of the *Biomphalaria glabrata* snail. Three separate copies of Esperanza's genome were isolated and sequenced, coming back with quite a few differences between them. Various genome analysis programs were used to examine the differences between these genomes, and most of the differences were determined to be sequencing artifacts. A transposable element was found in one copy of the genome, showcasing a snapshot of viral evolution. qPCR was attempted to determine the presence and amount of Esperanza in *Biomphalaria glabrata* snails, but a reliable qPCR assay has been difficult to develop. A metagenomic study of the viral community in the gut of *Biomphalaria glabrata* snails is in progress.

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**52. Rachel VanOeffelen, Calvin College**

**Biology**

(Co-Authors: Rachel VanOeffelen, Paula Kuiper, Herb Fyneweaver)

*"What kind of professor are you?"*

Our goal with this project, ultimately, is to help teachers be more effective – to improve learning in the classroom. What we have noticed is that there are a lot of good teachers out there, but they are good for different reasons. We hope to make teachers aware that no matter what teaching style they are comfortable with, there are ways for them to implement good teaching practices into their classroom. We desire to develop a survey to help teachers figure out which ideal types they identify with. Our future work consists of: Developing pilot questions from our data Testing the validity of our survey through Administration of pilot questions Factor analysis Revision and repeat Our research is starting to piece together and we are very excited for what is to come in the future.

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**53. Lauren Verstraete, Calvin College**

**Biology**

*"The Effect of Prairie Burns on Insect Populations at Flat Iron Lake, Kent County, MI"*

Controlled prairie burns are a part of proper land management. Prairies developed over millions of years to recover from and thrive with occasional wildfires started by lightning strikes. These burns reduce leaf litter, prevent shrub overgrowth, and suppress invasive species. However, it is not always clear how frequently burns should occur. Burning too frequently destroys insects and their eggs so much that they cannot repopulate the area. At Flat Iron Lake Preserve Calvin has alternately burned half of the preserve space each spring. The current project seeks to begin building an inventory of insect species in the prairie and to analyze the population structures of the prairie sections burned in spring 2013 and 2012. Insect samples were collected in pitfall traps. Transects of six traps each were set over 15m, paired by north- and south-facing aspect and by burn status of the sites. For 14 days all traps were sampled simultaneously for the burn comparison. 156 species were identified across 18 orders. It is clear from the data that there are population differences between the sites burned in 2012 and 2013. For most orders there were fewer individuals in the two-month burn site than in the year burn site. The most striking instance is in Collembola, the springtails, who had a striking 25 times the individuals in the year burn site.

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**54. Jake Waldvogel, Siena Heights University**  
(Co-Authors: R.R. Smith, J.L. Bateson and M.J. Luce)

**Biology**

*“Glyphosate decreases the reproductive success of the red worm, Eisenia fetida”*

We examined the effect of glyphosate, the active ingredient in the herbicide Roundup, on the reproductive success of the red worm, *Eisenia fetida*. An initial group of 40 worms was placed in each of three 5 gallon containers with approximately one cubic foot of bedding and maintained over a period of 8 weeks. One group of 40 worms was exposed every 2 weeks to the dose of Roundup recommended by the manufacturer for garden plot preparation or lawn replacement. The second group of 40 worms was exposed every 2 weeks to twice this dose. The third group served as a control, receiving no glyphosate exposure. We collected cocoons from each of the 3 containers every 2 weeks, isolated the cocoons, and monitored the hatching of juveniles for a period of 100 days. Our results indicate that glyphosate has a significant effect on cocoon production, reducing by about half the average number of cocoons produced per worm per week. This effect seemed to become more severe upon repeated, long-term exposure. The effect of glyphosate on the number of juveniles hatched from these cocoons was less pronounced, with each of the 3 groups producing about the same number of juveniles per cocoon. These results suggest a detrimental effect of this widely used herbicide on earthworm populations.

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**55. Tiffany Wells, Siena Heights University**

**Biology**

*“The Larva Survival and Development of Pieris rapae on Berteroa incana”*

The purpose of this project was to determine if *Berteroa incana* (Hoary Alyssum), a common summer wild flower, is a host for *Pieris rapae* (Small Cabbage White Butterfly), a serious cabbage pest. *B. incana* is a member of the cabbage family and *P. rapae* is a cabbage pest, but it is unknown whether *P. rapae* can complete its life cycle on *B. incana*. For the experiments, lab-reared butterflies were allowed to lay eggs on *B. incana* and the resulting larvae were observed, counted, and measured until they pupated. It was found that *P. rapae* could complete its life cycle on *B. incana* but with a 3.8-15.5% survival rate from egg to butterfly emergence. This work demonstrates that *B. incana* could serve as a natural host plant for *P. rapae*.

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**56. Christine Wiersma, Alma College**  
(Co-Authors: Shannon J. Timpe, Brian J. Doyle)

**Biology**

*“A Quartz Crystal Microbalance Biosensor for Screening Botanical Extracts”*

The development of new label-free assays is important for detection of unknown, biologically active chemicals in complex mixtures such as botanical extracts. A quartz crystal microbalance (QCM) can be used to measure the change in mass that occurs due to the binding of a ligand to a drug target protein when the protein is immobilized to the surface of a quartz crystal. This change in mass at the sensor surface results in a decrease in the natural resonant frequency of the crystal, and the mass of bound molecules can be calculated from this change in frequency. In this study, bovine serum albumin (BSA) was immobilized to the gold surface of a quartz crystal, then this surface was exposed to two different botanical extracts, turmeric root (*Curcuma longa*) and ginkgo leaf (*Ginkgo biloba*) at a concentration of 10 µg/mL. Binding of phytochemicals to the BSA protein was observed in both extracts. Frequency

changes of 8.43 Hz (110 ng ) and 6.75 Hz (90 ng ) were observed for the ginkgo extract and the turmeric extract, respectively. The results of these experiments will inform the development of a MEMS biosensor microarray that operates on a similar principle, and that will allow simultaneous detection of molecular interactions with multiple target proteins.

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**57. John Boss, Hope College**

**Biomedical Engineering**

(Co-Authors: Julia Slopsema, Johanna Forst, Derek Blok, Dr. Katharine Polasek)

*“Feasibility of Surface Stimulation to Alleviate Phantom Limb Pain”*

Phantom limb pain occurs to some degree in a majority of amputees with no known successful treatments. The overall goal of this project is to develop a non-invasive treatment to alleviate phantom limb pain. A leading hypothesis suggests that cortical reorganization (the remapping of the somatosensory cortex) could lead to phantom limb pain. To potentially reverse this, the median and ulnar nerves could be stimulated to provide their respective regions in the cortex with sensory information from the hand. Previous work had been conducted to acquire effective stimulation parameters to stimulate subjects’ median and ulnar nerves. In this study, stimulation amplitude and pulse width were varied within that effective space. Sensation strength, type (buzzing, tingling, pressing, etc.), and location in the hand were then recorded. Approximately 11% of the trials produced natural sensation when stimulating subjects’ median nerve. When subjects’ ulnar nerve was stimulated, 9% of the trials yielded natural sensation. In each test, subjects experienced sensations in larger areas of the hand when the stimulation strength increased. It was concluded that we could effectively induce unnatural sensation in both the medial and lateral portions of the hand. Future directions include using varying waveforms to obtain more natural sensation.

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**58. Lane Heyboer & Carson Tobias, Hope College**

**Biomedical Engineering**

*“Alleviation of Phantom Limb Pain through Surface Stimulation”*

Phantom limb pain is a post-amputation phenomenon where an amputee experiences painful sensations in their missing limb. The cause of phantom limb pain may be cortical reorganization, which occurs when areas that controlled the missing limb are activated by adjacent areas of the cerebral cortex. This reorganization could result in painful sensations when an adjacent area is touched. By using electrical stimuli as a substitute for sensory input from the missing limb, cortical reorganization may be reversed and therefore provide some relief from phantom limb pain. Previous studies by our group used voltage control stimulation while many other electrical stimulation applications used current control. The goal of this study was to compare the different sensations obtained between the two types of stimulation. The hand thresholds and maximum stimulation were determined to define the parameter space. Points within that area were tested at 100 $\mu$ s and 500 $\mu$ s pulse widths, all at 25%, 50%, and 75% of the range between the hand thresholds and maximum stimulation. These points were tested varying between current and voltage controlled stimulation. The type, magnitude, and location of sensation were recorded for each trial. Hand sensation and magnitude results were similar between the two types of stimulation; therefore voltage controlled stimulation will be used in future trials as there is less risk for painful sensation during testing.

*“Stress Resistance and Longevity can be Experimentally Dissociated”*

As the world increases in age, so does its population of people over the age of 60. With this sharp increase in people over 60 there is a bigger drive to figure out what exactly aging is and what part does in play in diseases, such as Parkinson’s and Alzheimer’s Disease. To help unravel the mystery that is aging, a small worm, called *C. elegans*, have been the primary model in aging studies. *C. elegans* have a fully sequenced genome and a short lifespan which makes it a convenient model for aging studies. Also the first gene that extends lifespan, *daf-2*, was discovered in *C. elegans*. Throughout past studies, it appears that these genes that extend lifespan, such as *daf-2*, have also shown an increase in resistance to stress. In this work the longevity and stress relationship was tested to see if stress resistance was necessary for longevity. What was found in this study was that stress resistance could be experimentally dissociated from longevity.

*“Paraffin Wax Sealing of Carbon Fiber Microelectrodes is a Comparable Electrode Sealing Agent to Epoxy”*

Fast-scan cyclic voltammetry (FSCV) is a powerful technique for measuring sub-second changes in neurotransmitter levels. One of the greatest limiting factors in the use of FSCV is the production of high quality recording electrodes; the most common recording electrode consists of cylindrical carbon-fiber encased in borosilicate glass. When the borosilicate is heated and pulled, the molten glass ideally forms a tight seal around the carbon-fiber cylinder. It is often difficult, however, to guarantee a perfect seal between the glass and carbon. Indeed, much of the time spent creating electrodes is in an effort to find a good seal. To that end, many labs will utilize epoxy resins to generate a seal between the surrounding glass and carbon. While this can be effective, it is irreversible (seals cannot be adjusted), wasteful (it cannot be reused once hardener is added), hazardous (hardeners are toxic), and requires extensive curing times and/or conditions. Herein we describe the use of paraffin as a novel electrode sealant for FSCV borosilicate cylinder electrodes. Paraffin boasts the advantages of immediate curing times, resealing capability, and lack of toxicity. It is reusable, cheap, simple, and provides stable waterproof seals capable of withstanding normal mammalian body temperatures. Electrode tips were broken and resealed with paraffin embedding wax, store-bought household paraffin wax, or epoxy resin. Excess wax was removed from the carbon surface by repeated cycling at an extended waveform (-0.4 to 1.4V, 400 V/s, 60 Hz) until the electrode size stabilized, at which point it was switched to a more standard waveform (-0.4 to 1.3V, 400 V/s, 10 Hz) and cycled until stable. Excess epoxy was removed with xylene prior to hardening and electrodes cycled at the 1.3V waveform until stable. Paraffin-sealed electrodes were just as effective at detecting dopamine as glass or epoxy-sealed electrodes, were stable, and caused a dramatic increase in the throughput of electrode production. From this it is clear that paraffin wax is an effective sealant for FSCV electrodes that not only decreases electrode production times, but provides a convenient substitute to epoxy sealants.

*“Screening the effects of candidate self-renewal regulatory genes in the developing chick embryo”*

Neural stem cells divide to produce daughter cells with the same developmental potential as their mother cell through the process of self-renewal. Many cell-intrinsic factors work to mediate this process. Here, we selected genes highly enriched in the neural stem cell pool of the developing nervous system to explore their potential role in self-renewal. Among these candidate genes is the homeobox transcription factor Barx2, previously shown to regulate chondrogenic differentiation, and zscan21, a gene that is upregulated in glioma and in neural stem cell populations. Utilizing In ovo electroporation, we overexpressed Barx2 in the developing chick neural tube to determine if it is sufficient for promoting proliferation and/or controlling differentiation of stem cells, two important regulators of self-renewal. Preliminary results suggest that overexpression of Barx2 enlarges the size of the ventricular zone of the developing spinal cord, indicating it may drive cell proliferation. Labeling for known markers of cell proliferation will give added insight into this effect. We also show progress with Zscan21, which is upregulated in glioma. These studies may further reveal the mechanisms that drive neural stem cell self-renewal, a process misregulated in the formation of central nervous system tumors.

*“Activation of Neuroprotective Receptors in Pig Retina: Implications for Glaucoma?”*

Glaucoma, a neurodegenerative disease, is a leading cause of blindness. It is associated with increased intraocular pressure that may lead to death of retinal ganglion cells (RGCs). Activation of nicotinic acetylcholine receptors (nAChRs) has been shown to have neuroprotective effects against this neurodegeneration. Activation of  $\alpha 7$  nAChRs enables isolated pig RGCs to survive toxic culture conditions. Previous results in our lab showed that a selective  $\alpha 7$  nAChR agonist displayed significant neuroprotective effects at concentrations in the low nanomolar range. In addition, a selective allosteric modulator enhanced the protective action of the agonist in a dose-dependent manner, with maximal effects exceeding cell-survival seen under control conditions. Preliminary results using a mitotic inhibitor indicate the enhanced cell-survival over control conditions is due to RGC division. Another study in our lab has been examining whether a potential Alzheimer’s drug can increase ACh release in the retina, as in the brain, to activate these neuroprotective receptors. Retinal ACh was labeled with tritium and release measured with a liquid scintillation counter. Flashing light (3Hz), selective nAChR compounds and elevated potassium were used as controls. Preliminary results show a dose-dependent increase in ACh release. Future experiments will try to determine the full dose-response characteristics, site of action in retinal circuitry, and possible effects on physiological responses of ACh release enhancers. Collectively, these results suggest that direct activation/modulation of nAChR and/or the indirect activation by increased ACh release may provide a novel therapeutic approach to combating RGC death observed in glaucoma.

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**63. Adam McMillan, Grand Valley State University****Biomedical Sciences**

(Co-Authors: Micheal Snider, Bopaiah Biddanda)

*“Motility of Lake Huron Cyanobacterial Mats”*

Cynobacteria residing in Lake Huron sinkholes form a unique mat community that relies upon communication and motility of individual filaments for survival in an extreme environment characterized by low-light, -oxygen and high-sulfur. These photosynthetic cyanobacteria, a type of Oscillatoria, use motility to optimize light intake, manage resources effectively, and sustain a symbiotic community. The problem of characterizing motility in regards to light availability and inter-filament communication, among other stimuli, can be investigated through the use of microscopy utilizing image analysis software and using a Diving PAM Underwater Fluorometer. By experimenting with simple petri dish analog communities in the lab, stimuli-dependent motile response behaviors were analyzed by measuring movement speed and distance traveled along with effective photochemical quantum yield. Individual filaments were characterized along with effective response groups, those aggregations of bacteria that responded identically to the same stimulus. These techniques also allowed for empirical analysis of toxic mechanisms and filament axial alignment determining direction as a pursuit of a parallel understanding of corresponding mat dynamics. Findings showed precision of movement in response to light and mat building behavior dependent upon inter-filament contact-mechanistic motility. The behavior described has profound implications for these extremophiles, encompassing coordination of communication to ensure community organization and survival. Such presumably long-evolved mat communities may reveal clues to cyanobacteria’s survival in early Earth and may be reservoirs of biochemical compounds of pharmaceutical value.

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**64. Chelsea Meloche, Grand Valley State University****Biomedical Sciences***“Utilizing Biomass As An Energy Source”*

Biomass, in this case cow manure, contains bacteria that are aerobic and anaerobic. The anaerobic microbes undergo multiple reactions in anaerobic digestion; during this process they enter four main reactions. These reactions include: hydrolysis, acidogenesis, acetogenesis and the final reaction, methanogenesis where methane is being produced thus being utilized as a source of energy.

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**65. Dana Collins & Michael Kneeshaw, Grand Valley State University****Biomedical Sciences**

(Co-Author: Dr. John Capodilupo)

*“Immunodetection of Isoforms of GAP-43”*

Growth Associated Protein-43 (GAP-43), found within the pre-synaptic terminals, has been shown to become phosphorylated due to increased activity of PKC (Protein Kinase C) during increased brain activity. The levels of phosphorylated forms of GAP-43 have been shown to increase following paradigms for learning and memory in a variety of species including primates, rats and mice. Current interests are to determine if significant changes in the levels of phosphorylated GAP-43 isoforms are associated with the dementing process of Alzheimer’s disease (AD). If significant differences are detected, phosphorylated isoforms of GAP-43 could be used as a biomarker for cognition. 2D western blots, immunodetection and primate brain matter, were used to enhance our resolution from a previous

study. We hope to eventually determine a baseline value of phosphorylated GAP-43 proteins in baboon brain matter. Upon completion of the experiments, we will determine if our techniques will be adequate for analysis of human AD brain tissue.

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**66. Ellie Morrison, Grand Valley State University**

**Biomedical Sciences**

(Co-Author: Dr. Margaret Dietrich)

*“Atypical Apical Growth, Timing and Hormone Response in a Physcomitrella patens Developmental Mutant”*

The moss, *P. patens*, is used as a model organism due to its simple development and the fact that its genomic sequence closely resembles that of the most basal of extant land plants. In particular, it is used for the study of apical (tip) growth, a process which underlies root hair and pollen tube growth in vascular plants. The protonema of *P. patens* is a filamentous network of chloronema and caulonema cells, which develop via apical growth. Here we analyze the development of a mutant on different media (nutrient rich and poor, plus and minus auxin) following mechanical fragmentation. When compared to the wild type, the mutant was found to exhibit: 1) an increased number of new polar growth initiations on chloronema cells, 2) delayed transition from chloronema to caulonema, which is especially evident in media containing auxin, 3) atypical timing of new polar growth initiations, in that it occurs on the first subapical cell rather than the second as in the wild type, 4) curling and/or undulating growth under nutrient-deficient conditions, and 5) differences in filament dimensions, with the biggest filaments produced under nutrient rich conditions plus or minus auxin. The basis for all of these observations lies with a defect in the mechanics of apical growth. Future genetic analysis will reveal the molecular underpinnings of this mutant.

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**67. Craig Russo & Kasey McKay, Grand Valley State University**

**Biomedical Sciences**

(Co-Authors: Joshua Lee and Merritt Taylor)

*“Screening the effects of candidate self-renewal regulatory genes in the developing chick embryo”*

Neural stem cells divide to produce daughter cells with the same developmental potential as their mother cell through the process of self-renewal. Many cell-intrinsic factors work to mediate this process. Here, we selected genes highly enriched in the neural stem cell pool of the developing nervous system to explore their potential role in self-renewal. Among these candidate genes is the homeobox transcription factor Barx2, previously shown to regulate chondrogenic differentiation, and zscan21, a gene that is upregulated in glioma and in neural stem cell populations. Utilizing In ovo electroporation, we overexpressed Barx2 in the developing chick neural tube to determine if it is sufficient for promoting proliferation and/or controlling differentiation of stem cells, two important regulators of self-renewal. Preliminary results suggest that overexpression of Barx2 enlarges the size of the ventricular zone of the developing spinal cord, indicating it may drive cell proliferation. Labeling for known markers of cell proliferation will give added insight into this effect. We also show progress with Zscan21, which is upregulated in glioma. These studies may further reveal the mechanisms that drive neural stem cell self-renewal, a process misregulated in the formation of central nervous system tumors.

*“Novel Biphenyl Ureas as Regulators of the Trace Amine Associated Receptor”*

The thyroid hormone (TH) regulates many physiological functions in vertebrates including the cardiovascular system, metabolism, brain development, and growth. A person suffering from a thyroid disorder can experience symptoms in these areas, and if left untreated, only get worse. Unfortunately, there are limited treatment options because thyroid hormone biology is not completely understood. Recent research has shown that T1AM, a compound found in various tissues throughout the body, may play a role in thyroid hormone regulation. T1AM acts on the Trace Amine Associated Receptor (TAAR). TAAR activation leads to physiological effects in opposition to those induced by TH. The goal of this project is to develop novel T1AM derivatives to better understand the role of TAAR and T1AM in TH biology. Specifically, these compounds will incorporate an extra phenyl ring and based on previous work may be antagonists for TAAR. Selective regulators for TAAR will be valuable biological tools.

(Co-Author: David Kurjiaka, PhD)

*“Effect Of Fatty Acid Structure On Endothelial Cell Connexin43 Levels”*

Obesity is one of the greatest health concerns in the Western world due to the increased risk of cardiovascular diseases. The positive energy balance that occurs with obesity can increase circulating fatty acids. Elevations in fatty acids likely compromise vascular endothelial cell function thereby contributing to the increased disease risk. Connexin protein expression is an indicator of endothelial cell function with increases in Cx43 expression linked to poor cell health. Thus, we assessed the impact of fatty acids on the expression of Cx43 protein in vascular endothelial cells. In particular, we wanted to determine the impact of fatty acid structure. The concentration dependence of Cx43 expression by stearic (saturated), oleic (cis), linoleic (omega-6), and elaidic acid (trans) were assessed after 24 hr. In addition, time dependence (0.5, 12, 24, and 48 hours) was assessed at the concentration that had the greatest Cx43 expression at 24 hrs.

*“The Mathematics of the Lipid Monoolein and its Cubic Phases”*

Lipids can form various shapes in water, called phases, and at different temperature, phases can change shape. These phase transitions integral to various cellular processes, such as division and pore formation. Furthermore, sugar helps stabilize cell membranes against dehydration and freezing. Understanding more about either of these is vital to knowing the processes that take place within cell membranes. Using a differential scanning calorimeter, or DSC, the phase transitions of the lipid monoolein when in a solution were analyzed by the energy they took in or gave off. Monoolein was chosen specifically because in recent years, a large amount of research has been done on it and the amount of patents related to monoolein has climbed significantly. Then, by using Avrami theory, how the lipids change phase was determined more precisely. Using mathematical equations and the online math program Sage, several surfaces of lipid phases were graphed to scale, allowing for comparisons between them. The cubic phases were particularly examined; based on a type of surface called minimal

surfaces, cubic phases can tessellate infinitely and in three dimensions, and were a major focus during the research.

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**71. Raven Dekker, Ferris State University**

**Biotechnology**

(Co-Authors: Piyadarsha Amaratunga, PhD, Bridget Lorenz Lemberg, Raven Dekker)

*“Evaluation of Amphetamine ELISA Screening Plates”*

Forensic Fluids Laboratories (FFL) uses ELISA plates to screen for the presence of amphetamines in oral fluid samples. This research study was designed to evaluate the precision, sensitivity and cross-reactivity of amphetamine plates manufactured by three different vendors: OraSure, Immunalysis and IDS. Each ELISA plate was validated according to a general protocol developed by FFL. The results indicated that the IDS plate was the most precise, the Immunalysis plate was the most sensitive, and the OraSure plate was the most selective. The basis of the screen will determine which plate is best for that particular screen.

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**72. Jamie Hook, Ferris State University**

**Biotechnology**

(Co-Authors: Xin Hong, Steve Kalkanis)

*“Expression of stem cell marker nestin is correlated with glioblastoma cell proliferation”*

Nestin is a type VI intermediate filament protein that labels neuroepithelial stem cells. In adults, Nestin occurs only in a small subset of cells and tissues including populations of neural stem cells in the subventricular zone and regenerating astrocytes. Nestin in U251n cells was down-regulating using microRNA technique. Human Nestin gene was cloned and constructed a Nestin expression plasmid using pcDNA3.1 vector. After down regulation tested proliferation, migration, invasion and colony formation of these cells in vitro. After performing Dot Blot assay and Western Blot assay, it was clear that as the wavelength increased, the cell proliferation increased and there was fewer cells seen. When performing a wound healing assay, the negative control had barely any cell migration to the center which was expected, with the RNAi 590 cells, there was an extensive amount of cell migration to the center. A Western Blot was also performed to detect key cell signaling kinases. The one that had a noticeable difference was p-AKT which decreases after Nestin down regulation. Cell migration from spheres showed that the cells tended to migrate farther the more Nestin was down regulated. When colony formation was investigated in soft agar, it showed that increased down-regulation of Nestin in U251n cells caused less colonies to be present on the soft agar. Viewing the colonies under a bright field microscope confirmed this. Nestin is correlated with cell proliferation not cell growth.

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**73. Allison Hosmer, Ferris State University**

**Biotechnology**

*“Substrate Ubiquitylation by K6-only Ubiquitin”*

Ubiquitin is a small 8.5 KDa regulatory protein composed of 76 amino acids and is found in the tissues of all eukaryotic organisms. Among other functions, ubiquitin plays an essential role in protein degradation by acting as a tag that marks proteins to be recognized by the proteasome. Ubiquitin covalently attaches to a target protein through the formation of an isopeptide bond between its terminal glycine and an amino group of the protein. The amino group is usually a lysine residue on the target protein in a process known as mono-ubiquitylation. Additional ubiquitin molecules can then be attached to this initial bound ubiquitin to form polyubiquitin chains by any of the seven lysine residues

of ubiquitin. Polyubiquitin chains can be produced for specific lysine residues by ubiquitin mutants (K6, K11, K27, K29, K33, K48, and K63) containing only a single lysine at a specific position. The lysines at the other six positions are mutated to arginine and are unable to form an isopeptide bond at that position. A K6 only ubiquitin mutant was purified by ammonium sulfate precipitation and multistep chromatography. An in vitro ubiquitinylation reaction was performed by adding the purified K6 mutant, E1, E2, and ATP which resulted in a K6 ubiquitylated substrate. K6 ubiquitylated conjugates can potentially be used as deubiquitylating enzyme substrates. USP-2 a general deubiquitylating enzyme was used to demonstrate that a K6 ubiquitylated substrate was formed.

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**74. Chase Judy & John Letherer, Ferris State University**

**Biotechnology**

(Co-Authors: Clarence Salazar, Aminna McGee, Abigail Solitro, and Bradley J. Isler)

*“A study of the association between anophthalmic conditions and variation in several candidate genes in rats”*

The purpose of this study was to investigate the association between anophthalmia and microphthalmia and SNPs within several candidate genes in rats. Anophthalmia and microphthalmia are genetic abnormalities that result in the reduction or absence of one or both of the eyes. DNA was isolated from three lines of inbred rats selected for the wild type (WT), anophthalmic (ANOP), and microphthalmic (MICRO) phenotypes. Six primer sets were designed to investigate the presence of SNPs in the Rax and Pax6 genes. DNA was pooled by combining five individuals from each line, the DNA was sequenced using an ABI 310 genetic analyzer, and then aligned using DNASTar. Alignments between pools were used to detect between line variations and three primer sets were subsequently selected for sequencing of individual animals. Individual sequences were aligned and three SNPs were detected. All three SNPs were heterozygous C/T in the WT and homozygous T/T in the ANOP and MICRO lines. Comparison between WT and ANOP lines showed no variation at aligned human SNPs from dbSNP that were previously cited by other researchers as having associations with the ANOP and MICRO conditions in humans. Overall we detected several promising SNPs, but found none that appear to be directly or indirectly associated with changes to exonic sequence. Our next step is to look at the remaining candidate genes OTX2, Sox2, and FoxE3 and the regulatory regions surrounding all candidate genes.

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**75. Shaughna Langerak, Ferris State University**

**Biotechnology**

(Co-Author: Dr. C. Zhu)

*“Dosage effect of TGF- $\beta$  signaling on aging regulation in Fruit flies (*Drosophila melanogaster*)”*

Aging is a naturally occurring body changing process that every species has to face, including humans. How does aging take place? What factors could lead to accelerated or delayed aging process? To answer these questions, we specifically tested the potential function of Dpp/Gbb signaling components from the TGF- $\beta$  family (Transforming Growth Factor-  $\beta$ ) on aging and lifespan regulation in fruit flies, using a genetic approach this summer. Our data shows that heterozygous fruit flies carrying a mutated allele for individual signaling components of Dpp/Gbb signaling pathway displayed delayed aging process and prolonged lifespan when they were compared to near-isogenic controls. This data suggests that Dpp/Gbb signaling may have a dosage effect on aging regulation. Higher dose of Dpp/Gbb signaling causes accelerated aging and shorter lifespan while lower dose of the signaling delays the aging process and leads to longer lifespan. These findings have medical implications since the Dpp/Gbb signaling pathway is highly conserved across species including humans.

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**76. Mallory Smith, Ferris State University****Biotechnology**

(Co-Authors: Dr. Gary Rodabaugh; Ferris State University-Biology Department, Lead Forensic Advisor Mallory Smith; Ferris State University-Biotechnology/Forensic Biology)

*“The Effect of Sunscreen on the Rate of Decomposition”*

During the summer of 2012, ten pork loins were studied under varying chemical conditions. Each loin was subjected to the same time frame and weather conditions, but four of six active ingredients of Banana Boat sunscreen (SPF 30) each coated a pork loin, and five other brands of sunscreen each coated the other five pork loins. All sunscreens studied were SPF 30. The project took place over a fifteen day period. The results indicate a combination of three chemicals may be responsible for delaying the onset or decreasing the rate of decomposition. These results become pertinent when determining a potential time of death in a homicide investigation.

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**77. Zachary DeBruine, Hope College****Cell and Molecular Biology**

(Co-Author: Dr. Maria Burnatowska-Hledin)

*“Antiproliferative Effect of Resveratrol in Rat Endothelial Cells in vitro is Dependent on the Post-translational Modification of VACM-1/cul5”*

Expression of the VACM-1/cul5 gene in vitro inhibits cellular growth by a mechanism which involves MAPK, estrogen receptor (ER)- $\alpha$ , and p53 signaling pathways. We have shown previously that the antiproliferative effect of VACM-1/cul5 is enhanced by Resveratrol in both endothelial cells and in breast cancer T47D cells. The mechanism by which Resveratrol enhances the antiproliferative effect of VACM-1/cul5 is not well understood and may involve post-translational modification of VACM-1/cul5 by Nedd8, an ubiquitin-like protein. Thus, the aim of this study was to determine if the effect of Resveratrol on cell growth is dependent on neddylation of VACM-1/cul5. Nedd8-aldehyde (N8a) was used to inhibit the de-neddylation process. Our results in Rat Endothelial Cells (RAMEC) showed that treatment with Resveratrol prevents the proliferative stimuli of N8a. These data support the hypothesis that Resveratrol enhances the anti-proliferative effect of VACM-1/cul5 by regulating its neddylation. In conclusion, our study suggests that the control of VACM-1/cul5 neddylation may be an effective target for anticancer drugs.

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**78. Alexander Fisch, Grand Valley State University****Cell and Molecular Biology**

(Co-Authors: Rebecca Uzarski, Robert Smart, William Schroeder, Osman Patel)

*“Effect of Telomerase Inhibitors on Malignant Breast Cancer Cells”*

Current therapies have nominal effect on the most intrusive-type of breast cancers (triple-negative) that have a higher tendency to metastasize or recur. Recent studies reveal an enzyme, telomerase, as key for unlimited cell growth (immortality) and replication. Therefore, our objectives were to assess (i) short- and (ii) long-term effects of a novel anti-telomerase agent (GV6) developed at our institute and compare it to a known analogue, BIBR1532, on MDA-MB 231 breast cancer cells. Cell viability was measured on days 5, 9, 14, 18 and 27 after treatment with GV6 (n=4), BIBR1532 (n=4) or Solvent alone (Control, n=3). The number of viable cells in GV6 and BIBR1532 treated flasks (T75) were about 40% (p<.05) of Control by day 14. It further dropped to 30% (p<.05) of Control by day 27 for both, GV6 and BIBR1532. Our

results indicate that the anti-proliferative effect of GV6 parallels that of BIBR1532 and further studies are necessary to explore the potential application of GV6 as an anticancer therapy.

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**79. Jamie Grit, Hope College**

**Cell and Molecular Biology**

(Co-Author: Dr. Steven J. Triezenberg)

*“Post-translational modification of a key transcription factor for herpes simplex virus infection”*

Herpes simplex virus type 1 (HSV-1) is a highly prevalent human virus that causes cold sores. The HSV-1 virion contains VP16, a potent transcriptional activator that recruits host cell proteins, including Oct-1, to initiate viral immediate early (IE) gene expression and therefore the lytic cycle. VP16 is also an important structural protein within the viral tegument. As VP16 is so multifunctional, we hypothesize that phosphorylation of serine 375 of VP16 is important for the regulation of VP16's function throughout different times during the lytic cycle. Immunoblots revealed serine 375 phosphorylation at 20 hpi (hours post infection). Immunofluorescence assays of infected cells revealed detectable VP16 phosphorylation by 8 hpi, with dramatic increases through 24 hpi. The phosphorylated VP16 appeared to localize to perinuclear “caps and spots” during these late times. Phosphorylated VP16 was also detected in the virions by western blot. These data indicate that phosphorylation of serine 375 may be necessary for VP16's role as a tegument protein. Future work will characterize the function of the “caps and spots” and determine if they are sites of tegument packaging or viral egress.

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**80. Ryan Hoogmoed, Grand Valley State University**

**Cell and Molecular Biology**

(Co-Authors: Ryan C. Hoogmoed, Neil V. Klinger, Rachel A. Powers)

*“Fragment-based discovery of novel inhibitors for the class D  $\beta$ -lactamase OXA-24”*

Since the discovery of the penicillin,  $\beta$ -lactam antibiotics have emerged as the preferred and most widely used antimicrobial agents. However, due to overuse of  $\beta$ -lactams, bacteria have become resistant to these therapeutics. The principal mechanism by which bacteria acquire resistances is through the expression of  $\beta$ -lactamase enzymes, which hydrolyze the  $\beta$ -lactam bond and render the antibiotic useless. Of the four known classes of  $\beta$ -lactamases (A-D), class D  $\beta$ -lactamases are the most diverse and pose a threat to the carbapenems, which are considered to be the “last resort”  $\beta$ -lactam antibiotics. Class D  $\beta$ -lactamases can be found in multi-drug resistant bacteria, such as *Pseudomonas aeruginosa* and *Acinetobacter baumannii*. Currently all clinically available inhibitors of  $\beta$ -lactamases contain the same  $\beta$ -lactam ring scaffold found in  $\beta$ -lactam antibiotics. In addition to the problem of containing the structure that  $\beta$ -lactamases have evolved to breakdown, available inhibitors also fail to affectively inhibit the class D  $\beta$ -lactamases. In order to address these serious problems, molecular docking was used to search for novel inhibitors of the class D enzymes. A database, of commercially-available chemical fragments, was screened against the class D  $\beta$ -lactamase OXA-24. Twenty-one compounds found in the top five hundred docking hit list were ordered and tested for inhibition of OXA-24. Of these fragments, four were found to have KI values of less than 5 mM. The structures of OXA-24 in complexes with two of the higher affinity inhibitors were determined to 1.67 Å and 1.78 Å resolution. The structural information gained from the complexes will be used to optimize this series of novel  $\beta$ -lactamase inhibitors.

(Co-Author: Dr. Margaret Dietrich)

*“Characterization of Polar Growth in a Physcomitrella patens Insertional Mutant”*

The characterization of polar growth can improve our understanding of the molecular mechanisms fundamental to root and pollen tube growth in angiosperms. Tip growth is critical as it increases the total root surface area for water and nutrient acquisition, and pollen tube growth is necessary for fertilization. This investigation aimed to determine the effect of a disrupted genomic sequence in *P. patens*, a model organism for the study of polar growth. We first characterized the recovery of tip growth from isolated protoplasts in early development of both the wild type and the mutant, and second, we continued characterizing polar growth in later development. Both the wild type and the mutant are able to recover tip growth. Normally the initial cell in the wild type is initiated on the second subapical caulonema cell while the filament tip cell keeps dividing. However, the initial cell is initiated on the first subapical cell in the mutant. Within ten days of growth, the wild type appeared very invasive covering a larger area than did the mutant, which also showed undulating filamentous growth. Finally, the wild type is able to develop completely to a young leafy gametophyte within 29 days; on the other hand, the mutant failed to develop leafy gametophytes as it stays in the chloronema-like caulonema stage. Our studies show that while the mutant can establish polar growth from protoplasts and can form initial cells, tip cell differentiation, the direction of tip cell growth, and the site of new polar growth initiations are all affected.

(Co-Authors: Andrew Neevel, Danielle Goodman, Megan Ludwig, Daniel Obregon, Virginia McDonough and Joseph Stuke)

*“Investigating the cytotoxic effects of mycobacteriophage Vix Gene 80”*

A bacteriophage is a virus that infects and reproduces in bacteria. During productive infections – those that result in construction and release of infectious phage particles – key host cell metabolic processes are modified by the infecting phage and redirected toward making new phage particles. Protein-protein interactions are likely involved in this process. In this work, gene 80 of mycobacteriophage Vix, a gene cytotoxic to host strain *Mycobacterium smegmatis*, was studied. Our hypothesis was that an interaction between the Vix80 gene product and a host cell protein caused growth inhibition. The Vix80 protein shares 68% amino acid identity with the product of gene 77 of mycobacteriophage L5. The L5\_77 protein has been previously shown to exhibit cytotoxic properties, and interacts with MSMEG\_3532, a L-serine dehydratase. The Vix80 and MSMEG\_3532 proteins were expressed in *Escherichia coli* and purified, but attempts to show a physical interaction in vitro have not succeeded. In addition, no interaction between Vix80 and MSMEG\_3532 was observed through two-hybrid analysis. However, Vix80 was shown to interact with itself through two-hybrid testing. HHMI-Pred analysis found that Vix80 contains a conserved domain of unknown function (DUF) near the N-terminus. The Vix80 gene was dissected, and the N-terminal 66 residues, encompassing the entire DUF, was found to be cytotoxic to *M. smegmatis*. DUF was found to be homologous to a region of three *M. smegmatis* ORFs, two of which are related by alternate initiation points of the same sequence. Efforts to test the interaction of Vix80 DUF with itself and the three host proteins are underway. Identifying the relevant phage and host gene products and understanding how phage exploit their host's weaknesses could lead to new therapeutic options for many bacterial illnesses.

*“Investigation of cellular interaction of Mid1 and potential phosphatase regulator, Dis2, in S. pombe”*

Affiliation: Grand Valley State University, Department of Cell and Molecular Biology, Allendale, MI 49401. Cell size, in accordance with shape, are principle factors contributing to the point at which a cell enters mitosis and ultimately divides into two equivalent daughters. In tandem with synthesizing the components that are essential for cell division, a determining characteristic of the G2 phase of the cell cycle is growth. In *Schizosaccharomyces pombe*, a concentration gradient regulates mitotic commitment with respect to cell growth. When the cell exits the DNA replicative S phase and enters the G2 phase, it is short and the majority of cell growth and elongation has yet to occur. A distinguishing feature of *S. pombe* cells is that they maintain a prolonged G2 phase when compared to other replication systems. At the beginning of G2 the cell is short, and as a result, there is an overlapping concentration of the negative mitotic regulator protein Pom1. As the cell elongates throughout G2, Pom1 concentration is maintained at high levels at the cell tips and progressively lower levels across the equator. Concurrently, positive mitotic regulators Cdr2 and Mid1 are restricted to the equator of the cell where the nucleus resides. Dis2 phosphatase at the cell tips leads to Pom1 binding the cortex. As Pom1 migrates towards the center of the cell from either tip, it autophosphorylates and dissociates from the cortex. Pom1 then migrates back towards the cell tip where Dis2 dephosphorylates it and the concentration gradient is maintained as the cell elongates. This trend continues until a growth threshold is reached where Mid1 has localized to the cortical interphase nodes and sets the stage for divisional septum formation. Mid1 serves as the scaffold that recruits proteins associated with the actin contractile ring, such as IQGAP protein Rng2 and myosin II essential light chain Cdc4, among various other proteins. Mid1 dissociates from the contractile ring as Sid2, the most downstream SIN kinase, is displaced from the spindle pole body to the division site to initiate contractile ring constriction. Though these interactions of Mid1 have been elucidated, many other Mid1 protein interactions may exist within the cell. A tandem affinity purification revealed Dis2 as a potential binding partner of Mid1, an interaction which has not yet been characterized. Preliminary results affirm that Dis2 dephosphorylates Mid1 in vitro. Mid1-GFP localization exhibits broad cytoplasmic distribution in *dis2Δ* cells when visualized in vivo. The principle aim of this investigation is to further elucidate the interactions between Mid1 and Dis2 and the factors that lead to their association. Grand Valley State University, Department of Cell and Molecular Biology, Allendale, MI 49401. This research is supported by National Science Foundation RUI Award #1157997.

*“Pistil Composition and Flower Morphology in Arabidopsis thaliana and a cbl10 Mutant”*

Unsustainable agricultural practices are rapidly degrading the world’s most fertile farm land. In order to secure the future of our food systems, it is important to understand how plants respond to environmental stresses, such as high-salt soil conditions caused by certain methods of irrigation. Studies have shown that the Calcineurin-B-like (CBL10) protein functions by binding calcium ions and is involved in the salt overly sensitive (SOS) signaling pathway in vegetative growth. In addition, this mutant exhibits a reproductive phenotype with stamens that are too short to self-fertilize and pollen tubes that do not properly elongate down the pistil for fertilization to take place. In order to investigate where CBL10 acts

in flower development, histological studies have been undertaken using hand-sectioned pistils and paraffin-embedded, microtome-sectioned flowers. A variety of stains have been used on hand-sectioned pistil samples, but we have yet to find any molecular staining differences between the wild-type and *cbl10* mutant pistils. These stains are also being performed on paraffin-embedded, microtome-sectioned flowers; in addition, the flower morphology will be assessed in these sections. Determining the role of CBL10 in flower development may help us better understand how plants deal with the stress of saline soil conditions and thus, may have enormous applications in agricultural regions of high soil salinity.

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**85. Mitch Roth, Grand Valley State University**

**Cell and Molecular Biology**

(Co-Author: Dr. Margaret Dietrich)

*“The Role of CBL10 in Stamen Development in Arabidopsis thaliana”*

For self-pollinating plants to produce seeds, the male and female floral organs must grow coordinately. Once the stamens grow tall enough and mature, the anthers release pollen onto the stigma, thus initiating fertilization. When *Arabidopsis thaliana* mutants unable to produce the Calcineurin B-like 10 (CBL10) protein are grown in standard conditions, floral growth and fertilization is relatively normal. However, when grown in the presence of 40mM NaCl, the stamens do not fully develop, preventing pollination and seed production, thus making the plant sterile. This suggests that the CBL10 protein aids in development of the stamen during salt stress, and initial RT-PCR results indicate a role in the jasmonic acid (JA) biosynthesis portion of the stamen development pathway. Gene expression comparisons of JA biosynthesis genes Allene Oxide Synthase (AOS) and Defective in Anther Dehiscence 1 (DAD1) between the normal and *cbl10* flowers are currently underway via RT-qPCR, using the validated references SAND and TIP41-like family genes. These reference genes were shown to be the most stable combination in our tissues of interest. Preliminary results indicate that AOS transcripts accumulate to a higher degree in NaCl-treated *cbl10* opening and first open flowers than in NaCl-treated WT flower clusters. Preliminary results with DAD1 expression indicate even more differences in transcript abundance. An understanding of this pathway may help us improve crop yields despite decreasing soil quality, such as high salinity from over-irrigation.

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**86. Patrick Schneider, Grand Valley State University**

**Cell and Molecular Biology**

(Co-Authors: Ashley DeWitt, Dawn M. Clifford Hart)

*“Codifying the proteins involved in the nuclear localization of the Mid1 protein in fission yeast cell division”*

The ability for *Schizosaccharomyces pombe* to undergo a successful round of cell division is contingent upon the regulation of protein rich punctate structures embedded within the medial regions of the yeast's cytoplasmic membrane. Cell cycle progression is directly correlated to fluctuations in the protein composition of these node-like frameworks. Mid1 is a prominent nodal protein that acts as a recruitment tool necessary to correctly assemble the contractile ring late in mitosis. During interphase, Mid1 localizes heavily within the nucleoplasm. Upon mitotic onset, a significant efflux of Mid1 from the nucleus is observed. This Mid1 emigration from the nucleus is regulated by the polo-like kinase Plo1. While this mechanism largely accounts for Mid1's cytoplasmic aggregation, little is known about the proteins involved in the extensive localization of Mid1 within the nucleus during interphase. Our ongoing research implicates Sid2 kinase as a viable candidate for such a task. Here we establish Mid1 as a substrate for Sid2 phosphorylation as well as Mid1's inability to enter the nucleus upon mutating its

Sid2 consensus motifs. In addition to these phosphorylation regions, there exists a classical nuclear localization sequence within Mid1's protein domain map. Its presence suggests the use of importin proteins to import Mid1 to the nucleus directly. Fission yeast contain two importin  $\alpha$  genes, imp1 and cut15, which may assist in Mid1's movement. Upon establishing the importin proteins responsible for Mid1's nucleocytoplasmic transport, the phosphorylation status of Mid1 will be investigated, as it may serve as a marker that affects its binding ability with the transport molecules. Furthermore, studies using importin  $\alpha$  orthologs have shown that they are phosphorylated by casein kinase II. Similar assays will be done to determine if this event is consistent within *S. pombe*, and if the potential phosphorylation of Imp1 and Cut15 affect Mid1 localization as well as their own. By determining mechanisms involved in Mid1's voyage during the cell cycle, cogent prospects can be made about points of regulation that contribute to Mid1 protein function.

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**87. Jordan Straight, Grand Valley State University**  
(Co-Author: Dr. Merritt Taylor)

**Cell and Molecular Biology**

*"Nato3 induces the expression of key DA neuron markers in a regionally and temporally specific manner within the developing CNS"*

In the developing stages of the central nervous system (CNS), neural stem cells gradually adopt specific cell fates and differentiate accordingly. The floor plate of the developing midbrain gives rise to dopaminergic (DA) neurons, an important class of neurons involved in Parkinson's disease. Better understanding of the mechanisms by which DA neurons are created is of great interest and would accelerate promising applications such as cell replacement therapies. Nato3, a basic helix-loop-helix transcription factor, is expressed in the floor plate region of the midbrain during development. In vitro studies suggest that Nato3 overexpression is sufficient to promote floor plate and DA neuron marker expression, whereas in vivo studies suggest that Nato3 is not. Here, we show that overexpression of Nato3 in the developing chick produces a regionally and temporally dependent increase in DA neuron markers Nurr1 (an immature DA neuron marker) and tyrosine hydroxylase (TH) (a mature DA neuron marker) within the ventral midbrain. In-ovo electroporation was used for transfection, and Nato3 overexpression was monitored using a bicistronic EGFP reporter expression vector. The observed effects were characterized by quantitative PCR and immunohistochemistry. The regionally specific action of Nato3 on DA neuron markers suggests that it is regulated by an unknown mechanism that functions early in development within the ventral midbrain. These data provide new insight into the action of Nato3 on DA neuron marker expression in vivo and help to better characterize the role that Nato3 plays in DA neurogenesis.

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**88. Katie Uhl, Grand Valley State University**

**Cell and Molecular Biology**

(Co-Authors: Katie Uhl, Dr. Robert Smart, Dr. William Schroeder)

*"Novel Telomerase Inhibitors synthesized from BIBR 1532 derivatives"*

As of 2011, cancer was the leading cause of death in the United States, second only to heart disease. Cancer is often referred to as being "immortal", because of its ability to divide a seemingly infinite amount of times. This ability stems from unusually high levels of telomerase. This project aimed to synthesize novel telomerase inhibitors that are derivatives of the compound BIBR 1532, which has already been proven to inhibit telomerase. The organic synthesis of these compounds took advantage of the synthesis of cinnamic acid, as well as the Schotten-Bauman protocol. The resulting compounds not

only include the active sites found on BIBR 1532, but have the added benefit of cinnamic acid's natural anti-cancer properties.

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**89. Leslie Wyman, Grand Valley State University**

**Cell and Molecular Biology**

(Co-Authors: Neil V. Klinger, Rachel A. Powers, Leslie A. Wyman)

*"Structure-Based Discovery of a Novel Inhibitor of OXA-1 Beta-lactamase"*

$\beta$ -lactams, like penicillin, are the most clinically prescribed antibiotics. However, due to their overuse, resistance has developed.  $\beta$ -lactamase enzymes are the most common resistance mechanism used by bacteria to combat the effects of these drugs. These enzymes efficiently hydrolyze the  $\beta$ -lactam ring that defines this class of antibiotics. In response,  $\beta$ -lactamase inhibitors were created to disrupt this type of bacterial resistance. Unfortunately, the structures of the inhibitors also contain a  $\beta$ -lactam ring. The chemical similarity has allowed for resistance to develop against the inhibitors as well. Additionally, these compounds do not inhibit members of the class D  $\beta$ -lactamases. Therefore, there is an urgent need for the discovery of a novel  $\beta$ -lactamase inhibitor that does not resemble a  $\beta$ -lactam. A structure-based approach was used to discover possibilities for potential novel  $\beta$ -lactamase inhibitors of the class D  $\beta$ -lactamase OXA-1, a key clinical target. The program DOCK was used to screen the ZINC database of commercially available compounds. Twenty-one compounds from the fragment subset were ordered and tested experimentally for inhibition of OXA-1. Of the twenty-one fragments tested, seven to inhibited OXA-1 with a  $K_i < 5\text{mM}$ . Subsequently, the structure of OXA-1 in complex with fragment 19 (150mM) was determined to 1.98 Å resolution. Using this structure as a template, optimization of a novel series of OXA-1 inhibitor is currently underway.

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**90. Corbin Jensen, Grand Rapids Community College**

**Cell and Molecular Biology/Genetics**

(Co-Authors: Corbin C. Jensen, Sander B. Frank, Cindy K. Miranti)

*"Investigating a Mechanism for p38-MAPK Regulation of Notch"*

Prostate cancer is the second leading cause of cancer related deaths in American men, with an estimated one in six men being diagnosed. The two major factors that drive prostate tumor progression are integrins and the androgen receptor (AR). A normal prostate gland is made up of two layers; the basal, or bottom, layer and the luminal, or top, layer. In a normal prostate the expression of integrins and the androgen receptor are mutually exclusive, with basal expression of integrins and luminal expression of AR. However in prostate cancer, there is a co-expression of integrins and AR. This abnormal co-expression results in enhanced survival and metastatic function in prostate tumors. One method for achieving a greater understanding of the role that AR and integrin co-expression have in prostate cancer is to first understand their roles in normal differentiation. In the normal formation of the normal prostate epithelium, the basal cells must differentiate to form the luminal cells. In order to accomplish normal differentiation the cells must halt expression of integrins and increase expression of AR. In prostate cancer the cell of origin is not known. One possibility however is that the co-expression of AR and integrins in prostate cancer arises from an alteration in the differentiation process. More specifically the cells don't fully turn off the expression of integrins when expression of AR increases. To test this hypothesis, our lab has created a model for in vitro differentiation in which primary prostate basal epithelial cells can undergo induced differentiation to form a bi-layer that closely resembles basal and luminal prostate cells in culture. Using this model, we then set out to gain a further understanding of oncogenesis, via an alteration of differentiation mechanism, in prostate cancer. We hypothesize that differentiation requires p38-MAPK signaling through Notch, which in turn results in the downstream repression of integrins. The p38-MAPK pathway is known to be involved in the initiation of differentiation in various other tissues, with preliminary data suggesting that is required in prostate

differentiation. This is the case in our differentiation model. When we introduced the p38 inhibitor SB202190, it resulted in the prevention of differentiation. Interesting was the fact the inhibitor had no effect of differentiation if the initiation of the differentiation process had begun prior to the addition of the inhibitor. This suggests that p38 is important in the initiation, not the sustaining, of the differentiation process. The role of sustaining differentiation seems to be driven by Notch signaling. In our model, the inhibition of Notch via the gamma-secretase inhibitor RO4929097, did not prevent differentiation from being initiated. However the inhibition of Notch resulted in premature death of the newly formed luminal cells. When Notch was inhibited, top layer cells formed but died shortly afterwards supporting the idea that Notch is required for the sustaining of prostate epithelial cell differentiation. Modulation of p38 expression in basal cells via siRNA or chemical inhibitor lead to a decrease in Notch 1 and Notch 3 protein, as well as a decrease in Notch 1 mRNA expression as determined by western blot and qRT-PCR analysis. When p38 expression was constitutively activated an increase in Notch 1 mRNA expression was observed. These data suggest that p38-MAPK can signal transcriptional regulation of Notch in normal prostate epithelium. Literature has hinted at this idea, however the mechanism remains unknown. Future experiments will further clarify the roles of p38-MAPK and Notch in prostate differentiation and resolve the mechanism of their interaction. Tet-inducible shRNA and cDNA will allow temporary knockdown or constitutively activation of p38 and Notch at various time points in the differentiation process. We will also knockdown p38 while activating Notch to interrogate and further understand the relationship and connection of the two pathways. A better understanding of the complex signaling pathways in normal prostate differentiation will provide a better context to understand how disruption of these pathways may be involved in oncogenesis.

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**91. Sarah VanOeveren, Grand Valley State University**  
(Co-Authors: Marian Testori and Dawn M. Clifford Hart)

**Cell and Molecular Biology/Genetics**

*"Identification of potential cytoskeletal proteins as binding partners of Mid1 in Schizosaccharomyces pombe"*

The anillin-like protein, Mid1 in *Schizosaccharomyces pombe* is responsible for recruiting the necessary cytoskeleton proteins to the medial plane of the cell to assemble the actin-myosin contractile ring during cytokinesis. This final step in cell division is a highly dynamic process that results in ultimate division of the cell into daughter cells. Orientating the contractile ring to the proper site of cell cleavage is vital to the equal distribution of genetic material. Mid1 contains several protein binding domains important for proper contractile ring formation, yet a complete understanding of Mid1 interactions has not been attained. To identify Mid1 binding proteins at the contractile ring, tandem affinity purification (TAP) complexes were isolated from mitotic extracts expressing TAP-tagged versions of Mid1. Using mass spectrometry for identification, several cytoskeleton proteins, such as Rho1 and Cpc2, were identified as potential binding partner of Mid1. Rho1, a small GTPase, is characterized for its role in myosin activities and actin assembly. This protein is known to be required for cytokinesis and accumulates in the equatorial region immediately before cell division. Cpc2, a RACK1 homolog, has a more global role and is implemented in translation of specific mRNAs and cytoskeleton integrity under certain stress conditions. Whether these cytoskeleton proteins physically interact with Mid1 is of important interest. Here, we hypothesis that Rho1 and Cpc2 can bind to Mid1 and may be important for both the formation and stability of the contractile ring. This research is supported by a National Science Foundation RUI Award #1157997.

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**92. Melinda Wilson, Lansing Community College****Cell and Molecular Biology/Genetics**

(Co-Authors: Jeff Cho, Nichole Coleman, John Shideler, Zachary Sokolowski, Robert Thomas, Elizabeth Thompson, and Melinda Wilson)

*“DNA Barcoding of Medicinal Marijuana”*

Since the legalization of medical marijuana in 2008 in Michigan, an illegal street drug was transformed into a pharmaceutical product, without the development of quality control standards. This lack of oversight leads to concerns related to the efficacy and safety of the drugs being given to patients. The use of Cannabis plants as a pharmaceutical is being prescribed for a wide variety of conditions. The purpose of this project was to determine whether different strains of medical marijuana currently being sold in Michigan could be differentiated using DNA Barcoding. DNA from Cannabis leaf lysates of varying strains was purified for PCR amplification and sequenced. The PCR amplification was completed using primers specific for a region of the plant gene *rbcl* (RuBisCo Large subunit) and sequenced by GENEWIZ, Inc. Bioinformatic analysis was accomplished on the sequence data using DNA Subway computational tools of iPlant Collaborative.org. Sequence data analysis will be discussed.

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**93. Melinda Wilson, Lansing Community College****Cell and Molecular Biology/Genetics**

(Co-Authors: Authors: (in alphabetical order) Jeff Cho, Nichole Coleman, Kirsten Robinson, Katelynn Shaw, John Shideler, Zachary Sokolowski, Robert Thomas, Elizabeth Thompson, and Melinda Wilson)

*“Lansing Community College Shigematsu Memorial Garden Plant DNA Barcoding”*

DNA barcoding was used as a way to introduce molecular biology students to the concepts of experimental design, scientific thinking, data analysis, project management as well as design projects that will contribute to new information that advances scientific understanding and use of DNA barcoding concepts. DNA was obtained from plants growing in the Lansing Community College Shigematsu Memorial Garden. In this garden, there is a variety of grasses, hostas, ground covers, and trees. PCR amplification of plant DNA was accomplished using primers specific for a region of the plant gene *rbcl* (RuBisCo Large subunit) and sequenced by GENEWIZ, Inc. Bioinformatic analysis was performed on the sequence data using DNA Subway computational tools of iPlant Collaborative.org. Sequence data analysis will be discussed.

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**94. Matthew Bailey, Grand Valley State University****Chemistry**

(Co-Authors: K. Stillwell William and R. Winchester)

*“Synthesis of Chiral Silanes”*

We will present progress towards the synthesis of organic compounds containing asymmetric silicon. Organic molecules with silicon stereocenters have potential application as chiral ligands, chiral auxiliaries, and chiral polymers, as well as proven use as chiral derivitizing agents. Our synthetic route makes use of silicon bonded to two alkyl/aryl groups and two menthoxy groups. Reaction of this type of starting material with organolithium reagents produces predominately monosubstitution of the menthoxy groups with moderate to fair diastereomeric excess.

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**95. Chad Barnhart, Alma College****Chemistry**

(Co-Authors: A. J. Ramirez, N. C. Dopke, J. A. Dopke)

*“Metal Catalyzed Substitutions of Dodecaborates”*

The substitution of cluster dodecaborates using copper and ruthenium salts was investigated using microwave heating to yield monosubstituted products. The product mixtures were purified using column chromatography. The substituted products were analyzed using boron-11, proton and carbon NMR spectroscopy, and mass spectrometry. The mechanism of substitution, as well as the generation of nitrogen-containing byproducts, will be discussed.

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**96. Allie Bouza, Grand Valley State University****Chemistry**

(Co-Authors: Roderick Morgan, PhD, William Schroeder, PhD &amp; Robert Smart, PhD)

*“Antibiotics to Fight Gram Positive Bacterium”*

A novel class of antibacterial substances has been discovered in a collaborative project between the Chemistry and Biology departments at Grand Valley State University (GVSU). These compounds do not rely on currently accepted antibiotic chemical structure, seemingly have a mechanism of action different from understood mechanistic pathways for treatment of infections, and are readily synthesized, avoiding complex, stereoselective, multi-step synthesis. This new class of antibiotics is composed of chemical derivatives of the telomerase inhibitor BIBR1532 [US Patent 6362210]. Our compounds demonstrated significant antimicrobial activity against a group of Gram-Positive microorganisms. The antibiotics minimum inhibitory concentrations (MICs) against these bacteria are equivalent to existing antibiotics (2-78 ug/ml). In subsequent in-vitro tests these compounds showed activity against methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin resistant enterococci (VRE), *Bacillus anthracis* (anthrax), and *Clostridium difficile* (Cdiff). The antibacterial activity against MRSA, VRE, and Cdiff strains of bacteria is promising as it demonstrates the ability of BIBR 1532 to inhibit microbial growth in organisms with resistance to common antibiotics. In 2008, GVSU patented this antibiotic family. Since then, we determined the frequency of bacterial resistance to this class of antibiotics is extremely low. Over 70 compounds were tested for antibacterial activity. Sixty demonstrated antibacterial activity and of these 18 were more thoroughly tested against 25 bacterial and fungal strains. We discovered a number of compounds had low minimum inhibitory concentrations (MICs) against *Staphylococcus aureus* (including MRSA strains), *Bacillus anthracis* (anthrax), *Clostridium difficile*, & *Streptococcus pneumoniae*. These results were encouraging as they demonstrate multiple bacterial targets with low concentrations of drug (2-8 ug/ml). Additionally, we tested six compounds in acute in vitro toxicity screening in a rat hepatoma (H4IIE) cell line: 24 hour exposure. All compounds demonstrated minimal toxicity to the cell line. These toxicity results demonstrate that potential negative side-effects to patients appear to be minimal. Further testing of our antibiotics revealed significant binding to human serum protein. This is potentially problematic in clinical use as there is less available compound in the blood. There are conflicting opinions as to the significance of binding to serum protein. For example, nine of the top 10 best-selling small molecule, single agent prescription drugs of 2006 had 90% or greater binding to serum protein and seven of the top ten had 95% or greater [Rydzewski, R.M., 2008]. A potential problem exists and we continue to work towards lowering this binding to increase potential available drug concentrations in the blood.

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**97. Katherine Coburn, Grand Valley State University****Chemistry**

(Co-Authors: Michael T. Peruzzi and Shannon M. Biros)

*“Extraction of Lanthanide and Actinide Metals with Multidentate Carbamoylmethyl Phosphine Oxide Compounds”*

Lanthanide and actinide metals from spent nuclear fuel (SNF) are dissolved in nitric acid and deposited in environmental repositories as part of nuclear waste remediation. Separation of the long-lived radioactive metals from the nuclear waste mixture would decrease the half-life of the waste and allow for them to be repurposed. Using carbamoylmethyl phosphine oxide compounds (CMPOs), lanthanide and actinide metals can be selectively chelated and removed from solution. To enhance selectivity for actinide metals, our group coupled three CMPOs with a cap molecule to take advantage of the chelate effect. Various R-groups and caps were investigated for their influence on the selectivity and extraction efficiency of lanthanides and actinides from nitric acid solutions.

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**98. Kimberly DeGlopper, Hope College****Chemistry**

(Co-Authors: Joseph M. Dennis, Catherine M. Calyore, Jeffrey B. Johnson)

*“Preparation of Gamma-Lactams via a Nickel-Catalyzed Addition of in-situ Generated Diorganozinc Reagents to Imides”*

A range of  $\gamma$ -hydroxy-lactams have been prepared from the selective direct addition of in-situ prepared diorganozinc nucleophiles to N-substituted aryl phthalimides with catalytic amounts of Ni(COD)<sub>2</sub> and PPh<sub>3</sub>. A wide range of substituted phthalimides and diarylzinc nucleophiles varying in electronic character have been prepared by condensation and lithium-halogen exchange reactions respectively. Diarylzinc reagents were added directly to the N-phenyl phthalimide without purification.

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**99. Joseph Dennis, Hope College****Chemistry**

(Co-Author: Jeffrey B. Johnson)

*“Development of Nickel-Mediated Decarbonylative Cross-Coupling Reactions of Phthalimides and Pendant Nucleophiles”*

Continued exploration of a nickel-catalyzed decarbonylative cross-coupling of N-substituted phthalimides and in-situ prepared diorganozinc nucleophiles has prompted the study of intramolecular, decarbonylative carbon-carbon and carbon-heteroatom coupling reactions. The previously studied diorganozinc coupling reaction proceeds through an intermediate capable of intercepting both

nucleophiles and  $\pi$  systems. With this insight, a variety of pendant substituents were screened in pursuit of synthesizing a range of cyclic amide compounds. Apart from investigating the scope of tethered nucleophiles utilized in the reaction, current work is being done to optimize reaction conditions as well as to incorporate a variety of imide backbones.

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**100. John Elenbaas, Calvin College****Chemistry**

(Co-Authors: Niecia Flikweert, John Elenbaas, Dr. Michael Barbachyn)

*“Preparation of Bicyclo[1.1.1]pentyl Stannanes and Their Applications in Palladium-Catalyzed Cross Coupling Reactions”*

This work is focused on the preparation of bicyclo[1.1.1]pentyl (BCP) stannane starting materials, first described in 1993 (Toops, D.S.; Barbachyn, M.R. J. Org. Chem. 1993, 58, 6505), followed by an exploration of their utility in palladium-mediated cross-coupling reactions. Initially, we included aromatic bromides and iodides, with either electron-donating or withdrawing groups present, as potential coupling partners. We also examined benzoyl chloride as a starting material. We further surveyed three different palladium catalysts. In a gratifying result, it was found that some of these cross-coupling reactions progressed to a significant extent, with some going to completion. One challenge that remains is getting rid of tin impurities in the final coupled products. It is anticipated that this work will eventually lay a foundation for the eventual exploration and development of BCP silanes and trifluoroborates as alternative and preferred agents for these coupling reactions. The targeted BCP cross-coupled products are envisioned as useful intermediates for further synthetic transformations, leading to potential applications in the drug discovery area. Of greatest current interest is the utility of the BCP moiety as a privileged bioisoteric replacement for, as an example, phenyl rings and alkyne subunits in some targeted antibacterial agents.

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**101. Niecia Flikweert, Calvin College****Chemistry**

(Co-Authors: John Elenbaas and Michael Barbachyn)

*“Substitution of the Benzylic Position of Quinoline Pyrimidinetrione (QPT) Antibacterial Agents”*

The quinoline pyrimidinetriones (QPTs) are a novel class of bacterial topoisomerase inhibitors that were discovered in 2002 and subsequently reported in the open literature in 2008 (Miller, A.A.; et al. Antimicrob. Agents Chemother. 2008, 52, 2806-2812). The initial lead QPT compound, PNU-286607, exhibited excellent in vitro activity and in vivo efficacy against problematic Gram-positive pathogens, including methicillin-resistant *Staphylococcus aureus* (MRSA). We have explored two strategies for selectively modifying the benzylic carbon of selected advanced QPT intermediates, an area that, to our knowledge, has not been previously explored. In the first of these approaches we exhaustively examined the application of various oxidation and bromination conditions to hopefully elevate the targeted benzylic carbon to a higher oxidation level. In a second approach, we initiated an examination of the utility of  $\alpha$ -hydroxyacetophenones starting materials as a vehicle to introduce an oxygenated methyl group to the benzylic location. Progress and prospects for the future direction of research in this area will be shared.

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**102. Sarah Fodor, Hope College****Chemistry**

(Co-Author: Jeffrey B. Johnson)

*“Exploring the Decarbonylation of Cyclic Imides Utilizing a Nickel Catalyst”*

Previous research established that the decarbonylative nickel-mediated cross coupling reaction of N-substituted cyclic imides with diorganozinc reagents is possible with a range of phthalimide substitution. The scope of the reaction was further expanded with a wide variety of diorganozinc reagents. Further

research is underway to develop reaction conditions that promote catalyst turnover, and to expand the scope to imides with saturated backbones.

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**103. Rina Fujiwara, Kalamazoo College**  
(Co-Author: Dr. Laura Lowe Furge)

**Chemistry**

*“Inactivation of Human CYP3A4 by a Piperazine-containing Compound”*

Human cytochrome P450 enzymes (CYPs) are monooxygenases that are responsible for metabolizing a variety of small compounds including many pharmaceutical drugs. The main drug metabolizing CYP is CYP3A4 that metabolizes around half of drugs. Some drugs are known to inhibit CYP3A4, lowering the ability of CYP3A4 to metabolize other compounds. 1-[(2-Ethyl-4-methyl-1H-imidazol-5-yl)-methyl]-4-[4-trifluoromethyl-2pyriny]piperazine (EMTPP) has a similar structural motif to SCH66712, a previously described potent inactivator of CYP2D6 and CYP3A4. EMTPP and SCH66712 both contain piperazine groups and substituted imidazole rings that are common in pharmaceutical agents. Understanding drug-drug interactions is important because inactivation of CYP3A4 can lead to serious adverse events. In this study, time- and concentration-dependent inactivation of CYP3A4 by EMTPP was observed. Furthermore, the partition ratio for potency of EMTPP inactivation of CYP3A4 was measured.

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**104. David Green, Hope College**

**Chemistry**

*“Testing quinazolinespirohexadienone photochromes as gateable photoinduced charge transfer initiators”*

The quinazolinespirohexadienone (QSHD) photochromes have the potential to gate photoinduced charge transfer (PICT). The long wavelength isomer, LW, is a modest photooxidant while the short wavelength isomer, SW, is not able to act as a photooxidant. SW isomerizes to LW by absorbing UV light. LW is capable of initiating PICT from a donor molecule after excitation by visible light. The cation radical of the donor molecule can then be used in a cation radical chain process. It is important that the fade from LW to SW occurs by a purely thermal mechanism so that the LW photochemical channel is available for PICT. Photochrome reversion from LW to SW has been studied for the parent photochrome, perimidinespirohexadienone (PSHD), and QHSD in the dark and with irradiation at 578 nm. After accounting for temperature differences between the solutions, it appears that PSHD LW reversion is a purely thermal process. QSHD photochrome LW reversion, however, appears to be slightly accelerated by 578 nm light. Though the QSHD LW is not a potent photooxidant, it should be sufficient to oxidize N,3-(Bis-trans-1-propenyl)carbazole. This readily oxidizable monomer is distinctive because upon one electron oxidation it undergoes a genuine cation radical polymerization. Syntheses of this monomer and close analogs are underway with the ultimate goal of testing QSHD's ability to gate their PICT-initiated cation radical polymerization reactions.

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**105. Virginia Greenberger, Kalamazoo College**  
(Co-Author: Regina Stevens-Truss)

**Chemistry**

*“Bacterial Action of Novel Cationic Peptides”*

Antibiotic resistance continues to pose a threat to the human race as bacteria become more and more resistant to antibiotics. New multi-drug resistant (MDR) strains of tuberculosis, methicillin-resistant staphylococcus aureus (MRSA), and vancomycin resistant enterococci (VRE), amongst other bacteria, are

causing expensive, painful and deadly diseases (Nikaido 2009). A need for new antibiotics to treat these infections has fueled scientists to revisit studying antimicrobial peptides (AMPs). AMPs, derived from a wide variety of natural sources, are categorized by their shape. In this project we investigated the ability of a series of cationic, amphipathic,  $\alpha$ -helical peptides derived from sequences within nitric oxide synthases (NOS) to inhibit growth of *E. coli* and *S. aureus*. Cell growth in the presence and absence of peptide was monitored as a change in optical density (OD) of a culture at 600 nm. Assays to determine the minimum inhibitory concentrations (MIC) were also conducted, and the peptides' ability to rupture cell membranes were assessed by measuring the rise in fluorescence of a solution containing dye encased liposomes. The results show that the peptide derived from the inducible NOS was not effective against either bacteria at the concentrations tested, nor did it cause leakage of dye from liposomes, while the peptide derived from the neuronal NOS was bacteriocidal to both *E. coli* and *S. aureus*, but also did not cause liposome leakage. These results are encouraging as potential starting points in the search for new agents that can be used as antibacterial agents.

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**106. Devi Haria, Grand Valley State University**  
(Co-Authors: James O'Keefe, Dr. Richard Rediske)

**Chemistry**

*"An Analysis of the Nuisance Cyanobacterium Gloeotrichia in Silver Lake, Michigan"*

Algal blooms have been observed over the past two years in Silver Lake (Oceana County, MI), often forming dense surface scums. The cyanobacterium (blue-green alga) *Gloeotrichia* has been identified as the dominant bloom-forming genus in the lake. In order to understand the potential consequences of *Gloeotrichia* blooms in silver lake we conducted nutrient bioassays to identify the nutrients limiting algal growth in Silver Lake. In addition, the effect of nutrients on algal community structure, chlorophyll a, and microcystin production was analyzed. Microcystin analysis was performed using LC-MS to evaluate cyanotoxin production. A mixture of microcystin LR and RR were detected in the bioassays and concentrations of both congeners increased after nutrient addition. Previous studies have relied on ELISA analyses which measure MC-LR and we are the first to report the presence of MC-RR. The concentration of microcystin LR and RR detected ranged from 0.20 -0.60 mg/L and 0.70 – 1.30mg/L respectively. The concentration of chlorophyll a ranged from 9.0-35.0 mg/L. The microcystin LR levels were below WHO guidelines however further monitoring is recommended to determine temporal and spatial variability.

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**107. Matthew Haveman, Calvin College**  
(Co-Authors: Matthew Haveman, Professor Douglas A. Vander Griend)

**Chemistry**

*"Examination of Protein Folding Using Sivvu™"*

As proteins unfold, many intramolecular interactions are replaced with solvent interactions. These exchanges can potentially be detected in the UV. Spectrophotometric data from the titration of a bovine serum albumin (BSA) with the denaturant guanidine hydrochloride is analyzed to ascertain the existence of stable, partially folded forms of BSA. Equilibrium-restricted factor analysis is then used to model the specific chemical equilibria involved. This technique should be extendable to other proteins under a variety of denaturing conditions.

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**108. Alexandria Hoerr, Calvin College****Chemistry**

(Co-Author: Andrea Bootsma)

*“Fluorescence of Aqueous Sycamore Extracts”*

In 2010, a study of West Michigan trees found that sycamore extract is the most fluorescent. The structure of the compound that causes this fluorescence is currently unknown, though the molecular formula has been suggested to be  $C_{13}H_{20}O_4$ . The main application of this research is twofold: first, by establishing structure and properties of the compound, we can begin to explore its' biological purposes in sycamores; second, because the compound comes from a local tree and is readily extracted under mild conditions, it is a good candidate for educational demonstrations of fluorescence. Our primary work this summer consisted of extracting and purifying the fluorescent compound and then running various tests and calculations to characterise and attempt to establish the structure of the molecule. While we were unable to get the structure for our compound of interest, we were able to obtain a significant amount of pure material and ascertain several things about the compound: first, it does have both a high and low pH form, meaning that its' fluorescence is pH dependent and suggesting there are one or more easily removed hydrogens present in the molecule; second, from our initial proton scan of the pure material, we can pick out twenty distinct hydrogens, implying that the molecular formula of  $C_{13}H_{20}O_4$  is likely correct; third, we were able to estimate the percent mass of sycamore wood that is fluorescent compound to be 0.0032%; lastly, we were able to find both molecules to compare our compound of interest to and possible candidates.

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**109. Sarah Jack, Alma College****Chemistry**

(Co-Authors: M. M. Strait, G. J. Flynn, D. D. Durda)

*“Using Porous Materials to Model Asteroid Disruption”*

In space, asteroids are a constantly colliding and disrupting. Since meteorites, the products of these collisions, have many components, they are categorized by characteristics. The characteristic being investigated is the porosity of the rock. A good test rock for porosity is pumice—it is inexpensive and easy to acquire. Disruption experiments are done at the NASA Ames Vertical Gun Range. In the gun chamber, foils are placed around a rock suspended in the center along with a sheet covering the floor. The rock is impacted with an aluminum projectile, disrupting the rock, causing particles to fly and pierce the foils, then collect in the sheet. In the lab, the foils and particles are analyzed to produce a graph. There are two distinct types of graph. One has a smooth “S” shaped curve—high on the left, flat in the middle and, low on the right. This is customary of a typical meteorite disruption. The second has the “S” shape but with a gap in the flat area. In previous shots of non-porous material, the rock completely shattered resulting in continuous particle distribution between  $7.1 \times 10^{-14}$  g and 0.03 g. In the pumice shots, the rock would either break into several large pieces or crater resulting in large particles between 0.0001 g and 100 g and then dust, as small as  $1 \times 10^{-11}$  g, with the gap between 0.0001 g and  $1.0 \times 10^{-9}$  g. This suggests that if an asteroid were made of porous material, blasting it would cause it to break into large pieces or to crater.

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**110. John LaGrand, Calvin College**  
(Co-Author: Dr. Carolyn E. Anderson)

**Chemistry**

*“Efforts Towards the Synthesis of Amino-Substituted  $\beta$ -Iodo N-Alkenyl Pyridones”*

The N-alkyl pyridone motif has garnered significant interest in the synthetic community, as it is found in naturally occurring and pharmacologically important structures. The Anderson research group has recently disclosed several methods for transforming O-propargyloxypyridines into N-alkyl and N-alkenyl pyridones in the presence of LiI. Previously these migrations had been performed with substrates in which R is an alkyl chain. The dense core of orthogonal functionality found in  $\beta$ -iodo N-alkenyl pyridones renders them important building block for the synthesis of other complex pyridone targets. Adding a nitrogen substituent to this scaffold is expected to significantly extend the range of potential targets that will be accessible.

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**111. Kelly Le, Grand Valley State University**  
(Co-Author: Randy Winchester)

**Chemistry**

*“Synthesis of Vinyl Substituted Chiral Silanes”*

We are interested in finding a method that provides high yields of chiral, non-racemic, silicon compounds that can be used in organic synthesis. Recently, we have been investigating the reactions of nucleophiles with prochiral at silicon dimethoxy-substituted silanes. We will present our results with the reactions of nucleophiles with dimethoxyphenylvinylsilane. The starting material, dimethoxyphenylvinylsilane was prepared from dichlorophenylvinylsilane. Dichlorophenylvinylsilane was reacted with 2 equivalents of menthoxyllithium in THF solvent to produce dimethoxyphenylvinylsilane, which was then purified by column chromatography and isolated in a 72.6 % yield. The dimethoxyphenylvinylsilane was used for the reactions with naphthyllithium, butyllithium, methylithium, and tert-butyllithium. These compounds were purified by column chromatography, then they were analyzed with the use of NMR, GC- Mass Spectrum, and HPLC. The yields of these reactions varied from 18.4% to 72.05%. Diastereoselectivities have been determined from  $^{13}\text{C}$ -NMR data, and in the case of the methylithium substitution initial results are consistent with a high selectivity for one diastereomer. To explain the observed selectivity we have calculated structures for the dimethoxy substituted silanes using Gaussian 03. These calculations show that one of the menthoxy groups should be more open for nucleophilic substitution.

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**112. Zackery Manning, Alma College**  
(Co-Author: Nancy Carter Dopke, Ph.D.)

**Chemistry**

*“Synthesis and characterization of platinum-ruthenium heterometallic complexes”*

Over the last two decades there has been a large interest in the use of platinum-ruthenium alloys as the anode in Direct Methanol Fuel Cells (DMFCs). Previously we reported that the reaction of a platinum-rich heterometallic complex with dimethylphenylphosphine using microwave heating results in a mixture of platinum-containing products. In an effort to synthesize a single product, the reaction was completed with conventional heating. While a single product was not produced, the results provide insight into the reaction. These insights will be discussed along with the synthetic efforts to produce a related heterometallic dimer complex containing a platinum atom and a ruthenium atom.

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**113. Nathan Murray, Michigan State University****Chemistry**

(Co-Authors: Nathan H. Murray, Dr. Robert L. LaDuca)

*“Unexpected Lactonization of Divalent Metal Coordination Polymers Containing 3-pyridylisonicotinamide and Their Related Structures”*

The reaction of divalent metal nitrates with 3-pyridylisonicotinamide (3-pina) and 2-carboxycinnamic acid (cca) resulted in layered coordination polymers upon the unexpected in situ lactonization of the deprotonated 2-carboxycinnamic acid. This lactone is an internal ester within a five membered carbon ring that formed when the acid cyclized. The reaction was then attempted with 3-(2-carboxyphenyl)propionic acid (cpp), which already is the cyclized version of cca. When this reaction was performed with Co as the divalent metal atom, it resulted in a layered coordination polymer with a hydrogenated uncyclized ligand very similar to cca, called 2-[(1E)-2-carboxyethyl]benzoate (ceb). Analogs with the various other divalent metal central atoms have been synthesized, but have yet to undergo structural determination by x-ray diffraction. Hydrothermal reaction of zinc nitrate with the isomeric 3-pyridylnicotinamide (3-pna), and homophthalic acid (hmph), a short armed version of cca, also generated layered coordination polymer with zinc dimers.

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**114. Benjamin Nicholson, Grand Valley State University****Chemistry**

(Co-Authors: Paul M. Morse and Shannon M. Biros)

*“Modified Bidentate Phosphoryl Compounds for f-Element Complexation”*

The chelation of lanthanides and actinides is of great importance due to the wide variety of applications such as nuclear waste remediation and fluorescence. Phosphoryl groups have been shown to have powerful chelation applications for extraction of f-element metal cations. Current industry standards employ monodentate or mixed carbonyl phosphoryl (CMPO) ligands. However X-ray crystallography has indicated that phosphoryl groups tend to contribute more to complexation than carbonyl groups. Our current research lies in exploring the potential chelation of bidentate phosphoryl ligands, and modifying the length of the carbon bridge between phosphoryl groups.

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**115. Sultan Qiblawi, Michigan State University****Chemistry**

(Co-Author: Principal Investigator: Dr. Robert LaDuca)

*“Divalent Copper trans-1,4-Cyclohexanedicarboxylate Coordination Polymers with Isomeric Dipyritylamide Ligands: New Pillared and Self-Penetrated Binodal Networks”*

Hydrothermal synthesis has afforded a pair of divalent copper coordination polymers containing trans-1,4-cyclohexanedicarboxylate (t14cdc) and one of two isomeric dipyritylamides, 3-pyridylnicotinamide (3-pna) or 3-pyridylisonicotinamide (3-pina).  $[\text{Cu}(\text{t14cdc})(3\text{-pna})]_n$  (1) manifests  $[\text{Cu}(\text{t14cdc})]_n$  4.82 layers featuring embedded anti-syn axial-equatorial bridged  $[\text{Cu}(\text{OCO})]_n$  chain motifs, pillared by anti-conformation 3-pna ligands into a new yet very simple binodal 3,5-connected (4.6.8)(4.66.83) network topology.  $\{[\text{Cu}_2(\text{t14cdc})_2(3\text{-pina})_2(\text{H}_2\text{O})] \cdot 5\text{H}_2\text{O}\}_n$  (2) shows two different copper/t14cdc chain motifs with isolated copper ions and  $\{\text{Cu}_2\text{O}_2\}$  dimeric units, respectively. These are linked together by 3-pina ligands to afford a new self-penetrated 4,6-connected binodal net with (4.64.8)<sub>2</sub>(426128) topology. Variable temperature magnetic susceptibility experiments reveal very weak ferromagnetism ( $g =$

2.01(1),  $J = 0.04(1) \text{ cm}^{-1}$ ) along the  $[\text{Cu}(\text{OCO})]_n$  chains in 1 and weak antiferromagnetism ( $g = 1.906(3)$ ,  $J = -3.4(3) \text{ cm}^{-1}$ ) within the  $\{\text{Cu}_2\text{O}_2\}$  dimeric units in 2. Thermal properties are also presented.

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**116. Krystle Reiss, Alma College**

**Chemistry**

(Co-Authors: Conner Daugherty, Kayla Tuttle, and Melissa Strait)

*“Searching for Chlorpyrifos in Gratiot County Produce”*

Obesity and type II diabetes are both growing problems in the United States. However, not all of the blame for this epidemic may be placed solely on poor diet and lack of physical activity. Rat-based studies have shown a link between an increased risk for type II diabetes and obesity and consumption of chlorpyrifos, a pesticide commonly used on crops and golf courses. In the past, samples have been taken of Gratiot County’s water supply and soil, as well as fruit from the farmers’ market. All these have tested negative for chlorpyrifos, with the exception of a single water sample from a sump hole. More recently, fruit and vegetable samples have been taken from Gratiot County supermarkets and grocery stores. While the large majority of these samples contained no detectable amounts of chlorpyrifos, two samples, asparagus skin and the flesh of a green bell pepper, appeared to test positive. Examination with high performance liquid chromatography showed chlorpyrifos at 0.09 ppm and 0.04 ppm, respectively. These results were confirmed by spiking the samples with chlorpyrifos and observing an increase in the size of the supposed chlorpyrifos peak. This shows that the pesticide chlorpyrifos has made it into the food supply of Gratiot Country residents and may be affecting local obesity and type II diabetes rates.

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**117. Dustin Rens, Hope College**

**Chemistry**

(Co-Authors: Dr. Kenneth Brown, Hope College Dr. Thomas Neils, Grand Rapids Community College)

*“The Electrochemistry of Tris[5-amino-1,10-phenanthroline] Iron (II/III) Polymer Films”*

The objective of this research in the area of chemically modified electrodes is to understand the electropolymerization of Tris[5-amino-1,10-phenanthroline] Iron (II) and the properties of the polymer films derived from the compound. Using a potentiostat and a three electrode cell system, the complex was oxidatively polymerized onto glassy carbon and indium tin oxide electrodes using a potential window from 0.70 volts to 1.50 volts. The coatings were characterized with cyclic voltammetry and atomic force microscopy. Cyclic voltammetric characterization studies show that the polymer films exhibit good charge transfer properties with no peak separation between the cathodic and anodic peaks, although the polymer films contain non-equivalent redox centers. The films are mechanically stable and adhere to ITO surfaces very strongly. Initial results indicate that these polymer films are durable enough to be used in sensors and biosensors.

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**118. Emily Rhude, Calvin College**

**Chemistry**

(Co-Author: Prof. Douglas A. Vander Griend)

*“Metal Ligand Solution Structure”*

In the solid state, tris-[3-(2'-pyridyl)pyrazol-1-yl] hydroborate, a tripodal hexidentate ligand, forms a tetrahedral 4:4 complex with octahedrally coordinated  $\text{Ni}^{2+}$ , and a 1:1 complex with trigonal prismatic coordinated  $\text{Co}^{2+}$ . Spectrophotometric titration data at various temperatures are modeled

to determine the number of distinct absorbers. Both systems are more complicated in solution than in the solid state. The best model for the Co<sup>2+</sup> data sets includes the species Co<sup>2+</sup>, [Co<sub>5</sub>L<sub>2</sub>]<sup>8+</sup>, [Co<sub>5</sub>L<sub>3</sub>]<sup>7+</sup>, [CoL]<sup>1+</sup>, [Co<sub>3</sub>L<sub>4</sub>]<sup>2+</sup>, [Co<sub>2</sub>L<sub>3</sub>]<sup>1+</sup>, and [CoL<sub>2</sub>] and has an RMS residual and R<sup>2</sup> value of 0.00069 and 99.99% at 293 K and 0.00109 and 99.98% at 310 K. The best model for the Ni<sup>2+</sup> data sets includes the species Ni<sup>2+</sup>, [Ni<sub>3</sub>L<sub>2</sub>]<sup>4+</sup>, [Ni<sub>4</sub>L<sub>3</sub>]<sup>5+</sup>, [NiL]<sup>1+</sup>, [Ni<sub>3</sub>L<sub>4</sub>]<sup>2+</sup>, [Ni<sub>3</sub>L<sub>5</sub>]<sup>1+</sup>, and [NiL<sub>2</sub>] with an RMS residual and R<sup>2</sup> value of 0.00061 and 99.98% at 295 K and 0.00077 and 99.97% at 310 K. The thermodynamic parameters for all of the species formed as well as their molar absorptivity curves are also presented. Interestingly, both systems seem to prefer the 1:1 complex in solution despite different structural preferences in the solid state.

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**119. Alaina Richard, Alma College**

**Chemistry**

(Co-Authors: R. Steeples, A. J. Ramirez, J. A. Dopke)

*“Buchwald-Hartwig Amination of Arenes with Cluster-Substituted Amines”*

The palladium-catalyzed substitution of haloarenes was accomplished utilizing amine-dodecaborates in the presences of strong base. The products were isolated by column chromatography and characterized by NMR and IR spectroscopy, and ESI-MS. These products have potential applications in the area of BNCT therapeutics. The mechanism of substitution as well as the observation of a diimine-ligated dodecaborate will be discussed.

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**120. Marissa Saladin, Aquinas College**

**Chemistry**

(Co-Authors: Manasi Pethe, Dr. Sagar Khare)

*“A Structure-Based Predictive Model for the Substrate Specificity of the Tobacco Etch Virus Protease”*

The substrate specificity of proteases underpins their diverse and crucial biological roles and provides a basis for the design of inhibitors that are commonly used as anti-viral drugs. Further more, proteases designed to target specific substrate sequences will be attractive therapeutic leads for specifically degrading any given disease-associated protein. We used the TEV protease, a commonly used laboratory reagent for the removal of affinity tags from recombinantly-expressed proteins, as a platform system to develop a structure-based predictive model for protease specificity. The enzyme functions as a highly specific cysteine protease and recognizes the canonical sequence Glu-Asn-Leu-Tyr-Phe-Gln-(Gly/Ser), with the cleavage occurring between the Gln-Gly or the Gln-Ser peptide bond. However, similar sequences can also be cleaved, and lists of cleavable and uncleavable substrate sequences have been experimentally determined. We used the Rosetta macromolecular modeling program to generate structural models of 70 cleaved and 342 uncleaved sequences, and used the components of the energy interaction between the protease and peptides to train support vector machines for developing a predictive classifier. On an independent test set, a preliminary classifier was able to predict cleaved sequences with 84.45% accuracy with a third degree polynomial kernel and with 81.46% accuracy with a radial based function kernel. Refinement and further testing of the model to recapitulate the specificities of variant proteases is ongoing. These studies may lead to the development of a new structure-based protocol for the design of proteases with novel specificities, which will serve as leads for a new class of therapeutic drugs.

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**121. Justin Shady, Grand Valley State University****Chemistry**

(Co-Authors: Alyssa A. Kulesza, Brooke Visser, Adam C. Boyden, Shannon M. Biros)

*“Synthesis of New Compounds For Sensitizing Lanthanide Luminescence”*

Our research is focused on the area of increasing the sensitivity of lanthanide luminescence. This has been achieved with the synthesis of several new carbamoylmethylphosphine oxide (CMPO) ligands. These ligands have different numbers of aromatic groups, which we believe act as antennas in these systems. Our two of our three CMPO ligands have been successful at sensitizing terbium. One of these ligands has also been shown to sensitize europium, dysprosium, and samarium luminescence. Detailed fluorescence data has been taken of the complexes and will be presented.

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**122. Julie Stoscup, Grand Valley State University****Chemistry**

(Co-Author: Principal Investigator: Shannon M. Biros)

*“Investigation of Multidentate Carbamoylmethylphosphine Oxide Compounds for Lanthanide and Actinide Chelation”*

Our lab is focused on the development of pre-organized tripodal carbamoylmethylphosphine oxide (CMPO) ligands to complex with lanthanides and actinides. By pre-organizing the CMPO ligands, by means of a specifically designed cap, we aim to increase the selectivity of f-elements. Applications of this research include, but are not limited to: the extraction of hazardous heavy metals for nuclear waste remediation, the enhancement of magnetic resonance imaging (MRI) abilities, the production of light-emitting diodes (LED) with enhanced lifetimes, and the exploration of heavy metal polymers.

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**123. John Strikwerda, Calvin College****Chemistry**

(Co-Author: Dr. Roger L. DeKock)

*“Successive Ionization Energies of Atoms: Theoretical Interpretation”*

Experimental studies show that successive ionization energies among most elements roughly follow an arithmetic progression. In an effort to correlate electronic structure with this trend in successive atomic ionization energies, we have employed General Atomic and Molecular Electronic Structure System (GAMESS) software and the recently developed spin constrained unrestricted Hartree-Fock (CUHF) quantum chemical theory, specifically for the cases of Ne and Ar. Our results suggest that the arithmetic progression displayed by these elements' successive ionization energies can be accounted for simply by “relaxation compensation” and the loss of a single valence electron-electron repulsion.

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**124. Caleb Uitvlugt, Calvin College****Chemistry**

(Co-Authors: Caleb Uitvlugt, Professor Chad Tatko)

*“Electrochemistry of Catechols”*

Catechols are common in the human body from ingestion or oxidative stress. Their antioxidant behavior has been suggested to arise from radical stabilization utilizing the aromatic ring. However, an alternative pathway to prevent oxidative damage is to inhibit Fenton-Type Chemistry. Tight binding between a catechol and metal center can potentially prevent the redox cycling found in Fenton-Type

Chemistry hydroxyl radical production. When a catechol is introduced into solution, the change in apparent pKa from metal ion binding allows the hydroxyl groups of the catechol to be deprotonated and to form a bidentate ligand bond. Our research explores peptide incorporated catechol-metal binding to identify the  $k$  values for mono-, bis-, and tris complexes using UV-Vis.

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**125. Brooke Visser, Grand Valley State University**

**Chemistry**

(Co-Authors: Justin R. Shady Alyssa A. Kulesza Adam C. Boyden Shannon M. Biros)

*“Synthesis of a New Compound for Lanthanide Luminescence”*

Our research is focused on the area of increasing the sensitivity of lanthanide luminescence. This has been achieved with the synthesis of several new carbamoylmethylphosphine oxide (CMPO) ligands. These ligands have different numbers of aromatic groups, which we believe act as antennas in these systems. Our two of our three CMPO ligands have been successful at sensitizing terbium. One of these ligands has also been shown to sensitize europium, dysprosium, and samarium luminescence. Detailed fluorescence data has been taken of the complexes and will be presented.

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**126. E Yasmine Walton-Durst, Grand Rapids Community College**

**Chemistry**

(Co-Authors: E. Yasmine Walton-Durst; Will Cantrell)

*“Effect of a Surfactant on the Contact Nucleation of Ice: A Study in Atmospheric Physics”*

We present the effect that a surfactant has on contact nucleation of ice. A novel technique to quantify the number of particles necessary for freezing is used. For this study the bacteria *Pseudomonas syringae* is used to catalyze the freezing of super cooled water with varying coverage of the surfactant hexacosane. Our data indicates that a surfactant has no effect on contact nucleation by *Pseudomonas syringae*.

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**127. Jacqueline Williams, Grand Valley State University**

**Chemistry**

(Co-Authors: Matthew E. Hart PhD)

*“Progress towards the development of urea based modulators of the trace amine associated receptor: Meta linked ureas”*

A naturally occurring thyroid hormone metabolite, 3-Iodothyronamine (T1AM), is a fast acting derivative which activates the Trace Amine Associated Receptor (TAAR1). In mice, T1AM exhibits effects opposite of those induced by the thyroid hormones. This presents a novel regulatory mechanism of thyroid hormone action. Studying this regulatory mechanism expands on the understandings of thyroid

hormone biology and may contain medicinal value. The project described herein examines T1AM analogs that contain a urea linker between the aryl groups and a meta linkage in the phenethyl amine portion. Additional substitutions on the distal aryl ring will also be examined. These analogs will be used in a cell-based assay to examine TAAR1 regulation.

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**128. Andrew Zahrt, Aquinas College**  
(Co-Authors: Andrew Zahrt and Jonathan Fritz)

**Chemistry**

*“Ligand Structure Influences Direct Arylation Regioselectivities”*

The production of biaryl derivatives is a synthetically important process in the production of many biologically active molecules. One method of synthesizing biaryl and heterobiaryl scaffolds is the Suzuki coupling. However, the need to pre-functionalize these precursors results in an inefficient production of biaryl compounds. A desirable alternative method is the process of direct arylation. In theory, direct arylation has the potential to be a highly efficient process for the coupling of two aromatic rings. However, in practice, the reaction still requires optimization. Although optimization of the selectivity is still being developed, multiple observations suggesting an electronic trend to selectivity were established. By altering the R-group on carboxylic acids, clear reversals in selectivity were achieved. Further, the foundation for research of the topic has been laid to facilitate future work in the area.

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**129. Peter VandeHaar, Calvin College**  
(Co-Author: Juan Pedro Steibel, Ph.D, Michigan State University)

**Computational Biology/Bioinformatics**

*“Exploration and Exploitation of Linkage Disequilibrium”*

We developed a package for the R statistical language to calculate linkage disequilibrium within populations and persistence of phase between them. These calculations are useful when finding associations between positions in the genome and phenotypic traits. The calculations are performed starting from genetic data at the sites of single nucleotide polymorphisms (SNPs). Within each breed, correlations between each pair of SNPs are calculated to obtain linkage disequilibrium information. Correlation between the linkage disequilibrium data of each breed are calculated to obtain persistence of phase information.

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**130. Jiaming Jiang, Calvin College**  
(Co-Author: Becky Haney, Loren Haarsma, Victor Norman)

**Computer Science**

*“Wealth & Inequality: What can Agent-Based Model Simulations Tell Us?”*

The research project implements an agent-based economic model in which agents gather resources, trade, and make devices that will increase the speed of gathering resources. By controlling the level of social inequality among agents, we can observe the results on economic growth and wealth inequality.

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**131. James Lamine, Calvin College**  
(Co-Authors: Loren Haarsma, Serita Nelesen)

**Computer Science**

*“Modeling the Evolution of Complexity with Digital Organisms”*

This computer model is used to study the ways in which protein complexes evolve. Simulations show that our organisms evolve the ability to efficiently gather chemicals, build proteins and complexes, and move to chemically rich areas of an environment. We have shown that reducing the rate of mutation impedes evolution, while increasing the chance that a protein is useful accelerates evolution. If the

mutation rate is set too high, useful proteins tend to undergo harmful mutations and complexity suffers. Given enough time, complexity can develop even with very low mutation rates.

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**132. Thomas Wodarek, Calvin College**

**Computer Science**

(Co-Authors: Abigail J. Streelman, Dr. Serita M. Nelesen, Dr. John T. Wertz)

*“HTMAD: High-Throughput Microbial Analysis and Dereplication”*

In the field of microbiology, identifying and comparing species of bacteria from large communities is commonplace. Traditionally, this has been achieved through physically isolating individual microbes and sequencing their genome, but this has proven to be a time-intensive and financially prohibitive process. Genome analysis via mass spectroscopy can be an effective and accurate process for preliminary analysis, as well as significantly faster and less expensive. We have developed a software package, HTMAD (“hat-mad”), to take in large datasets of spectra from MALDI-TOF mass spectroscopy and provide analysis. This analysis includes spectrum graphs, distance matrices, and comparison trees, which can be of individual bacterial samples or of whole communities. While HTMAD is still under development, it has proven useful in microbiological research at Calvin and we believe that it will become a useful tool for researchers on a greater scale.

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**133. Rachel Gaide, Calvin College**

**Engineering**

(Co-Authors: Professor: Xiuhua A. Si Student: Rachel Gaide)

*“Electrophoretic Focusing and navigation for Intranasal”*

Intranasal olfactory drug delivery provides a noninvasive practical method of bypassing the BBB and directly delivers the medications to the brain and spinal cord. However, a device designed for olfactory delivery has not yet been found. In this study, a new delivery method that utilizes the electrophoretic force to focus and guide drug particles to the olfactory region is proposed. The feasibility of this method was numerically evaluated with three designs in an idealized 2-D nasal airway model. The influences of drug release positions at the nostrils were also studied. It was observed that applying electrophoretic forces significantly enhanced the dosage to the olfactory region. In this pilot 2-D study, electrophoretic-guided delivery achieved olfactory dosages of two orders higher than that without electrophoretic forces. Furthermore, releasing drugs at the upper half of the nostril (i.e., partial release) led to olfactory dosages two times higher than releasing drugs at the whole nostrils. By combining the advantages of pointed drug release and appropriate electrophoretic guidance, more than 90% olfactory dosage could be achieved. Compared to the extremely low olfactory dosage (< 1%) of conventional inhaler devices, results of this study have important implications for developing new olfactory delivery devices for the treatment of neurological disorders.

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**134. Jeremiah Rocha & Julie Swierenga, Calvin College**

**Engineering**

(Co-Author: Professor David Wunder)

*“Impact of Antibiotics on Denitrifying Biofilm Bacteria”*

Low concentrations of antibiotics are found in surface waters worldwide, but the impact of antibiotics on biological drinking water treatment processes is largely unknown. This research investigates the effects of low µg/L concentrations of antibiotics on the denitrifying ability of biofilm bacteria used in

drinking water treatment. Experimental runs were performed by running untreated drinking water, acetate (as a carbon source), and antibiotics through a Continuous Rotating Annular Bioreactor (CFRAB). The viability of the bacteria was analyzed by performing volatile solids tests and live/dead staining. Using ion chromatography, the nitrate utilization rate of the biofilm in the reactor was evaluated for differing concentrations of antibiotics in the feed stream. Viability analysis shows that biomass increases in the presence of antibiotics, and denitrification data indicates that the presence of low concentrations of antibiotics (3.44 µg/L and 34.4 µg/L) decreases the denitrification rate of biofilm bacteria by nearly 50%.

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**135. Aldo Daniel Khoi Vu, Calvin College**  
(Co-Author: Professor Yoon G. Kim)

**Engineering**

*“Development of portable battery-operated wireless devices for environmental monitoring”*

The final goal of the project is to develop a portable Wi-Fi running computing device for environmental monitoring. The main function of the device is to measure such factors like noise, temperature, relative humidity, atmospheric pressure, and soil moisture through sensors and perform logging data for a month long period. The research carried the first stage of the whole project. Since this is the long-term project, the main achievement of this summer period is to stream video & audio wirelessly using Calvin’s internet server via a development board.

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**136. Okkar Myint, Calvin College**  
(Co-Author: Prof. Yoon Kim)

**Engineering**

*“Development of Maximum Power Point Tracking (MPPT) Controller for Photovoltaic (PV) Cells”*

The research focused on developing a prototype model of a MPPT controller. Maximum Power Point Tracking (MPPT) technology is an electronic system that changes the operating points/parameters based on voltage supply (from solar modules) to deliver maximum power. We combined the technology with a charger circuit. We were able to deliver up to 45 W to the load resistor.

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**137. Jerome Navarro, Calvin College**

**Engineering**

*“From Field to Filter: Fluoride Sorption onto Bagasse Charcoal”*

Toothpastes often advertise that they contain fluoride to fight against cavities and strengthen teeth. In small portions, fluoride can be beneficial. However, high levels of fluoride intake can be dangerous. As advertised by dental hygiene products, fluoride can help strengthen the structure of teeth, but at higher levels, fluoride starts to replace the calcium in the structure of teeth, making them brittle. At even higher levels, fluoride starts to weaken the composition of bones. Healthy concentrations are dependent on the climate, but the suggested limits of consumption by the World Health Organization are 1.5 mg/L for water and 6 mg/day consumed per person. Fluoride is naturally present in water, but can surge in concentration due to runoff from manufacturing of products containing fluorine compounds and fertilizers. Natural areas rich in fluoride-containing minerals can have water with concentrations up to 10 mg/L. In the United States, 0.2% of the population is exposed to more than 2 mg/L. Concentrations can reach 57 mg/L in countries like Kenya, where fluorosis caused by high fluoride intake has led to hip fractures and more brittle bones. Using the foundation of previous research done on bagasse charcoal,

which is a charcoal that could be easily and cheaply manufactured in third world countries, research was conducted on the effectiveness of the charcoal to filter out fluoride from water. Due to its structure of micropores (effectively becoming like a super sponge), charcoal has a high amount of surface area in a relatively small mass. It can therefore naturally adsorb contaminants as well as have them adhere to its surface, a process known as sorption. However, research indicated that due to the extremely electronegative nature of fluoride, it would be more inclined to bond with water than with the surface of the charcoal. Amending the charcoal with aluminum remedies this shortcoming; the fluoride more readily bonds with the aluminum than to water and thus attaches to the charcoal. The amended charcoal was checked for a model of sorption using batch testing and the Freundlich Isotherm, which describes the relationship between the amount of fluoride in the water at equilibrium and the fluoride in the charcoal at equilibrium. A column test (similar filtering process to a commercial Brita filter) was also conducted to check breakthrough curves of the amended charcoal. Data from these batch tests indicated that the aluminum amended charcoal was much more effective than its unamended counterpart. The unamended bagasse charcoal sorbed only minimal amounts of fluoride, even at higher mass levels. In contrast, the amended charcoal more effectively absorbed fluoride at higher mass levels. Desorption tests indicated that the unamended charcoal desorbed most of the little fluoride that it had sorbed, while the amended charcoal retained most of its fluoride.

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**138. Lukas Woltjer, Calvin College**

**Engineering**

(Co-Authors: Professor Richard DeJong and Matthew De Young)

*“Thermal Testing of Fenestration Systems”*

This project was to result in a testing chamber that could test the thermal performance of fenestration systems according to ASTM standards. Initial tests using panels of known thermal conductivity gave an experimental error of 28%. Further instrumentation and modifications to the chamber are in process, and will improve the accuracy and flexibility of the system. Most of the work performed this summer focused on design and construction of the testing chamber. Thorough testing and analysis will be a later stage of the project, to be done within the next year.

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**139. Andrew DeVries, Calvin College**

**General Biology/Pre-Med**

(Co-Authors: Dr. David Dornbos, Dr. John Wertz)

*“Exploring the Symbiosis of Frankia Bacteria with the Invasive Shrub, Autumn Olive”*

*Elaeagnus umbellata*, autumn olive, is a deciduous, actinorhizal shrub and invasive species found in Michigan. It thrives in soils particularly low in nitrogen due to its symbiotic relationship with the nodulating and nitrogen fixing bacteria, *Frankia*. The goal of this project was to compare the genetic similarity (measured via 16S rRNA and *nifH* gene sequencing) of *Frankia* among autumn olive collected from different ecosystems and to identify possible secondary symbionts involved in the nitrogen economy of autumn olive. Root nodules were collected at Pierce Cedar Creek Institute and Wittenbach/Wege Environmental Center. After surface sterilization, root nodules were homogenized and the bacteria were plated on media with and without novobiocin (to help reduce non-*Frankia* bacterial growth) DNA from each cultivar was PCR amplified using general bacterial 16S rRNA, *Frankia*-specific 16S rRNA, and *Frankia*-specific *nifH* primers. A non cultivation-based approach was also used, where DNA was extracted directly from root nodules and PCR amplified with general bacterial 16S rRNA and *Frankia*-specific *nifH* primers. PCR products were then cloned into plasmid vectors, transformed into

*E. coli*, and sequenced. Results of the cultivation-based approach showed a significant difference between bacterial communities from autumn olive nodules collected in the forest from those collected in the meadow ( $p = 0.0005$ ). High frequencies of known nitrogen-fixing bacteria were found including: *Mesorhizobium*, *Bradyrhizobium*, *Sinorhizobium*, and *Herbaspirillum seropedicae*. The results from the cultivation-dependent approach showed nodules primarily colonized by *Frankia*; however, there were a significant amount of non-*Frankia* bacteria found, Of the non-*Frankia* bacteria, *Sphingobium* sp and *Variovorax paradoxus* were found to potentially be involved in nitrogen transformation. The differences between the bacterial communities in Autumn Olive nodules leads to some interesting questions: Are the nodules dependent on the bacterial soil compositions in a given ecosystem? What could these differences mean for the growth of Autumn Olive? This research also shows that there may be possible secondary symbionts that assist Autumn Olive/*Frankia*; however, these are preliminary. Future experimentation will help clarify these questions.

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**140. Elaine Sheikh, Grand Valley State University**

**General Biology/Pre-Med**

*“Endosymbionts and the Evolution of Host Sociality”*

Animals form mutualistic endosymbiotic relationships with microbes. These microbes aid in digestion, supplement nutrients, increase tolerance to environmental stress, enhance host immunity, and increase fecundity. Other specialized symbiotic relationships can facilitate host functions such as bioluminescence or chemosynthetic energy production in gutless hosts. Endosymbiotic microbes specialize to meet their host’s requirements, sometimes resulting in cospeciation or coevolution between the hosts and microbes. The mutualism between hosts and microbes can be either obligate or facultative, and the microbes can be transmitted either vertically or horizontally. Lombardo (2008) proposed that host species requiring contact with conspecifics to obtain obligate endosymbionts would evolve social behaviors to facilitate microbial transfer between individuals. I reviewed studies published since 2008 review to test that hypothesis. Current data support the hypothesis.

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**141. Chengbi Liu, Calvin College**

**Geography**

(Co-Authors: William SooHoo and Jason VanHorn)

*“Creating a Web Application for Plaster Creek Watershed”*

Scant has been written about Ecology and GIS applications, even less about watersheds and GIS applications. This article, and our application, will hopefully enlighten many who do not yet realize the benefits of a WebGIS/online GIS application. Though there is a spate of ecologically based GIS applications, the tools they provide generally have a limited range of functionality, especially in regard for those with experience with GIS or with that specific ecological topic. On the other hand, there are many applications that do not have good interfaces; they look outdated and do not function as smoothly as they ought. This article attempts to show how to build an ecological application for both GIS experts and the general public that is a powerful (analytical) tool that also performs its functions well.

*“Sedimentation Rates and Sediment Composition in Brewster Lake as Indicators of Anthropogenic Land Use Changes Across Time”*

This study attempts an understanding of anthropogenic effects upon land and water ecosystems. I utilize two approaches towards this end, a paleolimnological perspective coupled with a historical study of one small watershed and lake. Lake sediments record the passing of time in an underwater vault that can be studied to provide insight into the past. Because of this, I expect to see evidence of historical terrestrial changes in the lake's sediment record.

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**143. Karl Campbell, Grand Valley State University**

(Co-Authors: John Weber, Grand Valley State University, Department of Geology Jenny Arkle, University of Cincinnati, Department of Geology)

*“Source to Sink, Trinidad and Tobago: Thermochronology of Pliocene Sediment from the Caribbean Sea”*

We are using thermochronology to study time-temperature (depth) rock histories of Pliocene sediment from the Caribbean Sea. This study's focus is to determine the exhumation (unburial) ages of possible bedrock (clastic) sources for a newly discovered offshore gas-rich sandstone of Pliocene (2-5 Ma) age. Two years ago, Centrica Resources Limited discovered a large biogenic gas field in this sandstone reservoir. Knowing the ancient sources of this sand (e.g. onshore Trinidad, onshore Tobago, other) will help predict where the reservoir sand is thickest and likely the most productive. Our goal is to match the apatite and zircon fission-track and apatite U-Th/He exhumation ages from grains in the sandstone reservoir (sink) with grains collected from onshore Trinidad and Tobago bedrock (possible source) samples. Previous apatite fission-track results indicate potential source rocks in Trinidad's western Northern Range were exhumed 4-6 Ma, and the bedrock in northeastern Trinidad and Tobago were exhumed much earlier, circa 15 – 22 Ma and 45 + 5 Ma, respectively. We build on these earlier results in our study.

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**144. Carlene Gilewski, Grand Valley State University**

(Co-Author: Dr. Ginny Peterson)

*“Constraints on P-T conditions during deformation within the Chunky Gal Mountain Fault, Central Blue Ridge, North Carolina”*

The terrane-bounding Chunky Gal Mountain Fault (CGMF) in the Southern Appalachian Central Blue Ridge lies adjacent to the Buck Creek-Chunky Gal mafic-ultramafic complex (BCC), an ocean crustal fragment that experienced peak (Taconian) conditions of ~825°C, 1.2 GPa. The CGMF separates the BCC mylonitic amphibolites, from garnet-biotite, and sillimanite-garnet-biotite gneisses, included in several focused shear zones. GCMF samples preserve complex physical and chemical textures that may help constrain the emplacement history of the BCC. A biotite gneiss ultramylonite (11L3) with sinistral asymmetry includes asymmetric garnet, K-feldspar, plagioclase, and muscovite porphyroclasts. Garnet zoning suggests preservation of prograde zoning (increasing Mg/decreasing Ca) similar to larger garnets at Winding Stair Gap (WSG) where peak granulite facies are documented. Increased Ca and Mn toward the rims is distinctive. Preliminary use of TWQ, Theriak-Domino, and GIBBS suggest peak temperature

estimates of  $\sim 750^{\circ}\text{C}$ , and retrograde matrix conditions of  $\sim 600^{\circ}\text{C}$ . Pressure estimates are more complex. Garnet growth zoning in 11L3 are similar to that reported for garnets at WSG with high Ca cores to lower Ca rims. However, in 11L3, we see a relatively sharp increase in Ca toward the rims that has not been previously reported. This may indicate a relatively late increase in pressure at reasonably high (Sillimanite-stable) temperature conditions and possibly loading by thrusting within the GCMF.

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**145. Saray Morales, Grand Valley State University**

**Geology**

(Co-Authors: Dr. John Weber (GVSU), Dr. Pablo Llerandi-Roman (GVSU), Dr. Peter La Femina (PSU), Halldor Geirsson, (PSU), Saray Morales)

*“GPS-derived Preliminary Vertical Tectonic Motions and Causes, Puerto Rico and Trinidad”*

We are undertaking a study of vertical tectonic motions in the Caribbean using data from continuously operating Global Positioning System stations (cGPS). The island of Puerto Rico (PR) is located in the plate boundary zone between the Caribbean and North American plates. Today, this zone is dominated by east-to-west strike-slip motion with additional minor convergence, which created the Puerto Rico trench north of the island. Ten Brink (2005) developed a series of models that show possible sub-surface trench geometries and possible causes of vertical motion in Puerto Rico. Differences in long-term (1955-2012) tide-gauge sea-level rise rates from Puerto Rico suggested that differential vertical tectonic motion might be resolvable. Our preliminary results from seven cGPS sites in Puerto Rico (Figure 1) show that the northernmost sites with sufficiently long time series (2008-2013) may be sinking at rates (2-sigma uncertainties) as follows: MOPR ( $-1.33 \text{ mm/yr} \pm 2.76$ ), MAYZ ( $-1.47 \text{ mm/yr} \pm 2.77$ ), AOPR ( $-5.33 \text{ mm/yr} \pm 2.42$ ), BYSP ( $-1.26 \text{ mm/yr} \pm 1.73$ ) and CUPR ( $-2.52 \text{ mm/yr} \pm 1.76$ ). This contrasts with the vertical motions of the suite of southern cGPS sites, which appear to be more vertically static: P780 ( $-0.5 \text{ mm/yr} \pm 1.94$ ) and MIPR ( $-0.6 \text{ mm/yr} \pm 1.70$ ). Trinidad is clearly tilting to the west into the Gulf of Paria pull-apart basin based on macroscopic geomorphic features (Ritter and Weber 2007), and sits in nearly a mirror image plate tectonic setting to Puerto Rico; Trinidad is located in the southeast corner of the Caribbean plate, in the Caribbean-South American plate boundary zone. In addition, causes of vertical motion are better understood in Trinidad than they are in Puerto Rico (Weber et al. 2011). Therefore, we also determined preliminary rates of vertical tectonic motion for Trinidad using a similar approach, and we used this island as an analogue to better understanding vertical motions in Puerto Rico. We analyzed data from five Trinidadian cGPS sites (ALBI, CALD, FORT, GALE, GRAN), and from one episodic GPS site (POST) located on the sinking northwest coast. Our preliminary vertical GPS rates (2-sigma uncertainties) are as follows: ALBI ( $-2.20 \text{ mm/yr} \pm 1.52$ ), CALD ( $-0.97 \text{ mm/yr} \pm 1.36$ ), FORT ( $0.49 \text{ mm/yr} \pm 1.67$ ), GALE ( $-0.90 \text{ mm/yr} \pm 1.78$ ), GRAN ( $-1.36 \text{ mm/yr} \pm 1.62$ ), and POST ( $-4.21 \text{ mm/yr} \pm 1.96$ ). Results from the northwestern Trinidadian sites (ALBI, POST) are consistent with subsidence. FORT on the southwestern coast has apparently moved down and then up, perhaps due to mud volcano inflation/deflation. The other central and eastern Trinidad sites (CALD, GALE, GRAN) appear to be more vertically static (See Figure 2 below). Our study now aims to define local vertical reference frames in Puerto Rico and Trinidad and to use these to quantitatively solve for the differential vertical tectonic motions on each island. This approach should reduce formal uncertainties and bring the qualitative differential signals described above out of the noise.

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**146. Kenton Shaw, Grand Valley State University****Geology**

(Co-Authors: Dr. John Weber, Grand Valley State University, Department of Geology Dr. Peter LaFemina, The Pennsylvania State University, Department of Geosciences Halldor Geirsson, The Pennsylvania State University, Department of Geosciences Kenton Shaw, Grand Valley State University)

*“GPS Geodesy Study of Seismic Risk on the Central Range Fault, Trinidad”*

We studied the Central Range Fault of Trinidad and Tobago using episodic Global Positioning System (GPS) data and continuous GPS data, and we are building our own GPS data processing center at GVSU. The Central Range Fault is effectively the Caribbean-South American transform plate boundary, as it takes up a significant portion of the total relative plate motion (20 mm/yr). We processed and interpreted GPS data from 1994-2011 at 21 episodic sites and 4 continuous sites in Trinidad at The Pennsylvania State University Geodesy lab using GIPSY-OASIS II. A preliminary elastic dislocation model shows fault locking at an anomalously shallow depth of ~1.5 kilometers and a fault slip-rate of ~17 mm/yr. According to previous work, the fault shows no signs of surface creep and has apparently had at least one prehistoric earthquake on it between 2700-550 years ago. A recent proposal to build a new government children’s hospital near the fault, together with a lack of stringent building codes, has invigorated a national debate on its seismic risk and hazard. Our new results, taken together with the previous data summarized above, suggest that a magnitude 6 earthquake is possible on the Central Range Fault.

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**147. Christian VanWyngarden, Grand Valley State University****Geology**

(Co-Authors: Christian VanWyngarden, John Weber)

*“An apatite fission-track study of Exhumation, Greater Caucasus Mountains, Azerbaijan”*

The country of Azerbaijan contains two major mountain belts, the Greater Caucasus Mountains to the North, and the Lesser Caucasus Mountains to the South. Both of these belts are believed to be resultant of the Arabian and Eurasian Plate collision. By studying the exhumation rates of the exposed rocks in the Greater Caucasus Mountains and surroundings, we hope to gain insight into the history of the formation of these mountains. In this study, apatite crystals extracted from Cretaceous-aged field samples were analyzed using fission-track thermochronology. Fission track length data were then modeled using the program HeFTy. Our HeFTy modeling indicates that the Greater Caucasus Mountains began their rise to the surface between 40Ma and 50Ma. Our Eocene pre-Caucasus samples from the flank of the Greater Caucasus were exhumed to the surface between 20Ma and 30Ma.

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**148. Jackie Gipe, Aquinas College****Mathematics**

(Co-Author: Dr. Michael McDaniel)

*“Consequences of working with chord diagrams from the open wheel Jacobi Diagram”*

This research proved that all chord diagrams from the open wheel Jacobi diagram are self-invertible. Our work also revealed several relationships between the closed wheel and the HOMFLYPT subspace of knot invariants of finite-type, including an easy basis and some interesting relations for weights of vectors.

(Co-Author: Thomas, Derek. P)

*“The Role of Post-Translational Modification of Rfg1 in the Regulation of Candida albicans Filamentation”*

*Candida albicans* is a commensal fungal organism that resides in the mucosal tissues of humans and is the fourth most frequent nosocomial infection in the US. Integral to the pathogenic potential of *Candida albicans* is the ability to reversibly switch its morphology between yeast cells, pseudohyphae and true hyphae. The ability to transition between these morphologies plays a key role in biofilm formation and pathogenicity. This research focuses on Rfg1, a negative regulator of the filamentation process. Rfg1 is believed to function in conjunction with Tup1 to repress genes associated with filamentation, however, the exact mechanism of interaction between the two proteins is unknown. Our current understanding is mostly extrapolated from *Saccharomyces cerevisiae*, but there is restricted homology between Rfg1 (65kDa) and the *S. cerevisiae* equivalent, Rox1(40kDa). Of the 1.8 kb sequence of Rfg1, 100 bp in the HMG DNA binding domain shares 52% identity with Rox1 and there is little similarity outside the HMG domain. Recent data from our lab has implicated post-translational modification in the control of the interactions between Tup1 and its co-repressors. In silico analysis has shown multiple amino acid residues in Rfg1 have the potential to be phosphorylated. Here we begin to analyze variations in post-translational modifications of Rfg1 and interactions with other co-repressors during different filamentation inducing conditions. The results should significantly further our understanding of the global repression that plays a key role in the regulation of filamentation, which is the most important virulence associated trait in *C. albicans*.

(Co-Authors: Clare Laut, Robert Parker, Carl Boehlert, and Shannon D. Manning)

*“Effects of pH and Nutrition Depletion on Group B Streptococcus Cells that Exist in Biofilms”*

Group B Streptococcus (GBS) is a pathogenic, gram-positive bacterium that is known to cause disease in babies and immunodeficient adults. Multilocus sequence typing has identified phylogenetically distinct strains associated with human colonization and human disease, such as ST-23 and ST-17, respectively. Despite this association, factors underlying pathogenicity such as biofilm production remain unknown. The specific aim of the project will be to use the SEM to confirm the physical differences in the biofilm cells in the ST-17 and ST-23 strains of GBS under the various stresses in relation to levels of biofilm production. This project will compare, using Scanning Electron Microscope (SEM) pictures and a biofilm assay, the phenotypic variation in biofilm production and strength that occurs in these two strains under various stresses such as acidic pH and nutrition depletion. All samples from both ST-17 and ST-23 exhibited similar growth according to variable conditions. Results show that reduced nutrient levels diminished the growth and biofilm density. A pH of 4.5 caused to greatest decrease in biofilm production and altered physiology. A connection can be implied between the clumps seen in the ST-17 SEM images and their ability to cause disease. ST-17 often persists after antibiotic treatment, and these structures could be a form of protection for the GBS cells by shielding much of the clustered cells from human immune system attacks. ST-23 can be treated with antibiotics without relapse and is thought to colonize placental walls, which could be connected to its chain structure. The structural differences between ST-17 and ST-23 indicate a potential explanation for variation in their pathogenic behavior and antibiotic response.

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**151. Andrew Valesano, Hope College****Microbiology**

(Co-Author: Dr. Aaron Best)

*“Transcriptome Profiling of the Life Cycle of Giardia lamblia using RNA-seq”*

The ubiquitous mammalian parasite *Giardia lamblia* is a causative agent of infectious waterborne diarrhea. *Giardia* is transmitted through the oral-fecal route and is characterized by a two-stage life cycle, an intestinal trophozoite form and the infectious encysted form. As one of the earliest diverging eukaryotes, *Giardia* holds a unique phylogenetic position. *Giardia* lacks the canonical transcription apparatus of eukaryotes and Archaea; its genome lacks TFIIB and has a highly degenerate TBP. Despite *Giardia*'s medical, veterinary, and evolutionary importance, expression profiles of each stage of the life cycle using RNA-seq have not been generated. We generated transcriptome profiles of *Giardia* at each life cycle stage in order to first approach the question of how *Giardia* accomplishes basal transcription. Messenger RNA was isolated from ten time points across the entire giardial life cycle. The mRNA from trophozoites and from cells after 4 and 12 hours of encystation was sequenced on a next-generation platform. A small subset of genes were found to have significantly different expression between each stage, most notably the cyst wall proteins. These data form the basis for investigating transcription and other fundamental functions in *Giardia*.

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**152. Rebecca Farr, University of Michigan-Flint****Molecular Biotechnology**

(Co-Authors: Asadullah Siddiqui, Kevin Tang)

*“Molecular phylogeny of cusk-eels (Teleostei: Ophidiiformes: Ophidiidae)”*

Cusk-eels (family Ophidiidae) are an enigmatic group of bony fishes that are found predominantly in marine waters around the world. Because the evolutionary relationships between the species of cusk-eels remain poorly understood, the purpose of this project is to reconstruct a phylogeny of them and determine their relationship to other fishes in the order Ophidiiformes. Genomic DNA will be extracted from subjects of all four subfamilies. Nine genes from their respective genomes will be amplified and sequenced using standard molecular biology techniques. To generate the tree of relationships, the data will be combined and analyzed using modern phylogeny reconstruction methods. The results of this study will provide an evolutionary framework that will be used to revise the classification.

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**153. Matt Davidson, Kalamazoo College****Neuroscience**

(Co-Authors: Briana Franz, Nick Hibbard, James McKim)

*“Naloxone Inhibits TLR4 Signaling in a Human Monocyte Model”*

Recent studies have demonstrated the binding of Naloxone, an opioid antagonist, by Toll-like Receptor 4 (TLR4) in microglial cells. TLR4 recognizes Pathogen-Associated-Molecular-Patterns (PAMPs) and endogenous ligands and responds by inducing genes encoding proinflammatory cytokines, including IL-8. TLR4 signaling has been implicated in a variety of inflammatory immunopathological consequences such as autoimmune disorders and shock. This study aims to elucidate TLR4 pathway integrity in an in-vitro model and to elucidate potential inflammatory-antagonistic effects of Naloxone. In the present study human monocyte (THP-1) cells were plated at 10,000 cells/well and challenged with Naloxone (1, 10, 100, 1000  $\mu$ M), or lipopolysaccharide (LPS) (0.1, 1, 10, 100, 1000, 10000 ng/mL), or simultaneously

with Naloxone and LPS. Cell-only, IL-8-only, and Naloxone-IL-8 controls were also tested. After 24h incubation (37°C), extracellular IL-8 content was determined via ELISA. THP-1 cells demonstrated dose-dependent IL-8 secretion (32.3 – 1841.8 pg/mL) in response to the known TLR4 agonist LPS. Naloxone elicited negligible IL-8 secretion (2.94 – 3.59 pg/mL) and showed no interference with IL-8 detection by ELISA. Co-administration of LPS and Naloxone greatly reduced LPS-induced-IL-8 secretion. These data provide evidence of a functioning TLR4/NF-κB pathway in THP-1 cells. These data also suggest inhibition of this pathway in THP-1 cells by Naloxone, however, the point of interference remains undetermined. These findings have significant implications for immunological research in THP-1 cells and for the administration of Naloxone in immunocompromised individuals.

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**154. Kristy Rieger, Grand Valley State University**

**Neuroscience**

(Co-Authors: Derek Haas, Merritt Taylor)

*“An In Vivo study of the Effects of Long Chain Fatty Acids on Neurogenesis”*

Abstract: Long chain fatty acids have been shown to play a role in the generation of new neurons, or neurogenesis, in vitro. In this study, the effects of long chain fatty acids are investigated in vivo. Docosahexaenoic acid (DHA) is a long chain fatty acids that has been shown to promote neurogenesis in vitro. In this in vivo study chicken embryos were injected with docosahexaenoic acid (DHA). After incubation, the tissues samples were analyzed to determine the effect of DHA on neurogenesis. The DHA injected samples in early neurogenesis showed a significant increase in neurons (NeuN+ cells) as compared to the control (BSA only). As neurogenesis progressed, the number of neurons in the control increased, but the number of neurons in the DHA injected samples remained the same. These results suggest that DHA drives differentiation in early neurogenesis at the expense of neural stem progenitor cells in later neurogenesis.

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**155. Yolanda Cruz-Olguin, Grand Rapids Community College**

**Nursing**

(Co-Authors: Rakumbar Mohan, Yiping Mao, Shungang Zhang, and Xiaoqing Tang)

*“Role of MicroRNA in Pancreatic Beta Cell Pathogenesis”*

MicroRNAs are involve in numerous of human disease including diabetes. Using a transgenic mouse, we were studying the role of MicroRNA-30d. The overexpression of miR-30d can activate insulin release and improve glucose tolerance in transgenic mice.

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**156. Brittany Cooke, Grand Valley State University**

**Physics**

(Co-Authors: Advisor: Dr. Richard S. Vallery, Brittany Cooke)

*“Generation of Diffraction Gratings Using Photographic Film”*

A diffraction grating splits a source of light into multiple sources that can inter-act with each other and create a diffraction pattern: a series of alternating bright and dark spots. Commercial diffraction gratings are often made from etched glass. This project determines how well diffraction gratings can be made using a variety of photographic slide films. This allows scientists to design custom gratings and manufacture them locally. Multiple types of diffraction gratings were tested in this project, including regular, angled, and forked gratings. Photographs of diffraction grating patterns were taken and developed onto slide film. The slides were tested using a helium-neon laser and factors such as exposure

(aperture size and time), focal length of the camera's lens, and ISO of the film were tested for effectiveness. Effective gratings were ones producing a quality diffraction pattern.

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**157. Julia Gjebic, Grand Valley State University**

**Physics**

(Co-Authors: Dr. Karen Gipson, Dr. Marlen Vavrikova, Julia Gjebic (P.I.))

*"A Study of Oboe Reed Construction"*

The construction of reeds is of much interest in the oboe community, because professional oboists spend as much time making reeds as they do practicing. Each oboist uses an individual methodology resulting from different training and personal physiology. To investigate how different reed construction affects the resulting sound, 22 professional oboists were recruited to make three reeds apiece for this study. First, a controlled batch of reed cane (internodes of the grass *Arundo Donax*) was selected based on microscopic inspection of cellular composition as well as macroscopic physical characteristics. For most of the participants, the cane was then processed identically to the stage known as a blank, after which the participants finished their reeds according to their usual methods. (The few participants who made their own blanks still used the controlled cane and also a controlled staple, the metal cylinder that attaches the reed to the oboe.) The sound spectra of recordings of each participant playing on his/her respective reeds were analyzed, as was a spectrum of the crow (sound without the oboe attached) of each reed in an anechoic chamber. These spectra were correlated to measured physical attributes of the reeds.

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**158. Danielle Harris, Grand Valley State University**

**Physics**

(Co-Authors: Dr. Richard S. Vallery)

*"DDS/DGEBA Epoxy Used as a Model for Studying Polymer Confinement in Polymer Nanocomposites"*

An interesting class of materials is polymer nanocomposites (PNC). Essentially, PNC's are polymer matrices with nanoparticles dispersed within it. These nanoparticles provide a surface for attachment within the polymer, potentially resulting in alterations of macroscopic properties, such as conductivity, hardness, and flame-retardance. This change in attachment can also alter microscopic properties, such as voids in the polymer. Since it has been well studied, an ideal model system for studying polymer attachment to silica nanoparticles (15-20 nm in diameter for this study) is diglycidyl ether bisphenol A (DGEBA) with 4,4'-diaminodiphenyl sulfone (DDS) hardener. Using Positronium Annihilation Lifetime Spectroscopy (PALS), we can study these voids by analyzing the lifetime of positronium (the bound state of an electron and its antiparticle, a positron) which tends to localize in the voids of the polymer matrix. Preliminary results will be discussed, as will the PNC fabrication process.

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**159. Margeaux Carter & Jacob Lampen, Calvin College**

**Physics**

(Co-Author: Professor Matthew Walhout)

*"Laser Frequency Stabilization Using an Acousto-Optic Modulator"*

In order to implement a magneto-optical trap (MOT) for argon atoms, we needed a laser that was frequency-tuned precisely to the atomic transition at 811 nm. To build a "laser-frequency lock" we used an acousto-optic modulator to separate a laser beam into two beams exhibiting a specific frequency difference. After both beams were sent through a sample of argon gas, the absorption signal of one was

subtracted from the other. This resulted in an electronic “zero-crossing”—and therefore a locking point—at the midpoint between frequencies of the beams. We used the lock in order to implement a MOT for argon atoms, but it was not stable for more than a few seconds at a time, so it will have to be improved.

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**160. Nathan McReynolds, Calvin College**  
(Co-Author: Nathan McReynolds)

**Physics**

*“Data Acquisition and Analysis with LabVIEW”*

LabVIEW has become a common programming language used in industrial and research occupations world wide. The graphical programming component of LabVIEW allows the programmer to gain a visual perspective of what is happening in the code which helps to make the code easier to interpret. Also, since LabVIEW comes with its own drivers for the physical hardware that are used in experimentation, the programmer is allowed to focus more on writing programs to test their scientific hypothesis rather than building code that is necessary for communicating with the physical system. My goal was to explore different ways to incorporate LabVIEW into my research group’s project which entailed trapping atoms. By the end, I had incorporated video taking and analysis of the atom trap. This particular test analyzed the light intensity of the atom trap. I had also created programs that could synchronize digital and analogue input and output signals. These data taking and analysis methods were done on mock set ups of the experiment and in future extensions I would like to see how these techniques would work on the experiment they were designed for.

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**161. Emma Patmore, Alma College**  
(Co-Authors: M.M. Strait, G.J. Flynn, D.D. Durda)

**Physics**

*“Detectors to Determine Variable of Particles in Impact Experiments”*

When asteroids are impacted they break up into smaller pieces that become interplanetary dust particles, micrometeorites and meteors that reach the Earth’s surface. Impact experiments have been conducted for several years at the NASA Ames Vertical Gun Range (AVGR) involving terrestrial and extraterrestrial samples. High-speed videos are taken of these impacts and then analyzed. In the videos the particles that develop from the impact appear to travel at varying speeds. This leads to the idea that the faster particles are composed of a different material than the slower materials. A basalt is being impacted to test this idea. This terrestrial igneous rock is composed of different materials, which may travel at varying rates. Different detectors have been developed to collect and separate the particles that travel at different speeds. Trial runs have been completed on one detector. This detector stands four feet tall and has a slit that falls down, exposing only an inch of the collector at a time. This allows for the separation and analysis of particles that travel at different speeds. Other detector styles being considered include a rotating drum that will shut itself off after one rotation of the collector, a shorter falling detector like the original, and a falling detector that uses springs and roller bearings to regulate its velocity. The most effective detector will be used in future experiments at AVGR to measure variable speeds of particles.

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**162. Benjamin Peecher, Hope College****Physics**

(Co-Author: Dr. Jennifer Hampton)

*“Electrodeposition and Dealloying of Nickel-Cobalt Thin Films”*

A nanoporous thin film's high surface area allows it to act as a particularly efficient capacitor and gives it enhanced catalytic properties. This project focuses on the electrodeposition and dealloying of nickel-cobalt thin films with the purpose of creating such a nanoporous structure on the surface of the film. Using an electrochemical cell and a three-electrode system nickel-cobalt films of various ratios were deposited onto gold substrates. A scanning electron microscope (SEM) with an energy dispersive x-ray spectroscopy (EDS) attachment was used to observe and characterize each sample's appearances, structures, and compositions. The depositions were remarkably uniform and smooth. The only defining characteristic was a large number of tiny holes measuring fractions of a micron scattered across the surface in varying concentrations. Analysis of the data gathered from the EDS showed that the percentage of cobalt in the film averaged nearly double that in the solution, suggesting that, when the two are deposited together, cobalt deposits at a much higher rate than nickel. Select samples were then dealloyed in the same electrochemical cell. This was achieved by reversing the potential across the electrodes, and, since cobalt re-oxidizes at a lower potential, it should strip off first, leaving behind an especially nanoporous surface. Preliminary results from the EDS suggest that dealloying cobalt from a nickel-cobalt sample is more likely with a higher cobalt to nickel ratio on the film.

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**163. Jonathan Shomsky, Calvin College****Physics**

(Co-Author: Prof. Matt Walhout)

*“Using laser light to decelerate argon and krypton atoms”*

We model the slowing of argon and krypton atoms as they interact with a laser beam and a magnetic field. Our aim is to identify a set of experimental settings that can be used to trap both species simultaneously. The slowing process involves repeated absorption and emission of laser photons by the atom in question. Each absorption gives the atom a “kick” in the direction of the laser beam. Each emission adds an additional kick in a random direction, but these random kicks cancel out over time. In order for continual absorption and emission to happen, the atom and laser must be in resonance. Therefore, in the experiment we are modeling, the velocity-induced Doppler shift of the atomic resonance frequency must be balanced by the magnetically-induced Zeeman shift. Based on the Monte Carlo method (using computer-generated random numbers to simulate probabilistic events), our simulation follows each atom's position and velocity throughout the deceleration process, and in the end it predicts the fraction of atoms that will be brought to a near standstill for any set of experimental settings. After exploring a range of settings, we identified parameters that allow for simultaneous slowing of both krypton and argon.

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**164. Michael Korn, Kalamazoo College****Pre-Medicine**

(Co-Authors: Max E. Davis, Jonathan P. Gumucio, Asheesh Bedi, Christopher L. Mendias)

*“The protective effects of simvastatin on muscle in a rat model of chronic rotator cuff injury”*

Rotator cuff tears are a prevalent cause of shoulder pain associated with muscle atrophy and infiltration of fat, known as “fatty degeneration.” Simvastatin is a generic HMG-CoA reductase inhibitor that, in addition to lipid-lowering effects, has demonstrated muscle protective capacity by reducing the expression and activity of certain matrix metalloproteinases. We hypothesized that administering simvastatin would reduce fat accumulation and extracellular matrix fibrosis following rotator cuff tear. To test this hypothesis, rats were subjected to a full-thickness supraspinatus tenectomy. Simvastatin was administered orally for 4 weeks, after which supraspinatus muscles were isolated and prepared for contractility, histology, or gene expression. Drug treatment increased muscle fiber specific force by 19% and decreased visible fat within and around fibers compared to control rats. Expression of genes associated with fat accumulation, inflammatory macrophage expression, and extracellular matrix fibrosis was significantly decreased. Simvastatin treatment increased cross sectional area and decreased percent composition of IIB fibers by 13% and 39%, respectively. These results indicate that simvastatin maintains rotator cuff muscle integrity by protecting against fatty degeneration following rotator cuff tear. Further investigation into the preservation of muscle health will help improve functional patient outcomes following rotator cuff repair surgery.

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**165. Maria Sanchez, DePaul University****Pre-Medicine**

(Co-Authors: Maria Sanchez and David N Everly Jr.)

*“Identification of Potential LMP1 Binding Proteins for Signaling of EBV Associated Diseases Using Bimolecular Fluorescence Complementation”*

The Epstein-Barr virus (EBV) is a herpes virus, which has been associated with many different types of diseases. EBV has been connected to Burkitt’s lymphoma, Hodgkin’s Lymphoma, gastric carcinoma, and nasopharyngeal carcinoma. EBV has also been connected to various autoimmune diseases, including multiple sclerosis, lupus, rheumatoid arthritis, and Sjögren’s syndrome. Understanding the association of EBV to multiple diseases is of particular interest to health professionals. It has been determined that a vital component of EBV infection and EBV associated diseases lies within the signaling of the viral oncogene, latent membrane protein 1 (LMP1). In a previous study, several proteins were identified as potential LMP1 binding proteins. The focus of this study is to determine if bimolecular fluorescence complementation (BiFC) between candidate proteins and LMP1 is affected by LMP1 signaling mutants. It is known that tumor necrosis factor receptor associated factors (TRAFs) are required for LMP1 signaling. BiFC between TRAFs and LMP1 signaling mutants has been shown to go down. Thus, the hypothesis is that if the identified LMP1 binding proteins are needed for LMP1 signaling, then BiFC between LMP1 mutants and the candidate proteins will decrease. Observed decreases in BiFC between LMP1 and prospective proteins suggest a critical role for these proteins in LMP1 signaling of infected cells. Such insights can be used to better understand the LMP1 signaling complex, and design novel therapeutic approaches to inhibit EBV associated diseases.

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**166. Erin Combs, Grand Valley State University****Science Education**

(Co-Authors: Veronique Shulz, Dr. Cindy Miranti)

*“How Do Cancer Cells Communicate with their Environment?”*

The c-Met protein has been found to play an important role in the survival and metastasis of prostate cancer cells. This study tested the hypothesis that cell survival is dependent on the physical interaction between integrin- $\alpha$ 3 and a specific portion of c-Met: extracellular or transmembrane. Viruses of these constructs were prepared and infected into primary epithelial prostate cells. Western-blot analyses showed that the viruses did indeed infect the cells. Successful siRNA knockdown of Met was conducted and we have begun testing the interactions between integrin- $\alpha$ 3 and c-Met in order to validate our hypothesis.

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**167. Nathan Colley, Grand Valley State University****Science Education**

(Co-Authors: Nathan Colley, Wendal Kane, Jared Toogood, Gary Greer)

*“Niche and Neutrality of Vascular Epiphytes at Mid-Elevation in Puerto Rico”*

This on-going study takes an island bio-geographical approach to the question of the relative influences of niche (species being distributed through deterministic factors such as competition, dispersal, and environmental conditions) and neutrality (ecologically equivalent species being distributed randomly and predicted mathematically) in determining spatial patterns of biodiversity using lower trunk epiphytic communities at El Yunque National Park, Puerto Rico as a model system. Field work was conducted in 2012 and 2013 with 88 trees being sampled in 8 clusters for amount and distribution of epiphytes. Photographs and preserved specimens will be anatomically analyzed to determine each plant's water demand and drought tolerance. Hopes to be completed by summer of 2014.

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**168. Sara Conrad, Calvin College****Science Education**

(Co-Authors: Karyssa C. Schrouder and Amy M. Wilstermann, PhD.)

*“Cancer Curriculum Initiative: Developing Resources to Improve Children's Understanding of Cancer”*

The Cancer Curriculum Initiative (CCI), a team of students and faculty from Calvin College that are dedicated to improving children's understanding of cancer, began its work in April 2011 with the development of a half-day workshop for K-5 students focused on the biology of cancer. Since that time, the CCI has centered its efforts on developing a complete library of educational resources that can be used to teach children of all ages (K-12) about cancer, cancer treatments, and caring for those with cancer. In July 2013, the CCI established a partnership with Helen DeVos Children's Hospital (Grand Rapids) and has begun to develop curricular materials that will support the classroom peer education efforts of Pediatric Hematology/Oncology and Child-Life staff. As a result of this project, children will understand the biology of cancer, at an age-appropriate level, how cancer differs from other illnesses, how cancer treatments work, and why patients experience symptoms commonly associated with cancer and cancer treatments. Children will demonstrate comfort discussing cancer and asking questions about cancer and will identify ways that they can support peers/family during their illness. Students will participate in service projects that support cancer patients or cancer research.

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**169. Joseph Lutz, Grand Valley State University**  
(Co-Authors: Sarah Staman, Dr. Rick Rediske)

**Science Education**

*“In-Country Prototype Biosand Filters”*

Abstract: The lack of access to safe water impacts millions of people around the world. Point-of-use filters are the most viable solution and biosand filters are the most widely adopted and proven method of providing safe water. This project compared a Prototype design based on a trash can with the HydrAid® biosand filter. The Prototype design is intended to be less expensive, employ local people in its construction and maintenance, and provide a larger filtering capacity to ensure an adequate quantity of water for the typical family. With preliminary data, the Prototype filter performed as well or better than the HydrAid® filter. Data on effectiveness with larger volumes is not yet available, but is the next step in the research plan.

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**170. Ashley Meyer, Grand Valley State University**  
(Co-Authors: All work done under Dr. B. Biddanda at AWRI)

**Science Education**

*“Climate Change, Lake Ecosystem Dynamics and Lesson Plan”*

The time-series observatory located in Muskegon Lake, MI collects real-time data on many environmental variables that are key to understanding lake dynamics. Using observatory data collected in 2012, air temperature, water temperature (at 5m), Photosynthetically active radiation (PAR), dissolved oxygen (at 5m), and Chlorophyll (at 5m) data was analyzed to monitor daily and inter-annual cycles to gain insight into larger time scale phenomena that drive climate change. Data was used to configure daily averages for the year 2012, hourly averages for four typical months, and trends from a typical day in each of those four months. It is important to monitor daily, seasonal, and yearly cycles in lakes to gain an understanding of the pulse of the lake and understand the effects of anthropogenic and regional climate change.

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**171. Joanna Richison, Grand Valley State University**  
(Co-Authors: Joanna Richison, Joeseeph Jaquot, and Paul Keenlance)

**Science Education**

*“Impacts of Savannah Restoration on Small Mammal Density and Diversity in West Michigan”*

Savannah and other grassland ecosystems are one of the most endangered ecosystems in Michigan and much of North America. Species which rely on habitat found in this ecosystem are frequently species of concern for management agencies. The US Forest Service is currently conducting a savannah restoration in areas which have transitioned to mixed deciduous forest. The impetus for this effort is to promote wild lupine (*Lupinus perennus*) regeneration and provide habitat for the federally endangered Karner Blue butterfly (*Lycaeides melissa samuelis*). Our objective was to analyze the impacts of the restoration project on small mammal diversity and density. A control and three treatment plots (shearcutter, bulldozer, and masticator) were monitored. Small mammals were trapped in a grid of 36 Sherman live traps within each replicate. Trapping results indicated that White-footed mice (*Peromyscus leucopus*) were the most prevalent species in all replicates. Other small mammal species present included Short-tailed shrew (*Blarina brevicauda*), Eastern chipmunk (*Tamias striatus*), and Thirteen-lined ground

squirrel (*Spermophilus tridecemlineatus*). More small mammals were captured in treatment plots than control plots and adult and juvenile thirteen-lined ground squirrels were captured throughout the treatment plots. Both are indications that savanna habitat is being restored and the savanna ecosystem is beginning to thrive.

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**172. Brad Stevens, Grand Valley State University**

**Science Education**

(Co-Authors: Patrick M. Colgan and Bradley S. Stevens)

*“Radiocarbon and sediment evidence for the Nipissing Transgression (~7000 to 6000 years ago) at Hemlock Crossing County Park, Michigan”*

Eight sediment cores from 1.5 to 3.5 meters deep were taken at Hemlock Crossing County Park in Ottawa County Michigan to interpret past lake level fluctuations of Lake Michigan. Sand Creek valley is cut into glacial silt formed in Glacial Lake Chicago during the retreat of the Lake Michigan lobe about 18,000 to 15,800 years ago. After the retreat the lake fell to the Chippewa low about 11,500 years ago. During this time the river eroded the valley into the glacial sediment. From 11,500 to 5,500 years ago the lake rose during the Nipissing transgression flooding the valley. Sediment was divided into five types. These include: 1) glacial clay 2) organics 3) organic silty fine sand 4) organics with sand beds less than 2 cm 5) sand with organic beds less than 10 cm. Four radiocarbon analyses indicate that organic sediment between 2 and 3 meters deep is 6,780 to 5,910 years old. Interpretations of the sediments are determined by using the same processes that form sediments today. We interpret that the radiocarbon and sediment types indicate that the lake was about 2 to 3 meters lower than present between 6,780 to 5,910 years ago and was probably rising to the Nipissing high (~6 meters higher than present), which occurred about 5,500 years ago. These data show that dated stream sediments can be used to reconstruct ancient lake level.

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**173. Kevin Sylvester, Grand Valley State University**

**Science Education**

(Co-Author: Principal Investigator: Ryan Thum Ph.D.)

*“eDNA Detection of an Invasive Aquatic Plant Species”*

Early detection of invasive species is critical for their management or eradication. Aquatic invasive species often go undetected until they have established a substantial population. Environmental DNA (eDNA) has been successfully used as an early detection tool for animal species, but until now, has not been used to detect the presence of an aquatic plant species. eDNA consists of fragments of loose DNA released into the environment from organisms that have been, or still are present in the environment. In this study we test whether the success of eDNA in animal detection will translate to the detection of aquatic plants. This study is groundbreaking for eDNA research since it is the first to work specifically with aquatic plants. It is also the first to demonstrate success in the detection of the aquatic plant *Myriophyllum spicatum* (Eurasian watermilfoil).

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**174. Rebecca Tauscher, Michigan State University****Science Education**

(Co-Authors: Alexandra Collins-Webb, Kathleen A. Jeffery, Lindsey Phillips, Ryan D. Sweeder\*)

*“Comparing the longitudinal impacts of active-learning and module-based undergraduate, general chemistry lectures”*

The ChemConnections project was supported by the National Science Foundation resulting in many teaching modules. ChemConnections was designed to help student learn chemistry concepts through relevant, real-world examples, yet few results have been reported about its success. This study compares the impacts on student learning and long-term preparation of general chemistry students taught using ChemConnections (N=56) and an active-learning lecture (N=308). A multiyear, online survey indicated that the ChemConnection had a small effect on increasing students' perceived ability to communicate through poster presentations (79.5% v. 58.3%,  $p=0.001$ ,  $d=0.464$ ) and written work (66.2% v. 51.5%,  $p=0.022$ ,  $d=0.286$ ). The ChemConnections also had a small effect in decreasing students' feelings of preparation for subsequent classes (4.9% v. 0.4%,  $p=0.005$ ,  $d=0.312$ ); although, matched pairs from both groups earned equivalent grades across nine subsequent classes (2.92 v. 2.87,  $p=0.560$ ). Both groups expressed essentially equal abilities to apply core chemistry concepts to subsequent classes, and no statistical differences were found in the graduation rates between the two classes in the percentage of students graduating five years after the class. This suggests that ChemConnections modules provide a viable method for teaching general chemistry.

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**175. Jennifer Woods, Grand Valley State University****Science Education**

(Co-Authors: Jennifer C. Waller, David J. Janetski, Carl R. Ruetz III, and James N. McNair)

*“Settling rates of stream invertebrates”*

This study aims to develop a better understanding of transport processes in streams. We compared the rates of benthic macroinvertebrate settling from the water column between (1) natural and channelized streams and (2) releases from the top and the bottom of the water column. Four field trials were conducted using marked amphipods to measure longitudinal loss as they settled from the water column. Marked amphipods were released at 15 successive points upstream of a catch net and counted to determine the settling rate. Stream discharge was measured on each sampling date, as well as velocity and depth at meter intervals up to 10 m upstream of the catch net. We found that settling deviated more substantially from an exponential decay model in the natural stream than in the channelized stream. Amphipods also settled more slowly in the natural stream, perhaps due to turbulence driven by high channel complexity. Settling rates of amphipods released from the top of the water column generally showed weak conformity to the exponential decay model in the nearfield relative to the bottom releases. Our findings indicate that particle transport and settling rates may vary considerably depending on stream characteristics and particle entry point. Incorporating these nuances into transport models will provide a more accurate depiction of particle dynamics in streams.

(Co-Authors: Mattox, Stephen, Grand Valley State University, and Herrington, Deborah, Grand Valley State University)

*“Using Pillow Lava Erratics to Investigate Glacial Pathways in Michigan”*

Abstract: In this study, my goal is to better understand the paths of glaciers in Michigan. I plan to test and provide more detail to the existing glacial pathways made during our last major advance/retreat. This study focuses on the last major glacial period (Wisconsin-10 to 15 thousand years ago). Although glaciation in Michigan has been extensively studied, the vast majority of data comes from current end moraine locations and striations left by advance and retreat of glaciers. For this study, I focused on pillow lava erratics located in Southeastern Michigan. These erratics are basalt flows that originally formed beneath water. The pillow shapes in the samples that were identified are formed from the contact of water, which cools the exterior skin of the basalt lava more quickly. Since pillow lava boulders are extremely rare in lower Michigan, the erratics are potentially useful as indicators for glacial movement. Due to their unique appearance, the pillowed basalts are very easy to identify. Pillow lava outcrops were chosen in the Upper Peninsula, near Marquette, and also in Canada, at Chippewa Falls. Rock samples were removed from our test locations and compared to rock cores drilled from the pillow lava boulders found in the Grand Rapids area. Since moraine and striation data strongly supports lobes of ice advancing in a generally southern direction, our possible source regions were chosen as the closest neighboring pillow lava outcrops to the north. Major and trace element chemistry was the primary method of investigation for this study. Chemical analysis was completed at Michigan State University's X-Ray Fluorescence Laboratory. Three samples from possible source regions up north were compared to three samples from the Grand Rapids area. 21 elements were analyzed for each sample. Comparison of samples was done by graphing and analyzing chemical data generated from the XRF process. Initial results indicate that Chippewa Falls was chemically dis-similar to samples from other locations. The strongest chemical similarity was between the two samples taken from the two Mona Schist outcrops near Marquette. Chemical variation within the Mona Schist location was determined by testing two samples from that particular outcrop. These two sample locations were a couple of miles apart from each other. There were also notable similarities between the Fruitridge boulder (in the Grand Rapids area) and the Mona Schist samples. According to less mobile trace elements Zr, TiO<sub>2</sub>, and P<sub>2</sub>O<sub>5</sub>, there was a significant similarity between the Jacob Street boulder and the two Mona Schist Samples. Although similarities and differences were observed, it is important to note that there are many variables to be taken into account. Weathering and chemical change are two processes that can cause samples to be altered over time, and the samples that are being studied have been radiometric dated from 1.1 to 2.65 billion years old. There were also a limited amount of samples that were available for us to study, due to the low number of SE Michigan pillow lava boulders. I “advertised” for additional samples, but no additional erratics were reported.

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**177. Sarah Weber, Grand Valley State University****Target Inquiry Program**

(Co-Authors: Hollister C. Swanson Rachel A. Powers Bradley J. Wallar)

*"Initial Characterization of a Catalytic Amino Acid in the Extended-Spectrum Class C  $\beta$ -Lactamase, ADC-7"*

*Acinetobacter baumannii* is a major health concern due to its resistance to a wide range of  $\beta$ -lactam antibiotics. *A. baumannii* contains a class C  $\beta$ -lactamase (ADC-7) which significantly contributes to the resistance to penicillins and cephalosporins by hydrolyzing the amide of the antibiotics'  $\beta$ -lactam ring, thus rendering it inactive. The active site of ADC-7 has specific amino acid residues that bind the substrates, in addition to playing a catalytic role in the hydrolysis of the  $\beta$ -lactam antibiotic. A similar class C enzyme, AmpC, has a conserved residue, tyrosine-150 (Y), which when mutated to a phenylalanine (F), greatly decreased the catalytic rate of the enzyme. In order to learn more about structure and function of ADC-7, a mutant ADC-7 (Y150F) was generated and subsequently purified. Using the purified ADC-7 Y150F enzyme, kinetic studies revealed that the mutation had almost no effect on substrate binding. However, the catalytic rate of turnover of the common cephalosporin, CENTA, was significantly decreased (> 250-fold). Structural determination by X-ray crystallography has been initiated by preliminary crystallization of the ADC-7 Y150F. The detailed structure and function of ADC-7 is important in creating antibiotics that will be successful against bacteria (such as *Acinetobacter baumannii*) that possess a broad range of  $\beta$ -lactam antibiotic resistance.

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**178. Shinnosuke Kondo & Carl Deeg, Hope College****Computer Science**

(Co-author: Matthew DeJongh)

*"Proposing Genes for Gap Reactions in Metabolic Pathways"*

A metabolic model is a map of the biochemical reactions that take place in an organism. These reactions are catalyzed by enzymes, which are encoded by genes in the organism's genome. However, there are reactions that are known to exist and needed to complete the metabolic model, but are not associated with any genes. These are called "gap reactions". Our goal is to find the genes that encode the enzymes that catalyze these gap reactions. We have researched two approaches: a knowledge-driven approach that focuses on finding a small set of good candidates, and a data-driven approach that focuses on scoring all candidates to rank their plausibility. Identifying the genes that are associated with gap reactions produces better predictive models and directs laboratory experimentation.

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**179. Zachary Diener, Hope College****Physics**

(Co-Authors: Matthew Weiss, Dr. Paul DeYoung and Dr. Stephen Remillard)

*"Analysis of Thin Semiconducting Films' Thickness and Stoichiometry"*

The electrical properties of a semiconductor can only be determined if the sample's thickness and stoichiometric makeup are known. The composition of thin films can be measured using Energy Dispersive X-ray Spectroscopy (EDS) in a Scanning Electron Microscope (SEM). However due to the low stopping power of electrons, EDS is limited to analysis of the surface. When compared, EDS results are complementary to those determined by Rutherford Backscattering Spectroscopy (RBS). RBS provides depth-sensitive compositional analysis due to the large stopping power of alpha particles compared to

protons. Unlike EDS, RBS allows for the simultaneous analysis of both the stoichiometric makeup and thickness. Semiconducting thin films composed of  $\text{AgIn}_{1-x}\text{Ga}_x\text{Se}_2$ ,  $\text{CuGa}_x\text{Se}_5$  and  $\text{Ag}(\text{InGa})_5\text{Se}_8$  deposited on glass or silicon substrates through a variety of techniques were analyzed. Modeling of some samples was straightforward; however in other samples the modeling was complicated due to various inhomogeneities.

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**180. Abigail Carlson, Grand Valley State University**  
(Co-Author: Daniel Bergman)

**Biomedical Sciences**

*“Crayfish cerebral ganglia preservation and sectioning for an assessment of exercise induced neurogenesis”*

Neurogenesis is the formation of new neurons from neural stem cells that occurs throughout adulthood in a variety of animals, including humans. Exercise enhances cell proliferation in mammals, and has been linked to ameliorating age associated declines in memory. Since the nervous system operates under common rules and themes in both vertebrates and invertebrates, our experiment aimed to observe the effects of exercise on the simpler nervous system of invertebrates using BrdU, which labels newly synthesized DNA and indicates cell proliferation. Multiple factors involved in sample preparation, preservation in paraffin, and sectioning via microtome created various challenges early on. Our fundamental focus has centered on mastering these techniques, as it is crucial to eliminate any variability that might affect results. After much practice and troubleshooting, we were able to obtain viable brain tissue sections and are now able to progress toward the exercise trials of the experiment.