West Michigan Regional Undergraduate Science Research Conference

Saturday, October 30, 2010

Program

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, Michigan, 49503 www.vai.org

WEST MICHIGAN REGIONAL UNDERGRADUATE SCIENCE RESEARCH CONFERENCE

October 30, 2010

SCHEDULE OF EVENTS

8:30 ARRIVAL AND POSTER SETUP *Cook-Hauenstein Hall*

9:00 WELCOME *Tomatis Auditorium*

Julie Davis Turner, Ph.D.
Assistant Dean of Van Andel Institute Graduate School

9:15 KEYNOTE ADDRESS *Tomatis Auditorium*

Sherry Queener, Ph.D.
Professor of Pharmacology & Associate Dean,
Indiana University Graduate School, Director of the Graduate Office at
Indiana University-Purdue University, Indianapolis (IUPUI).
"A Life in Science"

10:00 POSTER SESSION I *Cook-Hauenstein Hall*

Presenters at even-numbered posters
Refreshments served

11:15 FACULTY TALKS *Tomatis Auditorium*

Tim Evans, Ph.D.
Professor, Department of Biology, Grand Valley State University
"*From Ancient Tropics to Modern West Michigan: What Molecular Phylogenetics Can Tell Us About Plant Evolution"*

Roger Veldman, Ph.D.
Associate Professor, Department of Engineering, Hope College
"*An Experimental Evaluation of Lightweight Blast Mitigating Materials"*

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*

Mike McDaniel, Ph.D.
Professor, Department of Mathematics, Aquinas College
"*Alhazen's Billiard Problem In Hyperbolic Geometry"*

Mark Neff, Ph.D.
Scientific Investigator and Director of the Program for Canine Health and Performance, Van Andel Research Institute
"Dog Genetics: An Old Art, A New Science"

3:00 CONCLUSION

1. Catherine McKay, Calvin College **Astronomy**

(Co-Author: Professor Larry Molnar)

A Census of Collisional Asteroid Families

When two asteroids in the asteroid belt collide, they break up into a number of fragments that share common physical and orbital characteristics. We call this group an asteroid family. In our research this summer, we set out to discover the rate of formation of asteroid families by collisions in certain regions of the asteroid belt. First, we calculated precise descriptions of the asteroids' orbits so that we could make a careful survey of all the asteroid families in those regions. We then estimated the original masses of the asteroids that collided to form these families and how long ago the collisions took place. Using this information, we hope to test models of the rate of asteroid collisions in particular and of the history of the solar system in general. We also were able to use the observed colors of asteroids to confirm family membership and show that asteroids change color due toweathering after collisions.

2. Aja Nash, Hope College **Biochemistry**

(Co-Authors: Leah Chase and NaTasha Schiller)

B-Integrins traffic with system xc- in confluent and non-confluent cultures of human glioma (U138-MG) cells

System xc- is a plasma membrane transport system that is comprised of two proteins, xCT and 4F2HC. The transporter catalyzes the exchange of cystine and glutamate across the membrane glia and some neurons. Previous research in the Chase lab demonstrated that differences in basal transporter activity in confluent and non-confluent cultured human glioma (U138-MG) cells are a result of differential membrane localization of xCT. We hypothesized that the changes in membrane localization of the transporter is mediated by its association with cell-surface adhesion molecules, b1-integrins that form a dimer with 4F2HC. Specifically, we hypothesized that the decrease in transporter activity observed with increased cell density is a result of internalization of a 4F2HC: xCT: b1-integrin complex. To test this hypothesis, we measured relative membrane expression and internalization of xCT, CD98, and b1-integrin in cultures that were 95% confluent compared with 50% confluent. We first confirmed that xCT and 4F2HC complexed with b1-integrins in both confluent and non-confluent cultures. We then confirmed that the localization of b1-integrins on the membrane decreases with increased cell culture density. In addition, we explored the functional implications of these findings. We hypothesized that differences in membrane trafficking of System xc- among the cultures would result in a difference in their susceptibility to H2O2 -mediated damage. Using a cell death assay, we demonstrated that confluent cultures were less susceptible to H2O2 in comparison to non-confluent cell cultures ($p < 0.01$). These data provide further evidence that the trafficking of System xc- plays an important role in the acute antioxidant defense pathway of glioma cells.

3. Alexandra Cok, Calvin College **Biochemistry**

(Co-Authors: Dr. Larry Louther, Matthew Salie, Daniel Oram)

Effects of Berberine on Acute Activation of GluT1

Acute activation of GluT1 is stimulated by cell stressors such as glucose deprivation and treatment with azide and is not caused by movement of transporters to membrane. Our work explores various acutely activating reagents, with especial focus on those derived from natural substances. Initial studies with the compound berberine indicate that berberine is a very effective acute activator. Low concentrations are capable of large activations occuring in time periods shorter than 5 minutes. All research has been done using a standard 3H-2-deoxyglucose uptake assay in L929 fibroblasts, L6 myoblasts, and 3T3-NIH adipocytes.

4. Andrew Adkins, Calvin College **Biochemistry**

(Co-Author: Isaac Armistead)

Potential for Woody Invasive Plants to Produce Biomass for Ethanol and Improve Soil Quality

Research focused on evaluating the feasibility of using Common Buckthorn, Glossy Buckthorn, or Autumn Olive, three fast-growing, woody invasive species endemic to West Michigan, as a source of cellulosic ethanol biofuel. Switchgrass was also studied to provide a standard ethanol crop for comparison. Biomass samples were collected from Calvin College and Pierce Cedar Creek Institute. The carbohydrate composition of each species was quantified by gas chromatography using a NREL protocol and ASTM test method, with theoretical ethanol yields of each species estimated using the NREL ethanol yield calculator. Results showed that monosaccharide percent by mass was maximized by harvesting biomass before leaf drop. The most readily fermentable monosaccharide, glucose, was significantly reduced in three year growth of all invasive species. Theoretical ethanol yields per dry ton of all species were not significantly different. These results indicate that ethanol yield from these woody invasive species is optimized when biomass is harvested after one year of growth before leaves drop. Maximization of ethanol yield does not depend on the biomass identity, but rather on the quantity of biomass able to be grown per unit area annually. Future research of an established, controlled long-term field study will serve to confirm these results and will investigate the potential of these species to sequester carbon and enrich nutrient quality in degraded soil.

5. Anna Plantinga, Calvin College **Biochemistry**

(Co-Author: Amanda Witte and Kumar Sinniah)

Characterizing Riboflavin Antagonists for Targeted Drug Delivery Applications

Isothermal titration calorimetry (ITC) was used to determine the binding constant of riboflavin (RF) and RF antagonists to chicken riboflavin binding protein (RfBP). The equilibrium dissociation constants determined for riboflavin (Kd = 1.4 nM) and lumiflavin (Kd = 64.2 nM) in 0.1 M phosphate buffer, pH 7.4 by the microcalorimetric method are in close agreement with the binding data previously determined by fluorescence quenching spectrometry. Several of the RF antagonists screened showed dissociation constants in the micromolar range while some showed no binding. The RF antagonists will be used in future studies to target riboflavin receptors for cellular uptake as a potential route for the selective delivery of drug molecules to cancer cells that overexpress riboflavin receptors.

6. Brandon J. Burkhart, Calvin College **Biochemistry**

(Co-Author: Roger L. DeKock)

Theoretical Study of Hydrogen Migration in Binuclear Complexes

The fluxional behavior of hydride bridged bimetallic systems has been studied through DFT computational studies. We examined three different systems to illustrate a low barrier, a medium barrier, and a high barrier to fluxionality. The results indicate that stronger bridging interactions opposite the μ-H ligand correspond to higher transition barriers, and that breaking the opposite bridging interaction is the largest part of these barriers. The insertion of the bridging hydride into the M–M region to form a linear M–H–M framework is only slightly destabilizing; this is supported by computed M–M bond indices that indicate the metal–metal interactions are very weak.

7. Cheri Ackerman, Calvin College **Biochemistry**

(Co-Author: Dr. Eric J. Arnoys)

Diffusion and Transport of Galectin-3

Galectin-3 (Gal3) is a carbohydrate-binding protein that is up-regulated in thyroid, colon, breast, and prostate cancers. In order to perform its cellular roles, Gal3 must move in and out of the nucleus of the cell. In this project, we are studying three characteristics of Gal3 and its mutants to understand its localization and shuttling: (1) flexibility; (2) binding to exportin-1; and (3) rate of nuclear export and import under specific cellular conditions.

8. Christine Timmer, Calvin College **Biochemistry**

(Co-Author: Kumar Sinniah)

Investigating the Binding of Insulin to G-quadruplex DNA

The formation of guanine (G)-quadruplex in the guanine-rich tandem repeats of the insulin-linked polymorphic region (ILPR) is linked to transcriptional effects on the insulin gene. Recent studies demonstrate that these G-quadruplexes can bind insulin, and while this may impact the transcription of insulin, little is known about the binding mechanism. We have performed differential scanning calorimetry to characterize the binding interaction between insulin and G-quadruplex DNA. The consensus quadruplex ILPR sequence shows an unfolding temperature at 93.2 0C, while this peak is absent in a scrambled version of this sequence. The unfolding temperature of an insulin-G-quadruplex mix showed ~ 3 0C change in the Tm for the insulin peak in comparison with the unfolding of insulin alone, and a ~2 0C change from insulin-scrambled DNA mix. These results provide additional support for the binding of insulin to G-quadruplex DNA. Experiments are currently in progress to measure the binding constant of this interaction by isothermal titration calorimetry.

9. Daniel Oram, Calvin College **Biochemistry**

(Co-Author: Dr. Larry Louters, Alexandra Cok, Matthew Salie)

Interactions of Berberine with the AMPK Pathway

Glut1, an acutely activateable facilitative glucose transporter, has been shown to be activatable by berberine, an alkaloid botanical extract. Previous studies using 3T3 adipocytes and L6 myoblasts have indicated that AMPK, a "master switch" enzyme sensitive to cellular energy charge, is an important step in the signalling pathway activated by berberine. P38 and ERK1/2 have been identified as downstream effectors in the AMPK signalling pathway which activates Glut1. We investigated the role of these three enzymes in the berberine signalling pathway in L929 fibroblasts, which express only the Glut1 isoform of glucose transporter, and L6 myoblasts, which express both the Glut4 and Glut1 isoform. The inhibitors Compound C, SB203580 and PD98059 were used as selective inhibitors of AMPK, P38, and ERK1/2, respectively. Cells were incubated with berberine and one of the inhibitors and 2-deoxy-D-glucose uptake was measured. Compound C only diminished glucose uptake in L6 myoblasts, and SB203580 only diminished glucose uptake at maximal berberine stimulation. PD98059 diminished glucose uptake at both maximal and submaximal concentrations of berberine.

10. Eric Prins, Calvin College **Biochemistry**

(Co-Authors: Eric Arnoys)

Characterization of Galectins

Galectins are a group of proteins that are found widely throughout nature. Every galectin contains a carbohydrate-binding domain, which binds to specific beta-galactosides or sugars. Our group has found a galectin protein that undergoes alternative splicing within the nucleus, which results in the formation of three different proteins, two of which can be characterized as galectins based on their sequences and ability to bind lactose.

11. Isabella Felzer-Kim, Calvin College **Biochemistry**

Searching forTyrosine-Cysteine Cross-links with NMR

It has been discovered that when two particular amino acids, Tyrosine and Cysteine, are near to each other in a protein, they form a cross-link between the aromatic ring of Tyrosine and the Sulfur atom of Cysteine. Not much is definitively known about the details of the connection, how widespread the phenomenon is in the spectrum of proteins, and the functional significance of these cross-links. Our concern was learning more about the nature of the cross-links by trying to locate them with Nuclear Magnetic Resonance. The project included the expression and purification of relevant proteins and the use of the 500 mHz NMR to search for the cross-links in these proteins. Because of unforseen solubility, NMR scans of complete proteins were not obtained. Scans of Tyrosine and a cross-link analogue were done, and the cross-link chemical shift change located.

12. Jacob Artz, Calvin College **Biochemistry**

(Co-Author: Eric Arnoys)

Acute Activation of Glucose Transporter 1

Glucose Transporter 1 (Glut1) is a protein that is responsible forthe background level of the uptake of Glucose, which is one of themost essential energy sources for cells. Glut1 is located in the cellmembrane. In order for the Glut1 to function it must first becomeactivated. Understanding the activation of Glut1 could lead to betterunderstanding of certain cancers, diabetes, and Glut1 DeficiencySyndrome.To determine the activation pathway, two hypotheses had to be tested.Activation may occur when the Glut1 enters subregions of the cellmembrane, known as lipid rafts. Alternatively, Glut1 may bind toother Glut1 proteins and thereby activate itself in a process known asoligomerization. Our initial goal for this project was to set up an assay to evaluate these two hypotheses.

13. Laura Diffenderfer, Kalamazoo College **Biochemistry**

(Co-Author: David J. His, Evan J. Arthur, Laura Lowe Furge)

AutoDock as a Method for Predicting Binding for Substrates and Inhibitors of Human Cytochrome P450 2D6

AutoDock is a program from the Scripps Research Institute that can be used to simulate how a ligand docks to the active site of a protein based on three-dimensional structures. From these docking simulations, binding conformations for substrate and inhibitor binding can be predicted. We used AutoDock to simulate the interactions of a variety of substrates and inhibitors with cytochrome P450 2D6 in an effort to understand what types of interactions might lead to inhibition. We observed typical π- π stacking interactions between ligands and Phe120 of P450 2D6 that are thought to be involved in substrate binding and orientation. Given our interest in mechanism-based inhibition, we also noted proximity of potentially activated functional groups to protein nucleophiles. In particular, we examined how the P450 2D6 mechanism-based inhibitors containing piperazine rings interacted with the protein active site. The findings from these studies may aid in future predictions of mechanism-based inhibition of P450 2D6.

14. Lejla Cesko, Calvin College **Biochemistry**

Regulation of ccw12 by the a/alpha repressor in S. Cerevisiae

S. Cerevisiae, or the budding yeast, exhibit one of the two mating types in nature: a and alpha. In the haploid state, the cells either have an a or an alpha receptor on the surface of their membranes, which later allow them to mate and become diploid. The mating genes are specifically found on the MAT locus, and are silenced by Sir2 proteins when the cell is in the diploid state. We have previously found that if we knock-out sir2 in a temperature-sensitive cdc6-4 mutant, the mutant haploid cells behave as if they were diploid; therefore, these cells express the a/alpha repressor and consequently, they can grow at higher temperatures. The a/alpha repressor represses the expression of seventeen genes. Making an additional knock-out of the hml gene in the cdc6-4 sir2Δ mutant enables us to express all of the seventeen genes as the pseudo-diploid cell, once again, behaves as the haploid cell. The resulting phenotype of this mutant is the inability to grow at higher temperatures. By individually knocking out every gene in the cdc6-4 sir2Δ hmlΔ mutant, we have determined that it is solely the expression of ccw12 that permits the temperature-sensitive mutant to grow at higher temperatures. The result is strikingly odd because Ccw12 is a cell wall protein, and the exact mechanism of how a cell wall protein can regulate a nuclear process is still unclear. We explore this question by examining two MAPK pathways triggered by the Sln1 kinase, whose activity increases in ccw12Δ mutants.

15. Leslie Nagy, Kalamazoo College **Biochemistry**

(Co-Authors: Catherine Mocny, Laura Diffenderfer, David Hsi, Evan Arthur, Brendan Butler, Jairam Palamanda, Amin Nomeir, F. Peter Guengerich, Laura Lowe Furge)

Mechanism-based Inhibition of Cytochrome P450 2D6 by Schering 66712

Schering 66712 (5-fluoro-2-[4-[(2-phenyl-1H-imidazol5-yl)methyl]-1-piperzainyl]pyrimidine) is a mechanism-based inactivator of human cytochrome P450 2D6 (P450 2D6) that displays Type I binding with KS of 0.39 ± 0.10 µM. The partition ratio is approximately 300. Inactivation was not prevented by addition of an exogenous nucleophiles including potassium cyanide. Within 15 minutes of incubation with Schering 66712 and NADPH, ~100% of P450 2D6 activity was lost with ~40% loss in ability to binding CO. These findings support inactivation primarily by adduction of protein. ESI-LC-MS analysis of whole protein also indicates the presence of a protein adduct. Modeling of Schering 66712 in the active site of P450 2D6 suggests interaction between the phenyl group of Schering 66712 and the heme iron.
(Supported by: NIH GM086767-01 and RGM086767Z, a grant from the Howard Hughes Medical Institute to Kalamazoo College, and the Hutchcroft Fund of Kalamazoo College).

16. Matthew Borr, Calvin College **Biochemistry**

(Co-Author: Ryan Martinie)

Investigations of Tyrosine-Cysteine Crosslinks

Crosslinked protein derived cofactors (CPDCs) play an important role in enzyme chemistry. These cofactors have been shown to have key catalytic roles in the proteins in which they have been identified. This project focuses on the detection and formation of tyrosine-cysteine crosslinks.

17. Matthew Salie , Calvin College **Biochemistry**

(Co-Author: Dr. Larry Louters)

Western Blotting: The Search for GluT1

GluT1 is a glucose-transporting membrane protein found in most mammalian cells and is responsible for basal glucose uptake. But recently we have shown that the activity of this protein can be changed under varying conditions. In L929 mouse fibroblasts GluT1 becomes more active in response to glucose deprivation, but the mechanism of this activation is not known. Therefore, this project was carried out to understand the mechanism of GluT1 activation, utilizing the western blot technique to isolate GluT1 from the cells. Much of our time was spent fine-tuning the western blot procedure, but we were able to conclude that the concentration of GluT1 in the plasma membrane of L929 cells must be very low in relation to human red blood cells.

18. Michael Agius, Grand Valley State University **Biochemistry**

(Co-Author: Toni Rice)

Toward the synthesis of cyclic heterocyclic polyamides as tetraplex DNA interactive ligands using solid phase synthesis.

Higher-order DNA conformations can form within regions of DNA that are rich in guanines. Telomeric DNA located at the end of human chromosomes, is guanine-rich and can fold into tetraplex DNA. Compounds that should interact and stabilize telomeric DNA are being developed. The synthesis of heterocyclic monomeric units to be used in solid phase synthesis will be described. Fmoc protected heterocyclic carboxylic acids and Fmoc protected benzoic acids have been produced. Solid phase synthesis will be performed to build up linear polyamides. The final cyclization reaction will be achieved via the use of peptide coupling reagents and obtained after cleavage from the resin. Once the compounds have been obtained, biophysical testing will determine binding affinity and selectivity for tetraplex DNA.

19. Rick Armstrong, Alma College **Biochemistry**

(Co-Authors: Chris Duymich, Jeffrey Turk, Joe D. Beckmann)

Engineering the N1 Gene for Viral Neuraminidase Expression

Influenza (H1N1, etc.) impacts human and animal health worldwide, and development of preventative and therapeutic agents is continuing. The N# neuraminidase enzymes, required for viral propagation, are outer face membrane glycoproteins and thus available as targets of current and hopefully new drugs. Our overall project is to design, synthesize, and test novel inhibitors of N1. Although conducting experiments with whole virus is possible, the biohazard risk within an undergraduate setting compelled us to engineer the N1 gene for expression. We designed the project to utilize a mammalian cell expression system with the pSecTag vector (InVitrogen). H1N1 viral RNA was extracted and subjected to RT-PCR (Titan reagents, Taq + Pwo pols), using primers designed to adapt the N1 gene to the pSecTag reading frame. Amplicons were TA-cloned into pCR2.1, clones were EcoR1-screened for the 1.3 kbp insert, and several were selected for DNA sequencing. Correct inserts were then directionally-subcloned into pSecTag-A, screened, and Qiagen Maxi-prepped. Since the vector is T-antigen dependent, and also provides resistance to Zeocin, we chose to transfect COS-1 cells using Genefector reagent. Zeocin (0.2 mg/mL) was sufficient for selection, and resistant colonies were observed after two weeks of incubation. We are currently expanding these colonies and will soon test them for N1 transcription, N1 protein, and N1 activity. (NSF-funded)

20. Ryan Martinie, Calvin College **Biochemistry**

(Co-Authors: Professor R.L. DeKock)

Computational Investigations of Bond Order and Hydrogen Bond Cooperativity

21. Stephenie Graf, Calvin College **Biochemistry**

(Co-Author: Rachel Battershell)

Carbonic Anhydrase-Inhibitor Single Molecule Study

Single molecule force spectroscopy (SMFS) was used to investigate the enzyme-inhibitor interaction between carbonic anhydrase and a sulfonamide inhibitor. The enzyme was electrostatically immobilized on an ultra-flat gold surface such that the binding pocket was orientated up. The sulfonamide inhibitor was tethered to a gold-coated silicon nitride tip by a PEG linker. this setup was optimized by adjusting the concentrations of the sulfonamide inhibitor so that there would be a greater probability that only one inhibitor would interact with one enzyme. Previous studies explored this interaction by using multiple probes and pooling the data, while this study examined the interaction with a single soft cantilever (biolever) to minimize errors resulting from the variations in the cantilevers. Kinetic and thermodynamic parameters were estimated and compared with the multi-cantilever study.

22. Tom Arusoo, Grand Valley State University **Biochemistry**

(Co-Authors: Nate Strong, Toni Rice)

Towards the Synthesis of Novel Cyclic Heterocyclic Compounds to Interact with Higher-Order DNA

Higher-order DNA conformations can form within regions of DNA that are rich in guanines. Telomeric DNA is located at the end of human chromosomes, is guanine-rich and can fold into tetraplex DNA. Compounds that should interact and stabilize telomeric DNA are being developed to increase binding affinity and selectively over duplex DNA. Efforts towards the convergent synthesis of novel, cyclic compounds will be described in this presentation. The intermediate heterocyclic monomeric units were synthesized using a building block approach involving acid chloride-amine coupling reactions. The final cyclization reaction will be attempted via the use of peptide coupling reagents. These coupling reagents will be used in combination with the cation-template effect, to minimize polymerization reactions. The synthetic results obtained to date will be presented. Future goals of this study are to investigate the binding of these compounds to tetraplex DNA. In particular, the specificity and selectivity of tetraplex binding, in comparison with duplex DNA, will be determined. These results will drive subsequent synthetic efforts.

23. Isaac Armistead, Calvin College **Biochemistry**

(Co-Author: Dr. Stephen Matheson)

Knockdown of FHOD1 shows evidence of glioblastoma migration inhibition

Purpose: The spread of cancers like glioblastomas involves migration of cells from a tumor site into other tissues. Cell migration is regulated in part by the formin family of proteins, which remodel the actin cytoskeleton. The goal of this study was to determine which of the 15 human formins are most influential in the migration of U87-MG cells.
Methods: Expression of the 15 human formins in glioblastomas was knocked down serially using RNA interference techniques. The cells were then grown to a monolayer and a narrow area was denuded of cells by scratching. Migratory ability in the siRNA-treated cells was assessed by comparing scratch closure in treatment cells to control cells at a defined timepoint.
Results: Inhibition of migration was inconsistent amongst the various formin knockdown treatments. Diaphanous subfamily formins and FHOD1 were observed to inhibit migration to some extent when knocked down in cells. Cells with FHOD1 knocked down also displayed morphological changes.
Conclusion: Knockdown of FHOD1 in glioblastoma cells shows some evidence of migration inhibition, suggesting a role for this protein in the process of glioblastoma movement.

24. Aaron D. Lamphere, Grand Valley State University **Cell and Molecular Biology / Genetics**

(Co-Authors: David L. Cech and Rachel A. Powers)

Effects of Asn152 Mutation on Substrate Selectivity of P99 Cephalosporinase

β-lactams are a widely administered group of antibiotics that disrupt cell wall synthesis by inactivating bacterial transpeptidase enzymes. Unfortunately, an increasing number of bacteria resistant to β-lactams have emerged that utilize β-lactamases; the most widespread resistance mechanism to β-lactams. These enzymes hydrolyze the lactam ring, rendering the antibiotic inactive. Of particular concern is the appearance of extended-spectrum β-lactamases. The class C β-lactamase P99 is traditionally known as a cephalosporinase, due to its substrate preference. Mutation of the highly conserved asparagine residue at position 152 has a substantial effect on its substrate selectivity [1]. Three of these mutants, N152S, N152G, and N152T, exhibit a substrate selectivity switch, resulting in extended spectrum activity. However, the structural basis for this switch is not understood. Each mutant was successfully purified using an m-aminophenylboronic acid affinity column followed by ion exchange chromatography. Two of the mutants have been successfully crystallized, and these initial conditions are being optimized for improved diffraction. The X-ray crystal structure of an extended spectrum β-lactamase may provide insight into how resistance develops.

25. Alex Harris, Calvin College **Cell and Molecular Biology / Genetics**

(Co-Authors: Randall J. DeJong, John T. Wertz, Benjamin K. Johnson, Jeremiah D. Reenders, Kirsten N.G. Brink, Kyle B. Burghgraef, Steve R. Carnegis, Anna L. Casto, Ariangela J. Davis, Annelle M. Eben, Eric J. Edewaard, Drew S. Esterline, Joel M. Feldhake, Taylor C. Fleet, Katelyn M. Geleynse, Emily A. Huizenga, Ryan J. Martinie, Larissa J. Osterbaan, Anna Plantinga, Alex H. Schierbeek, Karyssa C. Schrouder, Rebecca M. Soyster)

Terms of Enlightenment: Discovering Novel Mycobacteriophage Anaya and Oosterbaan

Twenty students from Calvin College successfully isolated 20 Mycobacterium smegmatis-infective bacteriophage, obtained from various soil samples on campus. After phenotypic characterization and restriction digest pattern analysis, students and faculty selected two phenotypically different phage for further genomic sequencing – phage Oosterbaan and phage Anaya. Oosterbaan has consistently clear plaque morphology, whereas Anaya has a hazy plaque morphology. Genomic analysis of Oosterbaan placed it within the Siphoviridae; specifically in the mycobacteriophage B1 cluster, with 99% nucleotide identity to phage PG1. Genome annotation revealed 13 open reading frames (ORF's) of putatively identifiable function and 85 ORF's with unknown function. Anaya is also a member of the Siphoviridae, though it clustered with only three other mycobacteriophage in the K1 cluster, most closely related to Adephagia. Only 20 of the 98 ORF's were putatively identifiable. Interestingly, the genome of Anaya contains a translational frameshift, is the only phage to contain gene gp 86 (Pham 1475) from the C1 cluster, and contains 5 ORF's that have no known relatives in any mycobacteriophage or any other life form sequenced to date. In order to make inroads in identifying the many ORF's of unknown function, preliminary time-course proteomic studies were done using MALDI-TOF MS with Oosterbaan-infected M. smegmatis. These studies will serve as a foundation for more specific proteomic work in the future.

26. Allison Schepers, Calvin College **Cell and Molecular Biology / Genetics**

(Co-Author: Leanne Lash-Van Wyhe)

Evaluating the neuroprotective effects of formin intramimics in a mouse model of ALS

ALS (Amyotrophic Lateral Sclerosis) is a progressive neurodegenerative disease caused by loss of motor neurons in the spinal cord. Motor neurons are the longest cells in the body and are highly polarized, so they require a highly stabilized cytoskeleton to maintain neuronal viability. Our lab has shown that the Intramimic compounds activate formin proteins, which in turn induce microtubule stabilization, among other things. We predict that stabilizing the cytoskeleton will decrease motor neuron death and slow disease progression in the SOD1 G93A mouse model of ALS. To test this hypothesis, we treated SOD1 G93A mice with the intramimic compound and compared them to both non-treated and vehicle-treated littermates. The SOD1 G93A model is the most widely used mouse model for ALS, and the symptoms are predictable and reproducible. The model also replicates the human disease very well, both physically and pathologically. We measured the disease onset and progression by monitoring motor function using the Rotarod treadmill and gait-scan analysis. We also measured physiological changes by counting motor neurons in the spinal cord. In spinal cord sections treated with the Intramimic compound, more motor neurons were present at disease endstage than in the untreated mice. We hope these studies will show microtubule stabilization to be neuroprotective and that Intramimics could be used to slow ALS disease progression.

27. Amanda Mercer, Grand Valley State University **Cell and Molecular Biology / Genetics**

(Co-Author: Ryan Thum)

Loopholes in the regulation of invasive species: genetic identification techniques identify the sale of prohibited invasive aquatic plants

The aquarium industry is known to introduce non-native aquatic taxa into new environments. Many species of watermilfoils (Myriophyllum) are sold in the aquarium industry, including at least two species that are invasive in portions of the United States (M. heterophyllum and M. aquaticum). In fact, the sale of these species is prohibited in certain states where they are considered invasive. However, species of Myriophyllum are very difficult to differentiate on the basis of submerged aquatic vegetation - their typical growth form in aquaria - leaving open the possibility that some prohibited species are erroneously sold under different names. In this study, we purchased Myriophyllum from fourteen different internet aquarium plant vendors, and compared the scientific and common names listed by the internet vendors to our identifications based on genetic methods that have been shown to accurately identify Myriophyllum species. We found several instances of misidentification in the aquarium industry. For example, M. heterophyllum was sold under a variety of incorrect scientific and common names. It is therefore likely that invasive species are available for purchase in states where they are prohibited because they are sold under species names that are not prohibited.

28. Andrew Kienitz, Grand Valley State University **Cell and Molecular Biology / Genetics**

(Co-Author: Agnieszka Szarecka)

Electronic Structure and Conformational Analysis of Doripenem - A β-Lactam Antibiotic and Its Interactions with Class D β-Lactamases

We are presenting results of electronic structure calculations of two tautomeric forms a new generation β-lactam antibiotic from the carbapenem family called doripenem. Carbapenems are often used as a last resort to treat persistent bacterial infections, meaning that the emergence of new β-lactamase enzymes capable of hydrolyzing carbapenems is a serious clinical concern. The mechanism of carbapenem resistance to hydrolysis by β-lactamase enzymes, in particular by the class D (OXA) family, remains unclear and may involve tautomerization of the doripenem molecule after the acylation half-reaction, resulting in cleavage of β-lactam C-N bond and covalent bonding of carbapenem to the enzyme's nucleophilic Ser residue. In this study we present quantum mechanical conformational analysis of the Δ1 and Δ2 tautomers of doripenem carried out at the B3LYP/6-31+G* level. The gas-phase conformational preferences of the doripenem molecule, particularly of its β-lactam-pyrroline-S-pyrrolidine moiety, provide insight into the possible effects of the protein environment, as well as the effect of conformational strain on the rate of deacylation – the second half-reaction leading to the release of hydrolyzed and therapeutically inactive carbapenem ligand.

29. Ashley Herald, Grand Valley State University **Cell and Molecular Biology / Genetics**

(Co-Author: Dawn M. Clifford Hart)

Investigation of the interaction between Rad24 and Mid1 in fission yeast

During cell division, a ring structure composed of F-actin, myosin and several regulatory proteins assembles and constricts to physically separate a mother cell into two daughter cells. In Schizosaccharomyces pombe, the contractile ring is anchored in the cell center by the anillin-related protein Mid1. Mid1 directly associates with the cell membrane and components of the contractile ring. However, few direct interactions with contractile ring proteins have been characterized. Our preliminary results demonstrate that the cell cycle checkpoint protein Rad24 co-purifies with Mid1 isolated from mitotic cell extract. Here we investigated the possibility that the two proteins directly interact during mitosis. Cell lysates from S. pombe strains synchronized in interphase or mitosis were prepared. Bacterially produced and purified GST-Rad24 was incubated with cell lysate to test by pull-down assay for interaction with Mid1. Our initial results suggests that Rad24 specifically interacts with Mid1 from mitotic extracts. Given that Mid1 is hyperphosphorylated during mitosis, future experiments will determine if the interaction is dependent on phosphorylation.

30. Brad L. Jakubison, Grand Valley State University **Cell and Molecular Biology / Genetics**

(Co-Authors: Samantha K. Seaburg and Bradley J. Wallar)

Characterizing the Cellular Regulation of the Diaphanous-related Formin, mDia3, by Expression of the Constitutively Active Full-length Protein

A family of proteins known as Diaphanous-related Formins are important in the regulation of the cellular cytoskeleton. DRFs are regulated by autoinhibition , a mechanism which involves maintaining the DRF protein in an inactive state by the intramolecular binding of the Diaphanous-inhibitory domain (DID) to the Diaphanous- autoregulatory domain (DAD). Upon binding of an activated Rho GTPase to the DRF GTPase binding domain (GBD), the DID-DAD interaction is released, thereby activating the DRF protein. The autoregulation and cellular localization of activated mDia3 has not been widely characterized. Here, we show that M1053 in the DAD region of mDia3, much like the M1041 in mDia2 and the M1182 in mDia1, is involved in regulation by DID-DAD binding. By engineering full-length, constitutively active mDia3, we have been able to express mDia3 in three different cell lines (NIH3T3, PC12 , N1E-115. Constitutively activated mDia3 results in dramatically increased numbers of filopodia -like extensions in which mDia3 is significantly localized at the tips of the filopodia . Fluorescence anisotropy confirms that the M1053A mutation in DAD results in the inability to bind to the DID region of mDia3. In summary, these results demonstrate the critical contribution of M1053 to mDia3 autoregulation , as well as shed some light on the cellular effects and localization of full-length constitutively activated mDia3.

31. Brandon Nader, Grand Valley State University **Cell and Molecular Biology / Genetics**

Phosphoregulation of Mid1 Association with the Cell Cortex

Phosphorylation events are the driving force of the cell cycle. During mitosis and cytokinesis, fission yeast, Schizosaccharomyces pombe contractile ring organizing protein Mid1, changes phosphorylation states as it functions to guide contractile ring assembly. During early mitosis, Mid1p associates with the medial cell cortex through an amphipathic helix. Here we seek to determine if phosphorylation regulates Mid1p-membrane association. S. pombe cells were arrested at different cell cycle stages that correspond to hypo- and hyper-phosphorylated Mid1p. Membrane flotation assays and Opti-prep density gradient separation were preformed to collect fractions of cellular lysis from S.pombe cell cycle arrest mutants. Using SDS-PAGE, proteins were separated and detected through western blot analysis. We expect that hyper-phosphorylated Mid1p will fraction with the cellular membrane. Later research events will focus on the cellular localization of Mid1p phosphosite mutants and their ability to interact with the cellular membrane.

32. Caleb James, Grand Valley State University **Cell and Molecular Biology / Genetics**

(Co-Authors: Dr. Timothy M. Evans and Dr. Gregory K. Brown)

Phylogenetic Relationships within the Neotropical Plant Genus Lymania (Family Bromeliaceae) based on Four Chloroplast DNA Regions

The genus Lymania (family Bromeliaceae) consists of nine species of narrow geographic distribution within neotropical forests. Members of Bromeliaceae have undergone adaptive radiation, and there is evidence to support rapid radiation events along the lineage of modern Lymania. More recently, Lymania species have suffered from massive habitat loss due to human activity. Recent phylogenetic studies have provided weak support for a monophyletic Lymania, but relationships within the genus have not been fully resolved. A phylogenetic analysis of the genus was performed using DNA sequences from four chloroplast genes (matK, psbA-trnH, trnL-trnF, and ndhF). Preliminary analyses still support a monophyletic Lymania, but relationships among several genera remain unresolved. Analysis of phylogenetic branch lengths suggests a recent relatively high extinction rate in the genus, possibly due to the combination of habitat loss and narrow endemism.

33. Changqi C. Zhu, Ferris State University **Cell and Molecular Biology / Genetics**

(Co-Author: Michael B. O'Connor)

Activin signaling is required for Drosophila follicle cell development and normal female fertility

The Drosophila Activin signaling is initiated by Activin-type ligand Activin-β or Activin-like protein Dawdle, either of which can bind type I receptor Babo and type II receptor Punt leading to the phosphorylation of the cytoplasmic protein Smad2. This signaling event has previously been shown to regulate different aspects of Drosophila neurogenesis and axon guidance. Here we demonstrate that the two ligands Activin-β and Dawdle are expressed in developing follicle cells of female oocytes, and that the two ligands in developing oocytes are required to regulate the normal follicle cell adhesions. By expressing Smad2RNAi in developing follicle cells, we found that Smad2 gene is not only required for regulating follicle cell adhesions but also for maintaining normal follicle cell size and cell shape in female oogenesis. In concomitant with the follicle cell development phenotype, Activin-β mutant, Dawdle mutant, and Smad2 knock-down females ceased to produce mature eggs much earlier than the control females. These mutant or Smad2 knock-down females also showed egg-laying defect and fertilization problems.

34. Cody Hager, Grand Valley State University **Cell and Molecular Biology / Genetics**

(Co-Authors: Jennifer L. Jakubowski and Dawn M. Clifford Hart)

Identifying an atypical actin binding domain in the fission yeast Mid1 scaffold

The scaffolding protein Mid1 (middle 1), found in the fission yeast Schizosaccharomyces pombe , is thought to function as a scaffolding protein. This anillin-like protein assists in the assembly and placement of the actin contractile ring by directly associating with the cell cortex and components of the contractile ring to anchor the structure in the cell center. The placement and functionality of the division septum corresponds to the placement of the contractile ring. Therefore, identifying contractile ring proteins that directly associate with Mid1 will contribute to our understanding of proper cell division and equal transfer of the cellular contents, including the genetic material. Our preliminary results suggest that Mid1 contributes to the formation and placement of the actin contractile ring through the direct association of F-Actin filaments.
The main goals of this research project are to identify the actin binding domain in Mid1 and analyze the phenotypic consequence of disrupting the interaction. To test this, we are using actin cosedimentation assays with purified regions of Mid1 protein. After identifying the actin binding region within Mid1, Mid1 mutants with alterations to the actin binding region will be generated and analyzed for cell division defects.

35. Daniel Smith, Hope College **Cell and Molecular Biology / Genetics**

(Co-Author: Leah A. Chase)

Activation of System xc- trafficking via an Akt-dependent signal transduction pathway

System xc- is a heteromeric plasma membrane transporter involved in the exchange of intracellular glutamate for extracellular cystine–a critical step in the production of the antioxidant glutathione. Previous studies in our lab have demonstrated that within ten minutes of exposure to H2O2, the percent of xCT protein localized to the plasma membrane of cells increases. The study described herein sought to establish a link between a putative "oxidative-stress activation" of Akt and trafficking of System xc-. To date, the role of Akt in mediating xCT trafficking has not been confirmed, due primarily to a lack of experimental replicates. Activation of Akt was seen in U138MG cells following ten-minute exposure to 3mM H2O2, and cells treated with the Akt inhibitor 10-DEBC (2.5µM) showed decreased phosphorylation of Akt at Ser473. Similar inhibition of Akt phosphorylation at Thr308 was observed following treatment of cells with 1.0µM API-2. Stimulation of cell cultures with H2O2 following one-hour exposure to 10-DEBC did not result in increased phosphorylation of Akt at Ser473, but similar treatment of cells with H2O2 following exposure to API-2 did show increased levels of phosphorylation at Thr308. These results indicate that 10-DEBC might be a more effective inhibitor of Akt activation in response to oxidative stress than API-2. Future experiments will seek to confirm the putative role of Akt in the activation of System xc- trafficking during periods of oxidative stress.

36. Emi Okayasu, Calvin College **Cell and Molecular Biology / Genetics**

(Co-Author: Dana Freund)

Elucidation of Phosphoproteins Involved in the Cellular Response to Acute Metabolic Acidosis

Metabolic acidosis is caused by a decrease in plasma pH and the concentration of bicarbonate buffer in the blood. The proximal tubule cells of the kidney mediate the body's response to this pH stress by increasing the catabolism of glutamine, effectively producing bicarbonate for export to the bloodstream. Though this response is well characterized, the mechanisms by which this response is activated are unknown. In order to investigate the various pathways which might be involved in initiating this response, a proteomic analysis of the phosphoproteins expressed by proximal tubule cells modeling metabolic acidosis was done. The phosphoproteins expressed by these cells after a 24 hour treatment at pH 6.9 were run on 2D gels, and stained with a quantitative phosphoprotein stain and total protein stain. Analysis was performed with imaging software, and finally proteins were identified by LC-MS/MS and studied for their functional characteristics. Using this approach, both phosphoproteins abundant in the proteome of proximal tubule cells as well as many proteins changing in degree of phosphorylation were found.

37. Emily Diekema, Calvin College **Cell and Molecular Biology / Genetics**

(Co-Authors: Eric P. Lauzon and Elizabeth M. Sanford)

Characterizing Topoisomerase IIa Intermolecular Interactions

Topoisomerase IIα is an enzyme that relieves tension and resolves knots that occur in the genetic material during DNA replication, transcription, and mitosis. Because of its importance in these essential cellular processes, drugs that target topoisomerase IIα have been used as cancer treatments. Some of these agents inhibit enzyme activity by competing with ATP at it's binding site. We utilized various ATP analogs to enhance our understanding of the interactions that occur between topoisomerase II and it's ATP cofactor. Results indicate that the amino group on ATP is required for enzyme binding and enzyme activity. Furthermore, while alteration of the sugar ring does not affect ATP-enzyme binding, it does affect enzyme activity.

38. Jennifer Phelan, Grand Valley State University **Cell and Molecular Biology / Genetics**

(Co-Author: Dawn M. Clifford Hart)

Phospho-regulation of the anillin-related scaffolding protein, Mid1

Cell division is a fundamental biological event that underlies the growth and development of all organisms. Because human and fission yeast (Schizosaccharomyces pombe) cells divide symmetrically through constriction of the actomyosin ring, fission yeast provides an ideal model system to reveal conserved cytokinesis properties. In fission yeast, an evolutionarily conserved protein, Mid1, plays a critical role in organizing the early steps of contractile ring formation and functions as a scaffold to bridge the cell cortex with the contractile ring. Cells lacking mid1 form off-centered, highly disorganized ring structures and exhibit severe cytokinesis defects. Coincident with its cortical accumulation, Mid1 becomes hyper-phosphorylated. Our previous research demonstrates that cyclin-dependent kinase, Cdc2, and the polo-like kinase, Plo1, directly phosphorylate Mid1. In addition to consensus phosphorylation motifs for Plo1 and Cdc2, Mid1 contains several RXXS motifs, which fits the phosphorylation consensus sequence for Sid2 kinase. Sid2 is the most downstream kinase in the SIN signaling cascade, which signals from the spindle pole body to trigger constriction of the contractile ring. To examine Mid1 phospho-regulation, phospho-site mutants were generated at the endogenous mid1 locus and examined for cell division defects. Current studies focus on the consequence of treating phospho-site mutants with microtubule and actin destabilizing agents.

39. Jim O'Donnell, Ferris State University **Cell and Molecular Biology / Genetics**

(Co-Authors: Caitlin J. Williams, Ryan J. Walsh, Norman L. Lehman)

Expression of APC/C Substrates in Glioma Cell Lines

Aurora A and Aurora B are highly related mitotic serine/threonine kinases which are essential substrates of the Anaphase Promoting Complex/Cyclosome (APC/C) which are required for the proper completion of mitosis. Aurora A plays a role in the proper formation and function of the mitotic spindle during the early stages of mitosis. Aurora B regulates microtubule attachment to the centromere and plays a major role in the proper segregation of chromosomes along with several other APC/C substrates. Emi 1 is an inhibitor of the APC/C which prevents premature activation of the APC/C. Emi 1 also binds the APC/C substrate Cdc 20, which is a known activator of the APC/C. Emi 1 is present in large amounts before the cell enters mitosis and is destroyed as the cell progresses through mitosis by a mechanism separate from the APC/C. Cdh 1 acts as a tumor suppressor by preventing unchecked growth. Cdh 1 also is a regulator of the APC/C and plays a role in signaling the destruction of securin, which coincides with the switch from Cdc 20 to Cdh 1. Mutations in Cdh 1 are also known to lead to increased risk of some forms of breast cancer as well as cancer of the stomach lining. Mutations of this gene also make it more likely that cancer cells will detach from a tumor and metastasize in other tissues. When substrates of the APC/C are not degraded and removed at the proper point in the cell cycle, mitotic catastrophe will occur which leads to aneuploidy and abnormal growth.

40. Tu Thien Danh, Calvin College **Cell and Molecular Biology / Genetics**

(Co-Author: Dr. McCarthy)

Cloning a PCP-monooxygenase gene from M.chlorophenolicum

Pentachlorophenol (PCP) is a organochlorine compound that was introduced in the 1930s as a wood preservative, but banned in 1984 because of its toxicity. M. chlorophenolicum, a gram-positive actinomycete, is shown to be resistant to the toxic effects of PCP and to metabolize PCP. Previous research supports that the first enzyme of PCP metabolic pathway, PCP monooxygenase, is a member of cytochome p450 superfamily. Here, we report initial results in our attempt to clone PCP-monooxygenase from M.chlorophenolicum.

41. Melissa Oosterhouse, Calvin College **Cell and Molecular Biology / Genetics**

(Co-Author: Cassandra Diegel)

Expression of Lrp5 during Mammary Gland Development

The Wnt signaling pathway is involved in normal mammary gland development. However, the Lrp5 protein involved in that pathway has been linked to breast cancer and therefore could be an effective target for breast cancer treatment. This study aimed to determine the effects of a mammary gland specific knockout of Lrp5 on mammary gland development. Mammary glands were removed at two time points and the number of terminal end buds and side branches were quantified. At both 5 and 11 weeks, the knockout glands exhibited a specific phenotype, but this phenotype was not completely penetrant. Lrp5 remains a potential target for breast cancer treatment, but knocking out the protein can cause severe developmental delays.

42. Naila Kovacevic, Grand Valley State University **Cell and Molecular Biology / Genetics**

(Co-Author: Mark Staves)

The calcium concentration and density of the external medium affects gravity sensing in plants.

The current model for Gravitropism claims that sedimenting plastids are responsible for gravity sensing in higher plants. However this model cannot explain gravity sensing in statolith-free tissues and organisms. Therefore, we propose a new model, arguing that the entire protoplast functions as a gravity sensor, thus it is the density differential between the protoplast and the external medium that will determine gravity sensing rather than the sedimenting of intracellular plastids. The first objective of these experiments was to determine the effect of varying the density of the external medium with a dense, impermeable molecule on gravitropic curvature of (statolith-containing) rice roots. The gravicurvature of rice roots gravistimulated in media of varying densities was monitored using time-lapse digital photography over a 610 minute period. The second objective was to determine the external calcium requirement for gravitropism. To do this, we varied the calcium concentration of the external media from pCa 4 to pCa 7. Our results show that increased density of the external medium inhibited or even reversed gravitropic curvature of roots, whereas decreasing the external calcium concentration decreased (> pCa6.3) and ultimately completely inhibited (>pCa 7) root curvature. These findings support our new proposed gravitational pressure hypothesis and do not support the statolith model for gravity sensing.

43. Patricia Railing, Ferris State University **Cell and Molecular Biology / Genetics**

(Co-Authors: S. Samudre, P. Williams, F. Lattanzio, Jr, K. Rosen, J. Sheppard, Jr.)

Loteprednol Etabonate Increases Glucocorticoid Receptor Migration in Pterygia

Pterygia are fibrovascular degenerations contiguous with conjunctiva and cornea. They are associated with ultraviolet light exposure and induce significant astigmatism and irritation. Pterygia are commonly treated surgically but have a recurrence rate as high as 40%. Treatment with corticosteroids is hypothesized to delay pterygium progression. This study assesses the efficacy of 0.5% loteprednol etabonate (LE) by comparing glucocorticoid receptor (GCR) migration with clinical outcomes after steroid therapy. Seven patients with mild to severe pterygium were treated with topical LE four times daily for two weeks prior to excision. Pterygium biopsies were studied from steroid treated pterygia, treated normal conjunctiva and untreated naïve conjunctiva. Samples were homogenized in RIPA Buffer and supernatant collected for protein and Western blot analysis. GCR activation was measured as a function of GCR migration from the cytosol into the nucleus. The Bradford assays showed that the total protein concentration in treated pterygium was significantly lower than the untreated normal conjunctiva tissue. GCR migration activity increased significantly following treatment with LE. The receptor migration was most pronounced in the pterygium tissue with less effect on normal treated and untreated conjunctiva. These findings suggest that perioperative treatment with topical LE may result in favorable clinical outcomes in pterygium removal.

44. Rachel Van Dyken, Calvin College **Cell and Molecular Biology / Genetics**

(Co-Authors: John Ubels, Mark Schotanus, Julienne Louters)

Effect of UV-B Light on the Efflux of Potassium Ions From Human Corneal Epithelial Cells

Our research focused on the effects of high extracellular potassium on human corneal epithelial cells that had been exposed to ambient amounts of UV-B light. We hypothesized that the high concentration of potassium in tears prevents the loss of intracellular potassium upon UV-B exposure. I investigated the roles of potassium channel proteins, pumps and potassium ions in the process.

45. Steven Grzegorski, Kalamazoo College **Cell and Molecular Biology / Genetics**

(Co-Authors: Cindy Fukazawa and Daniel Wagner)

RIPK4 induces epidermal differentiation in early zebra fish embryos independently of IKK1

Understanding epidermal development is essential to answering questions about regulation of mature skin and its response to factors such as disease and injury. The zebra fish (danio rerio) offers a unique opportunity due to the accessible and visible nature of early embryos. Regulation by the NF-κB pathway has been a consistent focus of research. Two proteins IKK1 and RIPK4 have seen considerable interests and are now accepted to function in a similar role in the same pathway. However, up to this point, little research has been done in regards to understanding the specific relationship between the two proteins. Using multiple constructs of RIPK4 and a novel maternal effect mutant called poky, this study aims to understand the exact nature of RIPK4's function in zebra fish in regards to IKK1. Various attempts at dominant negative versions of RIPK4 were unsuccessful except for anomalies in a handful of embryos. More significantly, the creation of an activating mutation was able to induce markers of epidermal differentiation in deep layer cells as well as in the poky mutant. This suggests that RIPK4 acts in a downstream or parallel role in respect to IKK1. Focus was then shifted to analyzing the effects of IKK1 on RIPK4 stability and the effect of this stability on function.

46. Tiffany Choi, Calvin College **Cell and Molecular Biology / Genetics**

Development of loop-mediated isothermal amplification (LAMP) assay for rapid detection of Ureaplasma Urealyticum infection in Chorioamnionitis

Chorioamnionitis is a major cause of prematurity, perinatal morbidity and mortality of infants. It is mostly attributed to ascending infection of the placenta and chorioamniotic membrane during pregnancy. Screening for the infection during pregnancy is not routinely performed, but only under specific conditions including premature rupture of membrane and maternal fever. Studies have found several common bacteria related to the infection, and one of such is Ureaplasma Urealyticum, which cannot be detected by routine bacterial culture. In this research, we seek to develop an assay capable of rapid detection of U. Urealyticum, and explored Loop-mediated isothermal amplification (LAMP) as a technical platforms for our purpose.

47. Thomas Rogers, Grand Valley State University **Cell and Molecular Biology / Genetics**

(Co-Authors: Mark Katakowski, Benjamin Buller, Xinli Wang, Michael Chopp)

Functional microRNA is transferred between glioma cells

MicroRNAs are single-stranded 17-27 nucleotide RNA molecules that regulate gene expression by post-transcriptional silencing of target mRNAs. Here, we transformed rat 9L gliosarcoma cells to express cel-miR-67, a miRNA that lacks homology in rat. Co-culture of these cells with cells that expressed aluciferase reporter, which contained a complementary sequence to cel-miR-67, resulted in significantsuppression of luciferase expression. This effect was also observed in the U87-MG human glioma cell line.Moreover, luciferase suppression was inhibited by the addition of carbenoxolone to co-cultures,suggesting that gap junction communication regulates intercellular transfer of microRNA. Finally, in situhybridization revealed the presence of cel-miR-67 in cel-miR-67 null 9L cells after co-culture with cel-miR-67 expressing cells. Our data demonstrate that microRNA transcribed in glioma cells can be transferred toadjacent cells and induces targeted inhibition of protein expression in the acceptor cells. These findingsreveal a novel mechanism of targeted intercellular protein regulation between brain tumor cells.

48. Andrea J. Bouwhuis, Alma College **Cell and Molecular Biology / Genetics**

(Co-Authors: Shaina A. Sanders, John M. Gwizdala, Eric S. Calhoun)

Synthesis and Cloning of Tumor-associated FAM190A Transcripts

The use of high throughput technologies has yielded a significant amount of descriptive information that details the loss of genomic integrity in cancer. Our work on pancreatic cancer using Affymetrix SNP arrays have confirmed known regions of chromosomal loss while identifying several regions not previously reported. Many of the genes located within these deletions remain functionally uncharacterized; therefore establishing their role in tumorigenesis, or as passenger mutations, is difficult. FAM190A (family with sequence similarity 190, member A), identified as part of a homozygous deletion in the pancreatic cancer cell line, BxPC3, is one such gene. No other candidate genes were contained within the deletion suggesting FAM190A was the target and a putative tumor suppressor. FAM190A, located at 4q22.1, spans nearly 1.5Mbps and found within an area of common fragility (FRA4F). Two verified FAM190A transcripts have been reported which code for proteins of 900 (variant 1) and 677 (variant 2) amino acids in length. Each of the variants share exons 1-6 but have unique 3' exonic sequences consisting of five and one additional exons, respectively. No known protein domains are recognized, however, the high degree of sequence conservation among vertebrate species suggests an important, evolutionary preserved function. As a first step in elucidating its function, we report here our cloning of both FAM190A transcript variants into eukaryotic expression vectors.

49. Jessica Kenworthy, Grand Valley State University **Cell and Molecular Biology / Genetics**

Mapping of the Dbf4 binding site in the Cdc5 Polo box domain

50. Tim Godfrey, Grand Valley State University **Cell and Molecular Biology / Genetics**

(Co-Authors: Sheila Blackman and Rachel Schwallier)

Maturation drying and desiccation tolerance during seed development in Phalaenopsis

Tropical epiphytic orchid seed can be germinated asymbiotically only in tissue culture, usually after collection from surface sterilized immature capsules. This method could also be used to prepare seeds for long-term seed bank storage if the timing of maturation drying (shown to be critical for longevity in other species) were known. The aims of this work were to; establish if and when orchid seeds undergo maturation drying and measure viability and desiccation tolerance of the seed as a function of maturation. Capsules of hand-pollinated flowers of Phalaenopsis amabilis were tracked for capsule length and width and harvested between 100 and 185 DAP (just prior to capsule dehiscence) to measure seed water content, viability and desiccation tolerance. Capsules grew rapidly only until 60 DAP (shortly after fertilization) after which growth ceased. Seed viability increased from 30% at 85 DAP (early globular embryo) to 92% at 100 DAP (mature globular embryo) and remained high throughout the remainder of development. Seed water content (fresh weight basis) remained between 70 and 85% up to 150 DAP and then declined to 50% by 165 DAP. Seeds did not become desiccation tolerant until after 150 DAP. We found that desiccation tolerant seeds dried to a lower water content than the non-desiccation tolerant seeds (5 and 25%, respectively) under the same conditions, possibly reflecting a critical underlying biochemical change. Our work demonstrates that capsules of P. amabilis harvested after 100 DAP yield germinable seed. However, we propose that harvesting seeds for the purpose of seed storage should be delayed until water content drops below a critical threshold of 50% after 150 DAP.

51. Tony Ditta, Calvin College **Economics**

(Co-Authors: Loren Haarsma and Becky Haney)

Self-Organized Interlocking Complexity in Biology and Economics

Mechanical devices like clocks have parts which display interlocking complexity - remove one part, and the whole thing might stop functioning. Clocks must be assembled "by hand," but in some systems, interlocking complexity can self-organize. The modern industrial economy is one example; inter-dependence of industries developed slowly over decades. We have made a computer model in which agents gather resources to meet needs and wants, specialize, trade with each other, and combine resources to make tools and higher order devices. Over time, agents' wealth and inter-dependence increase. This model demonstrates self-organized interlocking complexity in an economic context.

52. Alex Porte, Hope College **Chemistry**

(Co-Authors: Balaji Babu, Sameer Chavda, Moses Lee)

Synthesis of 1-(3-Chloropropyl)-4-nitroimidazole-2-carboxylic acid and N-Aminoalkylimidazole Containing Polyamides

One of the primary endeavors in modern medicinal chemistry is the development of drugs that can control specific gene expression. The naturally occurring polyamide distamycin is one such molecule that binds to A/T-rich sequences of DNA in the minor groove. By altering the number and arrangement of pyrrole and imidazole heterocycles in analogous polyamides, specific sequences can be targeted. The polyamides exhibit a wide range of binding affinities to their complementary DNA sequences. By adding amino pendants to the nitrogen atom of pyrrole within the polyamide, it is known that binding affinity is improved. In order to determine the optimal DNA binding affinity of a particular polyamide, it is necessary to include amino pendants on imidazoles as well. The focus of this research is to synthesize polyamides which contain N-aminoalkylimidazole groups and to discover the optimal number of pendant amino groups and their location within the polyamide, in regards to binding affinity.

53. Alexandra Batt, Calvin College **Chemistry**

(Co-Author: Dr. Chad Tatko)

Miniprotein and H/D Exchange

54. Colin McGee, Grand Valley State University **Chemistry**

(Co-Author: Toni Rice)

Towards the Synthesis of C-terminus Modified Heterocyclic Polyamides as Duplex-DNA Minor-Groove Binders

Polyamides can bind in the minor groove of duplex DNA and are potential gene-targeting agents. These polyamides are derivatives of distamycin. A set of published binding rules exists; these predict the cognate sequence of DNA that these compounds should bind to; useful in compound design. To date, most of the published work has focused on modifications to the N-terminus e.g. acetyl vs. formamido groups. In contrast, modifications to the C-terminus have received less attention. This presentation will focus on the step-wise synthesis of modified C-terminal polyamides as potential DNA minor-groove binders. The intermediate monomeric units were synthesized using a building block approach involving acid chloride-amine coupling reactions. Formylation of the triamide intermediates will enable the target compounds to be obtained. The ultimate goal of this work is collaborative biophysical investigation to drive future synthesis. Binding affinity and selectivity for cognate and non-cognate sequences of DNA will be investigated. The current synthetic progress will be described in this presentation.

55. Colin Rathbun, Hope College **Chemistry**

(Co-Author: Jeffrey B. Johnson)

Kinetic and Mechanistic Studies of C-C Bond Activation in Quinolinyl Ketones

Carbon-carbon single bond activation reactions promise to revolutionize organic synthesis by opening the doors to new, more efficient synthetic methods. The mechanism of a previously recorded Rhodium catalyzed C-C bond activation reaction involving the intermolecular insertion of an alkene into a quinolinyl ketone was studied (Douglas, et. al. J. Am. Chem. Soc. 2009, 131, 412). This was done via a kinetic approach through varying the concentrations of the different reactants and examining the effect of this on the rate of product formation. Reactions were run in sealable NMR tubes, and relative concentrations were measured via NMR spectroscopy. Results from these tests indicate an unusual rate law that is zeroth order in substrate and first order in catalyst. Addition of triphenylphosphine to the reaction mixture was found to inhibit reaction rate. Additional tests were performed to determine the catalytic resting state, activation parameters and $^{12}C/^{13}C$ kinetic isotope effects.

56. Daniel Holycross, Central Michigan University **Chemistry**

(Co-Authors: Minghui Chai, Leela Rakesh, Stanley Hirshchi)

Solubilizing SWNTs in Water Using Hyper-Branched PEI Polymers

Recent studies have suggested that carbon nanotubes have a number of biological applications including targeted drug delivery and cellular imaging. The insolubility of pristine carbon nanotubes in water, however, is a significant barrier to their biological use. This research project seeks to solubilize single walled carbon nanotubes (SWNTs) using the water soluble hyper-branched poly(ethyleneimine) (PEI) polymers. We have been able to dissolve more than 5 mg different kinds of SWNTs including pristine short SWNT (S-SWNT), hydroxyl functionalized S-SWNT-OH, and carboxyl functionalized S-SWNT-COOH, respectively in 1 mL deuterated water in the presence of ~200 mg of PEI polymers for the NMR studies. In 13C NMR spectra, carbon signals from the nanotubes showed a broad area of chemical shifts from 90 to 150 ppm, indicating the nonequivalent environment of the SWNTs. For S-SWNT-COOH, besides the peaks from the nanotubes, we also clearly observed the carbon resonance of the carboxyl group around 164 ppm, which indicated the carboxyl group is highly conjugated with the aromatic ring in the nanotubes. Atomic force microscopy (AFM) was also used to investigate how PEI polymers interact with the nanotubes to disrupt the bundling behavior displayed by non-solubilized SWNTs. Furthermore, rheological studies on these systems were also performed to show the stability of these SWNTs in aqueous solutions.

57. Darryl Corley, Western Michigan University **Chemistry**

(Co-Author: Sherine O. Obare)

Synthesis, Catalytic Properties and Immobilization of Monodisperse Bimetallic Alloy Palladium-Nickel Nanoparticles

An important area of research is to identify new catalysts that are effective in the conversion of products derived from biomass into commodity chemicals. The catalysts must be designed so that they function in an aqueous environment, are homogeneous in their morphology and can effectively function in reduction reactions. We have investigated the effectiveness of nanoparticles composed of nickel and palladium toward the reduction of pyruvic acid to lactic acid. The nanoparticles were synthesized using hexadecylamine as a stabilizer, using a pyrolysis reaction. The resulting nanoparticles were characterized by transmission electron microscopy and X-ray diffraction. We compared the results of pyruvic acid conversion to lactic acid using nickel nanoparticles alone, palladium nanoparticles alone, and palladium-nickel alloy nanoparticles. The results showed that the bimetallic nanoparticles had superior catalytic activity relative to the mono-metallic nanoparticles. The synthetic procedures and characterization of the mono-metallic and bimetallic nanoparticles as well as the catalytic are shown.

58. David Todd, Hope College **Chemistry**

(Co-Athuors: Thomas Endean and Jeffrey B. Johnson)

Origin of diastereoselectivity in a Gilman addition to an α,β-unsaturated ester

Under typical conditions, a Gilman addition to α,β-unsaturated esters proceeds without selectivity. Yet, in a recent journal publication (Kuwahara et. al., J. Org. Chem. 2008. 73. 6913-5), a specific γ-substituted α,β-unsaturated ester was reacted with a Gilman reagent and resulted in a completely diastereoselective product. Kuwahara proposes the Felkin-Anh model of stereoselectivity as an explanation for the behavior of the reaction. In contrast we propose that the stereoselectivity results from alkene-metal interactions to an additional tethered alkene in the α,β-unsaturated compound. This work presents the results of our study to test this hypothesis with a saturated analogue of the initial compound. The relative influences of the Felkin-Ahn and metal-alkene models will be discussed.

59. Doug Ragan, Grand Valley State University **Chemistry**

(Co-Authors: Mary E. Karpen and Andrew W. Lantz)

Using Cyclodextrins to Bind Organic Pesticides: A Computational Study

Non-toxic water-soluble cyclodextrin molecules can bind small hydrophobic molecules, such as pesticides, aiding in the removal of these toxic substances from foods and the environment. In previous work, binding constants for a variety of pesticide-cyclodextrin complexes were measured using capillary electrophoresis. To explain these binding affinities on the molecular level, we simulated the molecular dynamics between select pesticides and the α- and β-cyclodextrins in explicit solvent, using the CHARMM force field. Pesticides with high experimental binding affinities form stable binding complexes during 500 ps of molecular dynamics simulation. Certain pesticides, such as 2,4D have preferred binding orientations, and other pesticides, such as dimethenamid, show no orientation preference.

60. Duong Ngo, Central Michigan University **Chemistry**

(Co-Authors: Nalinda Almedia, Leela Rakesh, Minghui Chai)

Probing the Release of Drug on Preloaded Zeolites with and without Dendrimers

Amphiphilic dendrimers like PAMAM can encapsulate lipophilic NSAID drugs such as salicylic acid and ibuprofen with their internal hydrophobic voids and carry the molecules into an aqueous system by taking advantageous of their hydrophilic surface. In this work G4 amine-terminated PAMAM dendrimer with an diaminobutane (DAB) core was utilized to encapsulate salicylic acid molecules, which could enhance the solubility of the drug in water significantly. Furthermore 13X zeolite were employed to absorb the drug and drug-dendrimer systems for a preliminary formulation study on drug-dendrimer system. Then the release of salicylic acid in aqueous solution was probed using kinetic NMR and UV-Vis techniques. Multidimensional NMR techniques have been used to characterize the systems for NMR resonance assignments. The results from NMR studies indicated that there are two kinds of salicylic acid molecules exist in both systems (drug molecules on molecular sieves with and without the PAMAM dendrimer). Diffusion NMR has also been performed to gauge drug dynamics in the systems quantitatively.

61. Elizabeth Bejcek, Western Michigan University **Chemistry**

(Co-Authors: Setare Tahmasebi Nick, Bruce E. Bejcek, Sherine O. Obare)

Surface Modification of Metallic Nanoparticles for Effective Destruction of Brain Tumor Cells

Synthetic procedures that produce nanoscale materials with controlled morphology are advantageous particularly when utilizing nanomaterials for biological applications. We have developed a strategy to fabricate metallic nanoparticles and examined their toxicity toward brain tumor cells. Non-toxic nanoparticles were used as scaffolds to conjugate stilbene derivatives. These stilbene molecules show little to no activity on their own toward brain tumor cancer cells, however when conjugated onto the nanoparticle surface, the resulting hybrid is highly effective in killing the cells. We attribute the effect to polyvalent interactions between the stilbenes and the cells when bound to the nanoparticle surface, and surface effects that impact the activity of the stilbene. The presentation will focus on the synthesis and characterization of the nanoparticles, attachment of the stilbenes and their interactions with brain tumor cells.

62. Gillian Morris, Calvin College **Chemistry**

(Co-Authors: Chad Tatko and Laura Kavlie)

Alteration of Redox Potentials of L-Dopa in Short Chain Peptides

3,4-dihydroxyphenylalanine, or L-Dopa, is an aromatic amino acid often associated with diseases such as Alzheimer's and Parkinson's in vivo. In order to better study the influence of L-Dopa's peptide environment, 6-mer beta hair-pin peptides containing L-Dopa at one terminus and a varied amino acid at the other terminus were synthesized, purified using High Pressure Liquid Chromatography, and analyzed in solution using a potentiostat. Redox potentials between L-Dopa and the varied amino acid were measured and compared to 1H NMR data for that peptide. Primary results in peptides with a varied aromatic substituent demonstrated that the redox potentials of L-Dopa generally increased with increasing chemical shifts; in peptides with a varied hydrophobic substituent, the redox potentials of L-Dopa generally increased with increasing hydrophobicity.

63. Ian Robertson, Calvin College **Chemistry**

(Co-Author: Chad Tatko)

Identifying the Role of Aromatic Networks in Amyloid Fibril Formation and Anti-Alzheimer's Therapeutic Action

Alzheimer's disease affects more than 30 million people each year. It is thought to be caused by an oligomeric peptide, Amyloid-β. Extended aromatic interactions play a key role in the aggregation of these peptides. We have designed a three-stranded beta-hairpin peptide that should model the aromatic features of Amyloid fibrils, while remaining soluble, so as to be conducive to a variety of assays.

64. Gregory Patten, Grand Valley State University **Chemistry**

(Co-Author: Dr. Laurie Witucki)

Design and Synthesis of Focal Adhesion Kinase (FAK) Inhibitors

Focal Adhesion Kinase (FAK) is a non-receptor protein tyrosine kinase that plays a crucial role in many cell-signaling pathways. This kinase has been implicated in many cancers and found to be upregulated, making FAK an interesting target for anticancer drug development. Our approach involves taking LS-1, a substrate developed in our lab modeled from a phosphorylated protein CAS, and creating derivatives designed to maintain binding ability to FAK while removing the functional group necessary for phosphorylation. Using solid phase peptide synthesis we designed and synthesized several compounds that vary in the para position on the N-terminus phenylalanine and have plans of creating several more. These potential inhibitors will then be analyzed by P32 kinase assays to determine their binding affinity to FAK.

65. Jeremy Cusick, Grand Valley State University **Chemistry**

(Co-Author: George McBane)

Ab initio study of quenching of excited triplet states of O2 in collisions with neon

A theoretical study of quenching of the Herzberg states of oxygen was performed using ab initio electronic structure calculations. The study aimed to find the quenching pathways from A 3Σu+ and A' 3Δu states of oxygen to ground electronic state oxygen. CASSCF [Knowles & Werner, Chem. Phys. Letters 115, 259—267 (1985)] calculations with MP2 correction [Amos, Andrews, Handy, & Knowles; Chem. Phys. Letters 185 256—264 (1991)] and a PVTZ basis set [Dunning; AIP 90(2) 1007—1023 (1989)] were performed to generate potential energy values. This study used neon as a simpler substitute for N2 to look at potential electronic transitions to the ground state. Potential energy curves were generated for bond lengths of O2 between 1.2 and 2.5 angstroms with neon approaching in a "T" shaped geometry at distances of 4.4 to 2.4 angstroms. These curves demonstrated that neon could induce no purely electronic transitions from the excited A and A' states to the ground state. The question of a purely electronic transition caused by interaction with N2 still needs to be addressed, though based on the results of this experiment it seems less likely. This means that the quenching process is most likely at least partly vibrational in nature and further study needs to be performed to determine its mechanism.

66. Katherine Hekstra, Grand Valley State University **Chemistry**

(Co-Author: Cory DiCarlo)

The use of United States consortia microbes in an anaerobic fuel cell for the production of energy from municipal waste water

A simple fuel cell was constructed previously by Mohar et. al., using consortia bacteria native to India.1 The cell was able to produce a significant amount of power, suggesting the possibility of using United States microbes to obtain a similar result. The use of consortium bacteria in an anaerobic fuel cell would provide power from a sustainable and environmentally friendly source, municipal waste water. Power output would be fueled using flow-cell introduction of waste water feedings and appropriate environmental conditions. A fuel cell was constructed using a proton exchange membrane and low cost construction and the resulting power output of this cell is discussed.

67. Kent C. Kammerme , Hope College **Chemistry**

(Co-Authors: Howard A. Dobbs and William F. Polik)

Free-Jet Vibration-Rotation Spectroscopy of Unstable Species

Vibration-rotation spectroscopy is used to characterize molecular potential energy surfaces and thereby describe chemical interactions. Unstable species are highly reactive and electronically complex, making them valuable spectroscopic targets. However, such species must be created during the measurement process. This experiment uses an electric discharge nozzle to fragment a precursor molecule which is then analyzed using laser spectroscopy. Both fluorescence excitation and dispersed fluorescence spectra of dichlorocarbene (:CCl2) were recorded. Vibrational levels of the ground electronic state have been assigned from these spectra.

68. Keun Ah Ryu, Calvin College **Chemistry**

Synthesis of N-Alkyl Pyridines

Explored the scope and optimized migration conditions of propargylic systems for O- to N-alkyl migration using the LiI catalyst.

69. Kirsten Tissue, Grand Valley State University **Chemistry**

(Co-Authors: Felix Boucher and Shannon Biros)

Organic Synthesis of Novel MRI Contrast Agents

Ionized gadolinium (Gd) is a potent contrast agent used in medical resonance imaging (MRI). As gadolinium is a nephrotoxin, chelating agents are needed to prevent toxicity to the patient. Current chelating agents are available; however, they suffer from a lack of water solubility or by having a negative effect on water's relaxivity rates. An ideal chelating agent binds well to Gd while allowing it to simultaneously interact with individual water molecules. Our lab is developing a novel class of chelating agents containing carbamoylmethyl phosphine oxides (CMPO's), which have the potential to be more soluble in water than current commercially available agents while retaining a favorable affect on water relaxivity.

70. Lauren Thompson, Grand Valley State University **Chemistry**

(Co-Authors: Stephanie Schaertel and Shannon M. Biros)

The Development of a Supramolecular Chemistry and Molecular Recognition Laboratory Experiment for upper-level Chemistry Majors

We are in the process of developing a physical chemistry laboratory for upper-level chemistry majors investigating the thermodynamics of a supramolecular host-guest system. Students will use VT 1H NMR to study the effect of temperature on the binding constants of a series of cationic guests for a water-soluble tetracarboxylate cavitand host. By plotting this data in the form of a Van't Hoff plot, students will discover whether guest binding is entropically and/or enthalpically favorable for this system.

71. Lauren Cichon, Aquinas College **Chemistry**

(Co-Author: Dr. E.A. Jensen)

Thermal Behavior of Ionic Liquid Crystalline Compounds of Transition Metals with Dimethyldihexadecylammonium and Hexadecylamine Ligands

Synthesis of the complex salts [(C16H33)NH3]2[MX4] (M= Mn, Fe, Co, Ni, Cu, Zn and X=Br, Cl) and [(C16H33)2N(CH3)2]2[MBrx] (M= Mn, Fe, Co, Ni, Cu, and Zn and x=4 for all metals except Fe, where x=5) was performed and their liquid-crystalline behavior was evaluated by differential scanning calorimetry and Mel-Temp analysis. Synthesis was performed using a variety of hydrous and anhydrous metal halides and a ligand with different solvents. Ten of the synthesized compounds were observed to exhibit a thermotropic liquid crystal phase beginning between 51°C and 123°C. Compounds that did not exhibit a mesophase either decomposed or sublimed around 200°C.

72. Lauren Manck, Calvin College **Chemistry**

(Co-Author: Douglas Vander Griend)

Nanomolecular Building Projects and Spectrophotometric Characterization

As technological innovations in our world continue to move towards materials that require nanometer-sized features, synthetic techniques that make use of "bottom-up" verses "top-down" methods of production have also increased. Here, supramolecular chemistry has afforded methods of building up structures from smaller, self-assembling molecules and has been applied throughout the field of nanotechnology. Our goal has been to study such supramolecular systems in situ via equilibrium restricted factor analysis in order to better understand the assembly process of these supramolecular systems. For this research we have collaborated with Dr. Michael Ward and his graduate students at the University of Sheffield in order to study their cobalt(II) tetrahedron as well as with Dr. Amar Flood and Andrew Share of Indiana University in study of their copper(I) grid. We have been able to succsessfully analyze both of these systems and have obtained thermodynamic data pertaining to their assembly processes.

73. Matt Gregory and Mia Savagian, Hope College **Chemistry**

(Co-Authors: Balaji Babu, Sameer Chavda, Moses Lee)

Testing the Predicted Enhancement in DNA Sequence Specificity and Binding Affinity of Formamido-pentaamides over their Formamido-triamide Counterparts

Polyamides that contain imidazole and pyrrole heterocycles are known to target the minor groove of DNA in sequence specific interactions. Such molecules have the ability to alter gene expression. Analogs of the naturally occurring product distamycin have been developed and shown to bind in stacked anti-parallel dimers, but range in their affinity and specificity towards their target sequences. Although the formamido group is usually omitted from these analogs, it has been found to be important in increasing affinity and binding site size. Various formamido triamides have been synthesized, with f-ImPyIm showing the greatest affinity in targeting its cognate DNA sequence, 5'-d(ACGCGT)-3'. The established pairing rules for minor groove recognition indicate that the formamido-pentaamide, f-ImPyImPyIm, should bind with greater specificity to its cognate sequence without sacrificing affinity. This also calls for the synthesis of f-PyPyPyPyPy, which would target the control sequence 5'-d(AAATTT)-3'. The focus of this research is directed towards the synthesis of f-ImPyImPyIm and f-PyPyPyPyPy and testing their affinity and specificity in comparison with their triamide counterparts.

74. Michael R. Perez, Western Michigan University **Chemistry**

(Co-Authors: Minghong Liu and Sherine O. Obare)

Synthesis, Characterization and Cytotoxicity of Nickel Nanoparticles

Metal nanoparticles have been proposed and demonstrated to be effective drug carriers. However, the cytotoxicity of the particles toward biological cells remains largely unexplored. Magnetic nanoparticles, especially nickel nanoparticles are attractive carriers due to their ability to be manipulated using an external magnetic field. In order to determine the toxicity of the nanoparticles, and how cytotoxcity depends on the particle size, it is important to establish synthetic procedures that produce nanoparticles that are uniform in morphology. We have developed new organic ligands that are not only effective stabilizers for nickel nanoparticles, but also allow the nanoparticles to be produced in uniform sizes. The nanoparticles were characterized by transmission electron microscopy (TEM), scanning electron microscopy (SEM), powder x-ray diffraction (XRD) and SQUID magnetometry. Nickel nanoparticles were interacted with normal epithelial cell. However, the nanoparticles were found to have no effect on the cells, indicating that these nanomaterials, under the investigated conditions, do not pose cytotoxicity to the cells.

75. Nathan Romero, Calvin College **Chemistry**

(Co-Authors: Benjamin M. Klepser and Dr. Carolyn Anderson)

Gold-Catalyzed Synthesis of Ketone-Containing N-Alkyl Pyridones

N-alkyl pyridones are an important structural motif frequently found in natural products and compounds of pharmacological interest. In an attempt to create a synthetically useful means of accessing this array, we have developed a new method for the selective conversion of propargyloxypyridines into ketone-containing pyridones utilizing catalytic gold(III) in the presence of an amine base and Dowex resin. The optimization, scope, and application of this transformation to targets of biological interest will be presented.

76. Noah O. Masika, Western Michigan University **Chemistry**

(Co-Author: Sherine O. Obare)

Facile Synthesis of Monodisperse Metallic Nanoparticles

Nanoscale metallic particles are of great interest due to their importance in advanced technological applications. Synthetic procedures that produce gram-scale, well defined and monodisperse metallic nanoparticles with controlled size and shape, especially within the 1-4 nm size range is a continuing challenge in nanoscale science. We have developed new organic ligands that when used as stabilizers for metal nanoparticles, provide the ability to gain control of the particle size in one-step synthetic procedures. Monodisperse metallic nanoparticles were synthesized and characterized using spectroscopic, microscopic and x-ray techniques. We have further investigated the electrochemical quantized double-layer (QDL) charging differences of 1-4 nm metallic nanoparticles. Within this size range, the electronic properties transition from a bulk-like continuum of electronic states to molecule-like, discrete electronic orbital levels. Such properties have led us to investigate their charging and discharging at large band-gap semiconductor interfaces. The results are paramount toward understanding and developing advanced materials for catalysis. We demonstrate the efficiency of the semiconductor/metal nanoparticle interfaces for energy transfer applications.

77. Nolan Worstell, Calvin College **Chemistry**

Liquid Extraction Method Development for Rice (Oryza sativa) Volatiles

There are volatiles (chemical components that tend to vaporize) in almost everything. The most noticeable type of volatiles is the chemical compounds that we can smell and give various fruits, amongst other items, a scent. For instance, when you are baking a cake you can always tell the kind of cake that is being baked. For my summer research, I and Dr. Rolfe Bryant took the idea of volatiles and began to develop a method which improved upon current methodologies to quantify the amount of the volatiles in rice using liquid extraction so as to tell the quality and shelf life of various types of rice—Jasmine, Basmanti, or Bengal--.

78. Ryan Schoenborn, Grand Valley State University **Chemistry**

Using Dynamic Simulations of Water to Determine the Condensation Coefficient

Dynamic computer simulations of water are used to model the interactions between a gaseous water molecule and the surface of an aerosol. An attempt was made to accurately model the 0.2 condensation coefficient that was derived experimentally.

79. Robert Sjoholm, Hope College **Chemistry**

(Co-Authors: Balaji Babu, Sameer Chavda, Moses Lee)

Design and synthesis of a novel Pyrrole- and Imidazole-containing polyamide targeting a rif gene repressor sequence in Plasmodium falciparum

Downregulation of malarial rif gene expression, a process implicated in malarial evasion of the human immune system, has been linked with repressor protein binding to the DNA element ATGCAA in Plasmodium falciparum. A Pyrrole- and Imidazole-containing polyamide was designed with the purpose of recognizing that DNA sequence based on previously reported pairing rules. The polyamide was also designed to target P. falciparum over mammalian cells by exploitation of the protozoal P2 aminopurine transporters. It is hypothesized that the target polyamide, by blocking repressor protein binding, will effectively enhance rif gene expression in P. falciparum, allowing immune destruction of the protozoan. The synthesis of the polyamide will be reported. Future studies will ascertain the binding properties of the polyamide to the target DNA sequence, the affinity of the molecule to the P2 aminopurine transporter, and the ability of the molecule to enhance rif gene expression in P. falciparum cultured in human erythrocytes.

80. Sheila Ryan, Grand Valley State University **Chemistry**

(Co-Author: Stephanie Schaertel)

Use of a modular Raman spectrometer for detection of peptide nitration and analysis of ice samples

Raman spectra of solid amino acids and short peptides were acquired using a modular Raman spectrometer to assess the ability of the spectrometer to detect spectral differences arising from nitration. Spectra of tyrosine and nitrotyrosine, while not free of fluorescence interference, showed a measurable peak shift, suggesting that with further sample purification or the use of a different wavelength laser this configuration could be an effective means of detecting nitration. A second configuration of the spectrometer was optimized for collection of spectra from liquid and ice samples and was capable of detecting differences in the position of the O-H stretching peak in liquid versus frozen water. Several molecules were examined as possible probe molecules for Raman studies of the quasi-brine layer that forms at the surface and grain boundaries of ice. In general the aqueous samples either did not show the peaks of interest (sodium sulfate), proved too difficult to freeze in high enough concentrations (sodium perchlorate and nitric acid) or displayed too much overlap of major peaks with broad ice peaks (ethanol). Ice samples also melted quickly and sample tubes rapidly developed condensation. While this configuration may be useful for the study of ice, improvements must be made: a better freezing method for higher concentration solutions, a temperature- and humidity-controlled sample cell, and a more sensitive spectrometer that can provide spectra for more dilute samples.

81. Stacey De Haan, Calvin College **Chemistry**

Quantum Dots: Single Molecule Style

Two systems, a biosensor and a chemosensor, were tested with single molecule fluorescence spectroscopy with the goal of increasing the sensitivity of these sensors and lowering the lower limit of detection (LOD). The biosensor was composed of a CdSe/ZnS quantum dot attached to maltose binding protein with a His-tag (MBP-His). The MBP-His was labeled with an electron donating group. The chemosensor was a CdSe/ZnS quantum dot with a 1-(2 mercapto-ethyl)-3-phenyl-thiourea capping group.

82. Timothy L. Atallah, Calvin College **Chemistry**

(Co-Author: Ronald L. Blankespoor)

Highly Enantioselective Amination of Allylic Carbonates With a Chiral Rhodium Catalyst

The rate of enantiospecific and regioselective rhodium-catalyzed amination of a series of para-substituted phenyl allyl carbonates using benzylamine increases as the substituent becomes more electron-withdrawing. The scope of this substitution reaction is also explored.

83. Caitlin Peirce, Hope College **Computational Biology/Bioinformatics**

(Co-Authors: Aaron Best and Matthew DeJongh)

Generation and Comparative Analyses of Genome-scale Metabolic Models for the Genus Shewanella using the Model SEED

The genus Shewanella consists of aquatic microorganisms that are distributed worldwide. Their features include respiratory and metabolic diversity as well as the ability to thrive in extreme environments. The study of Shewanella's versatile metabolism can provide insights into the species' capacity for biotechnology such as bioremediation and microbial fuel cells. The Model SEED (http://seed-viewer.theseed.org/models), a web-based resource for microbial genome analysis, was used to generate genome-scale metabolic models for sequenced Shewanella genomes. The draft metabolic model for S. oneidensis was curated, focusing on areas of metabolism that have not been well-curated in previous modeling efforts (e.g., anaerobic respiratory systems, lipopolysaccharide biosynthesis). The goals of this work are to 1) expand the coverage of metabolic diversity in databases used for metabolic modeling, 2) design and refine software tools to facilitate manual curation of metabolic models and 3) generate a complete S. oneidensis metabolic model that can be used with computational tools and highthroughput experimental approaches to advance our understanding of the metabolic strategies and physiology of the genus Shewanella.

84. Nekody Lenkner, Calvin College **Computer Science**

(Co-Author: Professor Victor Norman)

A virtual Reality System for Visualization of Small Protein Molecule Docking

The Spatial Virtual Reality System at Calvin College provides three dimensional output to a headset and tracks the location and orientation of up to four sensors in this three dimensional (3D) space. The system was adapted to allow the visualization of proteins in 3D, as a precursor to viewing the interactions between to two proteins (called "docking"). In addition, the system was documented extensively, and small sample programs were written to demonstrate how to interact with the various hardware and software modules in the system (so that future students can more quickly learn the system). These small programs include a Earth viewing application, and a "top-down" viewer that shows what is being seen in the headset or clipped out of the viewing area of the headset.

85. Adrienne Gibson, Grand Valley State University **Ecology and Evolution**

(Co-Authors: Lauren Villalobos and Eric Snyder)

Low-Head Dam Removal Causes Immediate Physical Habitat and Water Chemistry Degradation

This two year study focused on understanding the effects of the removal of the low-head Nashville dam on the Thornapple River in Barry County, MI. A comparison of data taken before the dam was removed, to data taken after the dam was removed indicated changes to the physical habitat, as well as water chemistry. In the reach directly below the dam there was an increase in fine sediment that accounted for an average cross-sectional channel aggradation of 26 cm, from pre- to post dam conditions indicating reservoir erosion and subsequent downstream deposition. This was in contrast to the relatively minor changes in the cross-sectional profile observed throughout the other study reaches, both up and down stream of the former dam. In addition, there still appears to be a turbidity signature directly below the dam in response to increasing discharge. Specifically, at the site directly downstream of the former reservoir, we observed a 0.5-1.0-fold elevation in turbidity during the rising limb of a flood event, above that observed at other measurement locations further down and up stream. Results indicate that conditions 1-year post-removal are still degraded, but that these impacts are quite proximate to the former dam site.

86. Christopher Bouma, Calvin College **Ecology and Evolution**

(Co-Author: Stephanie Rentschier)

Autumn Olive, Root Nodules and Nitrogen Fixation

Nonnative and invasive species are an increasing concern as native species are out-competed, relationships between species are altered, and ecosystem services are reduced. Autumn Olive, Elaeagnus umbellata, is a particularly invasive shrub that has invaded meadows and forest understories. Previous research demonstrated that Autumn Olive exhibits higher photosynthesis rates than most native species, largely due to high leaf chlorophyll content. We hypothesize that Autumn Olive gains these competitive advantages through the ability to fix atmospheric nitrogen, the benefit of which is reflected in high leaf chlorophyll content. We counted and measured the root nodules, the structures in which nitrogen fixation occurs, and measured the leaf chlorophyll content of 1-2 year, 3-4 year, and 5-7 year Autumn Olive plants growing in five different soil types at Pierce Cedar Creek Institute (Hastings, MI). Autumn Olive plants with a greater number, but not larger, nodules produce leaves with higher leaf chlorophyll content. Older Autumn Olive plants growing in meadow soils produced more root nodules, leaves with higher chlorophyll content, and faster photosynthesis rates than Autumn Olive in forest soils. These studies suggest that nitrogen fixation by Autumn Olive may provide a nutritional advantage in poor soils that manifests itself through higher leaf chlorophyll content and faster plant growth due to higher photosynthesis rates.

87. Grady Zuiderveen, Grand Valley State University **Ecology and Evolution**

(Co-Authors: Dr. Timothy M. Evans and Dr. Robert B. Faden)

A Phylogenetic Analysis of trhe African Plant Genus Palisota (family Commelinaceae) based on Chloroplast DNA Sequences

The plant genus Palisota (family Commelinaceae) consists of approximately 20 species and is distributed throughout the forests of tropical Africa. The genus exhibits several unusual morphological characteristics, and as a result has been difficult to classify based on morphology. Molecular phylogenetic studies have placed it near the base of Commelinaceae, but the exact placement of Palisota within the family is not clear. As the African continent has become more arid in recent geological times, the forests have receded, reducing the habitat for Palisota species and potentially impacting speciation and extinction rates within the genus. The goal of this study is to sequence the chloroplast-encoded gene rbcL in several additional species of Palisota and its relatives in order to: 1) determine the phylogenetic relationship of the genus with respect to other members of Commelinaceae; 2) evaluate phylogenentic relationships among species of Palisota; and 3) infer relative speciation/extinction rates within the genus. Additionally, we are exploring the use of other molecular regions for phylogenetic analysis with the genus.

88. Jacob Jeffers, Aquinas College **Ecology and Evolution**

(Co-Author: Dr. Robb Bajema)

Woodpeckers and Their Selection of Trees for Nesting and Foraging Purposes

In this experiment we looked at woodpeckers and their selection of trees by comparing snags (standing dead trees) that were used and those that were not. The reasoning behind this experiment was to develop better forestry management practices. Typically on some properties such as Aquinas College, dead trees are removed to upkeep the property. This could be taking an effect on woodpeckers because snags are typically used for nesting and foraging. Pierce Cedar Creek Institute in Hastings, Michigan offered a variety of different forest types where dead trees are left alone to study. By taking several measurements such as diameter, height, surface area, density of wood, and number and sizes of cavities, we were able to get a better understanding of what woodpeckers use most often in snags. Correlation was seen between size of tree and density of the wood in relationship to number of cavities. Also, an idea of what species of snags were used most was acquired. With further studies, there is potential to gain a further understanding of what woodpeckers utilize most.

89. Jake Zwart, Calvin College **Ecology and Evolution**

Summer Phenology of the Open Water at Flat Iron Lake

90. Jill Roos, Calvin College **Ecology and Evolution**

(Co-Authors: Kelly Peterson and Dr. David Warners)

Forest Restoration on Calvin's Campus

Our goal is to assess the relative success of native woodland herbs in the understory of a restored forest. We collected performance measures on six native species from replicated quadrats, each of which was subjected to four different soil treatments prior to planting. We also assessed survivorship over the first two years of the project. We discovered that among the six species being evaluated, Geranium maculatum (Wild geranium) and Podophyllum peltatum (May apple) showed the greatest response, while the state threatened Diarrhena americana (Beak grass) has declined. We found little differentiation in response by soil treatment but proximity to certain tree species does appear to influence performance. We hope this work will provide insight into how best to restore and establish woodland habitat, particularly in urban settings.

91. Joe Singer, Calvin College **Ecology and Evolution**

(Co-Authors: Rachel Abma and Amanda Harris)

Immune Function and Mercury Exposure in Common Loons of the Adirondack Park

Exposure of common loons (Gavia immer) to mercury through atmospheric deposition and biomagnification is a concern throughout the upper Midwestern and Northeastern US and Canada. Mercury is a known neurotoxin, and has also been shown in the lab to affect proper immune function of young loons. Blood samples were collected from adult and juvenile loons. Samples were assessed in the lab using the in vitro BrDU ELISA. Lymphocyte proliferation in adult loons showed no significant correlation with increasing blood mercury levels, but in general, a positive, nonsignificant trend was present. Due to lack of significance with blood mercury concentration, more potential factors were examined. Low lake pH (<6.3) puts adult loons at higher risk for immunological effects of mercury. A small data set (n=3,4) suggested that blood mercury stimulated the immune systems of loon chicks. Three of the mitogen treatments revealed a statistically significant positive trend. These correlations were consistent with observations that developing immune systems are often more sensitive to environmental contaminants. Biomagnified mercury's effects on the immune systems of loons will hopefully help present a solution to struggling populations of loons in the Adirondack region.

92. Kelseyann Kremers, Grand Valley State University **Ecology and Evolution**

(Co-Author: Robert Hollister)

Response of Luzula arctica and Luzula confusa to warming in Barrow and Atqasuk, Alaska

Because low temperatures limit arctic plant growth and reproduction, plant performance in the arctic is greatly affected by warming. In order to predict future responses of tundra vegetation to global climate change, an experiment was conducted to estimate the impact of increased temperatures on plant growth and flowering. The objective of this study was to observe and compare the responses of Luzula arctica and Luzula confusa to warming during the summer of 2010. The study sites were part of a long-term warming experiment established in Barrow and Atqasuk, Alaska. Plots of vegetation (1m2) were warmed using open-top fiberglass chambers. L. arctica and L. confusa are common rushes at both study sites and are often associated with disturbances. At both sites warming increased the number of inflorescences produced by both species. While the date of peak inflorescence production occurred earlier in Atqasuk than in Barrow, both species produced more inflorescences in Barrow than in Atqasuk. In Barrow, both species produced taller inflorescences in the warmed plots while in Atqasuk, L. arctica showed no response. Inflorescences were taller in Atqasuk than in Barrow for both species. Neither species showed a significant difference in leaf length with treatment at either site. Results indicate that L. arctica and L. confusa show increased reproductive effort when warmed. A change in reproductive activity could cause changes in community composition.

93. Lauren M. Villalobos, Grand Valley State University **Ecology and Evolution**

(Co-Authors: Adrienne M. Gibson and Eric B. Snyder)

Low-Head Dam Removal Positive Affects on Macroinverabrate Community Structure

Dams are added to rivers for many reasons, including flood prevention and reservoir creation. Many of these dams are reaching the end of there life span and must be either repaired or removed. We studied the removal of the Nashville Dam on the Thronapple River in Berry County, MI, by comparing three up and three down-stream reaches. One year post-removal, we found that the percent EPT on artificial substrate increased from an average of 27.07 to and average of 63.77 at all sites below the former reservoir. Further in 2009 isopods dominated the site directly below the dam, exceeding 2,000 individuals per artificial sampler, while an average of 22 isopods were found at all downstream sites. In contrast,in 2010 we found an average of 7 isopods per artificial sampler at all of the downstream sites combined and an average of 16 at the site just below the former reservoir. Our results demonstrate that the removal of a low-head dam improved the macroinvertebrate community immediately below the dam. This was in contrast to a decline in habitat quality.

94. Lisa Bol, Grand Valley State University **Ecology and Evolution**

(Co-Authors: Marci Baiz, Kyle Bibby, Liberty Hightower, Rachelle McLaughlin, Deb Near, Matthew Romeyn, Lena Spadacene)

Factors that affect egg mass in Tree Swallows

Egg mass is positively correlated with nestling weight at hatching and subsequent survival so is an important component of parental investment by female birds. From 2008-2010, we recorded female age, weather conditions, laying sequence, and egg mass of Tree Swallows nesting on the GVSU campus. Experienced females laid heavier eggs. Laying order had an effect on egg mass; eggs 1-3 were significantly lighter than eggs 4-6. Experienced females laid eggs earlier in the season and their eggs got heavier as the season progressed and air temperatures increased. In contrast, inexperienced female egg mass was not correlated with laying date or air temperatures. Air temperature affects the availability of aerial insects the main food source of Tree Swallows. These results suggest that experienced females were able to energetically respond to improving environmental conditions by laying heavier eggs, whereas inexperienced females were not. However, both experienced and inexperienced females varied their investment in egg production relative to laying order.

95. Marci Baiz, Grand Valley State University **Ecology and Evolution**

(Co-Authors: Kyle Bibby, Lisa Bol, Liberty Hightower, Rachelle McLaughlin, Deb Near, Lena Spadacene)

Sex differences in parental anti-predator responses during the nestling period in Tree Swallows

Parental effort influences the survival of nestling birds. Previous research demonstrated that the patterns of parental effort differed between the sexes in Tree Swallows. We examined sex differences in parental responses to a potential human predator in 2009, and to a mounted raccoon model in 2010, during both the first and second halves of the nestling period. During each trial we recorded the number of attacks by each parent, brood size, weather conditions, and time of day. Parents treated the human and model raccoon predator the same. There was no significant difference in the number of attacks made by males and females, but both sexes attacked more frequently during the second half of the nestling period. Females attacked consistently across the 5 min observation period while males did not. Females that attacked often during the first half of the nestling period also did so in the second half. Males did not show this pattern. Parental nest defense efforts did not appear to be coordinated and the sexes differed in nest defense efforts based on mate presence. Male nest defense effort may be related to physical quality as estimated by the number of louse holes in their wings and tails. The attack rates of individuals were not repeatable between years. Attack rates were not influenced by brood size, weather conditions, or time of day. These results suggest that parents increased defense as nestlings got older, but male and female patterns differed.

96. Monica Zipple, Grand Valley State University **Ecology and Evolution**

(Co-Author: Jodee Hunt)

Did dad lick the kids today? Male and female parental roles and microbe transmission in convict cichlids (Cichliasoma nigrofasciatum).

Males and females may make distinctly different contributions to parental care. In cichlid fishes, females typically care for embryos while males guard territories. Parent-offspring contact may enhance transmission of beneficial microbes. Microbial sharing between group members is a potential mechanism for the evolution of social behavior (Lombardo 2007). Parental care is unusual among teleost (bony) fishes, but is ubiquitous among the cichlid fishes, and convict cichlids (Cichlosoma nigrafasciatum) exhibit biparental care. We (1) quantified the parental behavior of males and females to determine whether they differed in amount or type of physical contact with their offspring; (2) collected samples of parental slime coats, embryos, and fry to compare the microbes associated with each, comparing samples from subsets of broods receiving parental care to others where parental contact was prevented. Females touched embryos significantly more often than males, but physical contact with fry is much less common and initiated by fry rather than parents. To date, molecular data support our prediction that fry receiving parental care bear microbes more similar to female vs. male parents, and to parents vs. siblings that did not receive care. Assuming this trend continues in subsequent samples, we conclude that parents are an important source of microbial inocula and that female contact during immobile developmental stages is especially important for microbial transmission.

97. Rachel Abma, Calvin College **Ecology and Evolution**

(Co-Authors: Joe Singer and Amanda Harris)

Assessing the Health Effects of Environmental Pollutants on Colonial Waterbirds in Areas of Concern in Michigan

For decades colonial waterbirds have been studied to assess the impact of pollutants such as polychlorinated biphenyls and chlorinated dioxins on the Great Lakes ecosystem. In the present study, herring gulls (Larus argentatus), Caspian terns (Sterna caspia), and black-crowned night herons (Nycticorax nycticorax) were assessed in Areas of Concern throughout the Great Lakes region in order to determine health effects of pollutants. Embryonic nonviability, chick growth, and immune function were measured. Herring gull nests were marked and monitored during egg-laying, and embryonic viability was assessed during mid/late incubation using an embryonic viability detector sensitive to heartbeat and movement. Health of prefledglings was assessed through body size measurements, and immune function was assessed using the phytohemagglutinin skin test for T-cell mediated immunity. In herring gulls, embryonic nonviability was elevated on Little Charity Island in Saginaw Bay in 2007 (10.1%) compared to Chantry Island, a reference site in Lake Huron (3%). In some years, reduced growth or abnormal weight loss between 3 and 4 weeks post-hatch was observed in herring gulls and Caspian terns in Saginaw Bay. All three species at contaminated sites in Saginaw Bay also displayed significantly low T-cell mediated immune responses. Continued study and analysis is necessary as waterbirds in Areas of Concern continue to show immunosuppression, high embryonic death and poor growth and productivity.

98. Scott Jones, Calvin College **Ecology and Evolution**

Field Botany at Flat Iron Lake Preserve: Flower Phenology and Tree Inventory

The purpose of this study was to collect data on the plants of Flat Iron Lake Preserve as part of a long-term study. In particular, this study aimed to collect phenology data on the flowering plants of the preserve to enable the recognizing of patterns in flower phenology over the years. These data included which species were growing in the preserve, what habitats they were growing in, and when they started and stopped flowering (if applicable). Attention was focused on the Southwest swamp and on inventorying the trees in the preserve. Plants were identified using field guides, and data were recorded in an Excel file for further study. Unknown or unusual specimens were collected and pressed at the Flat Iron Lake House. In total, data on 237 plant species were recorded; this included phenology data on 165 species. This year's data are only a small fraction of what will be a very large dataset; long-term patterns are not yet visible. That being said, compared to only two years' previous data, flower opening was about a week early this year. Weather plays a large role on flower phenology, so weather data should be collected in the future along with plant data.

99. Stephanie Rentschler, Calvin College **Ecology and Evolution**

(Co-Author: Chris Bouma)

Alterations in Soil Fertility by Autumn Olive May Temporarily Affect Native Shrubs

Nonnative and invasive species are an increasing concern as native species are out-competed, relationships between species are altered, and ecosystem services are reduced. Autumn Olive, Elaeagnus umbellata, is a particularly invasive shrub that has invaded meadows, the forest understory, and was actively promoted to be used in mine spoils and roadsides through the 1980s. Previous research demonstrated that Autumn Olive exhibits higher photosynthesis rates than most native species, largely due to high leaf chlorophyll content. We hypothesize that Autumn Olive gains these competitive advantages through the ability to fix atmospheric nitrogen, the benefit of which is reflected in high leaf chlorophyll content.We planted an Autumn Olive seedling with a Gray Dogwood, Black Cherry, Black Walnut, or a Hawthorn seedling in gallon pots. Previous studies reported that Black Walnut trees with Autumn Olive planted within the drip line grew significantly taller and had higher leaf chlorophyll content than control Black Walnut trees over a nine year period. After just six weeks, native shrubs comparable in size with Autumn Olive shrubs produced more leaves with higher leaf chlorophyll content than when grown with another plant of the same species. Neighboring native species gain at least a temporary advantage from Autumn Olives nitrogen fixing capacity, however, the faster growth of Autumn Olive likely enables it to outcompete the nearby native plants in the long term.

100. Tyler Bleeker, Calvin College **Ecology and Evolution**

Assessing Transplant Survival in Native Kent County Trees

This research project sought to analyze the survival and growth of transplanted tree seedlings. Transplant survival was assessed using two methods: an observational study evaluating transplant survival of volunteer seedlings; and an experimental setup evaluating the growth of trees in a nursery planting technique proven to increase transplant survival. All the trees used in this study are native to Kent County.

101. Michael McDaniel, Aquinas College **Mathematics**

(Co-Author: Nate Poirier)

Alhazen's Billiard Problem in hyperbolic geometry

Alhazen's Billiard problem has, as given, two points in a circle. Mathematicians sought an inscribed, isosceles triangle with one point on each leg, by construction. After 1000 years, the general construction was proved impossible. My student, Nate Poirier and myself proved the same for the hyperbolic case. I will also describe the use of a wiki in our research.

102. Kate Coveney, Grand Valley State University **Mathematics**

(Co-Author: Bopaiah Biddanda)

Sink to Source? Effect of Climate Warming on Plankton Metabolism in Muskegon Lake

Throughout June and July of 2010, we performed several experiments to determine the impact of rising temperatures on the metabolic balance of Muskegon Lake. Rising temperature is believed to have a positive effect on both plankton respiration and gross primary production; however, we wanted to find if one process was more temperature dependent than the other and therefore how the balance of production to respiration (P/R ratio) would respond to changing climate. We ran four experiments over the summer: two short term 24 hour incubations and two long term 7 day incubations. Water was collected from Muskegon Lake in 20 L carboys and immediately brought to the lab for incubations in BOD bottles at three temperatures: ambient, 4°C above ambient, and 4°C below ambient. After the incubations, we determined the dissolved oxygen concentrations as a proxy for metabolism. Acridine Orange and Autoflourescence slide counts were also performed in order to calculate total microheterotrophs and total microautotrophs per milliliter. We found that plankton respiration and gross primary production generally increased with temperature, but that respiration had a greater temperature dependence than production, indicating a decrease in the P/R ratio with increasing temperature. Our results suggest that lakes are likely to act increasingly as net carbon sources to the atmosphere-potentially reversing their current role as net carbon sinks.

103. Andrew M. Howard, Aquinas College **Microbiology**

(Co- Author: Dr. Jennifer L. Hess)

Proteolytic Comparison of IdeS and IdeZ and Novel MWCO Filtration with ELISA Assay

The immunoglobulin-degrading enzyme of Streptococcus pyogenes, IdeS, is an unusual cysteine protease produced by group A streptococci for which the only known substrate is immunoglobulin G (IgG). IdeS and a homologous cysteine protease, IdeZ, originating in Streptococcus zooepidemicus, have not been found to cleave any of the other known synthetic substrates that typical cysteine proteases hydrolyze. In this study, we have compared the proteolytic activity of catalytic site-directed mutant IdeS with homologous mutants from IdeZ to determine if there is any direct or indirect association between the cleavage activity of IgG-degrading enzymes. Using both qualitative protein immunoblotting and quantitative ELISA techniques, the IgG cleavage profiles of IdeS and IdeZ do not appear to be significantly different. Enzyme variants of IdeZ in which critical amino acids found in the active site of the enzyme were changed as a consequence of site-directed mutagenesis were found to be non-functional. The presence of these various bacterial cysteine proteases with such similar substrate preferences remains intriguing and merits further analysis, especially with respect to the expression pattern in infected hosts and the potential implications for clinical applications of research concerning these enzymes' activities.

104. Julie Wesselink, Grand Valley State University **Microbiology**

(Co-Authors: Dr. Roderick Morgan, Dr. Robert Smart, Dr. William Schroeder)

GV-1 Chemical Derivatives as Potential New Antibiotics

Despite advancements in many areas of human medicine, infectious disease continues to be a leading cause of morbidity and mortality worldwide. Improper and excessive use of antibacterial compounds has led to the rise of resistant species of bacteria like Methicillin Resistant Staphylococcus aureus (MRSA), Vancomycin Resistant Enterococci (VRE), and Extreme Drug Resistant Tuberculosis (XDR-TB). We have found a possible alternative that would replace the current ineffective treatment methods – a potentially new class of antibiotics that inhibits Gram-positive bacteria growth. These chemical compounds have shown inhibition against S. aureus and E. faecalis, so MRSA and VRE strains were then tested. Inhibition by the newly developed compounds was identical to their inhibition levels against non-resistant strains of both species. These carboxylic amide compounds are novel, non-Penicillin based antibiotics, and could be used to treat MRSA and other Gram-positive infections.

105. Lauren Bylsma, Calvin College **Microbiology**

(Co-Author: Arlene Hoogewerf)

Role of a Copper ATPase in the IL-1β-Induced Growth of S. aureus Biofilms

Biofilm bacteria, adherent bacteria with an extracellular secreted polysaccharide film, are known to be more virulent than planktonic bacteria. Many genes are differentially expressed in biofilms compared to planktonic cells, and researchers predict that altered gene expression and growth metabolism contributes to the increased virulence. Cytokines, especially those of the Interleukin-1 (IL-1) family, can induce growth in certain biofilm bacteria. Since IL-1β is secreted by activated macrophages, the use of IL-1β by S. aureus biofilms as a growth-promoter may contribute to the increased immune system evasion by biofilms. The secretion of the signal peptide-less IL-1α depends on its binding to copper and the copper-binding S100A13 protein. IL-1β is a 17kDa protein that does not contain a signal peptide sequence. The passage of IL-1β through cell membranes may also involve similar protein and copper-binding mechanisms. The goals of this study were to:• determine and isolate the S. aureus protein that binds IL-1β • determine whether IL-1β is a copper-binding protein• determine the effect of copper on the IL-1β-induced growth of various strains of S. aureus • determine if gene expression of the S. aureus cytokine receptor occurs preferentially in biofilm cells• determine if cells lacking the S. aureus cytokine receptor have reduced immune system evasion• determine if the identified S. aureus cytokine receptor is present in clinically-relevant strains

106. Lindsay Rios, Calvin College **Microbiology**

(Co-Author: David DeHeer)

Bacterial Production of Ethanol

The purpose of this research is to measure the amount of ethanol our bacteria will produce utilizing glucose and xylose as sugar sources. The bacterium used was Zymonomas mobilis 8b, a bacterium that can metabolize six-carbon sugars to produce ethanol and which was genetically modified (by others) to metabolize five-carbon sugars and resist two antibiotics. It thrives in anaerobic conditions while tolerating two antibiotics to kill containments. The National Renewable Energy Laboratory in Colorado, our collaborators and where this experiment was first done, provided the bacterium. Our intent was to replicate their experimental data to ensure our bacterium can produce ethanol at a commercial level before experimenting with alternative sugar sources.

107. M. Aaron Baxter, Grand Valley State University **Microbiology**

(Co-Authors: Phillip Kaseska, Bradley Geal, Andrew S. Lux, Bradley D. Jones)

Analysis of a Cyclic Peptide Library to Identify Proteins That Effect hilA and fimZ Expression and Salmonella Invasion

Salmonella enterica serovar Typhimurium is a gram-negative bacterium that produces a self-limiting, localized gastroenteritidis in humans upon ingestion of contaminated food or water. Pathogenesis demands Salmonella recognition of multiple environmental conditions which activate a 40 kb region of DNA known as Salmonella Pathogenicity Island 1 (SPI-1). The expressed SPI-1 proteins manipulate normal host cell function and direct the uptake of the bacteria into targeted cells. The expression of the SPI-1 genes is controlled via the sensing of various environmental conditions through multiple pathways. When conditions are optimal for invasion, these various inducing signals are directed toward the SPI-1 transcriptional activator hilA. A secondary regulator in this system is fimZ. This regulator has been shown to influence motility, adherence through the expression of type-I fimbriae and invasion of the intestinal epithelium. In collaboration with Brad Jones at the University of Iowa, we have acquired a plasmid library that produces small random cyclic peptides. Currently, we are screening this library in E. coli containing either a hilA::lacZY or fimZ::lacZY reporter, in an effort to identify cyclic peptides that inhibit hilA and/or fimZ expression. Once these specific inhibitors have been identified, we will then characterize the affects of these peptides on Salmonella gene expression and bacterial invasion.

108. Robin Morrison, Alma College **Microbiology**

(Co-Author: Dr. Tim Keeton and Rachel Burckhardt)

Identifying Local Sources of Antibiotic Resistance Genes and Their Effect on Surrounding Microbial Populations.

Antibiotic resistance remains an ever-increasing problem in both human and animal medicine. Recently there has been an increased interest and awareness of the impact Confined Animal Feeding Operations (CAFOs) and other animal waste producers - including municipal sewage treatment plants - have on the distribution of Antibiotic Resistance Genes (ARGs). Resistance arises naturally in microorganisms as part of their evolutionary struggle for survival, hand-in-hand with the evolution of the antibiotic compounds themselves. However, our ever-increasing use of antibiotics in clinics and animal feedlot operations has greatly accelerated the spread of resistance genes in the environment. To test whether potential local ARG sources are altering the occurrence of ARGs in the environment, DNA is extracted from various soil/streambed sediment samples, then analyzed by standard polymerase chain reactions specific for known tetracycline resistance genes. We have been able to detect TetR genes in sediments from a drainage ditch particularly effected by CAFO waste disposal; this same gene family normally appears to have a limited distribution in the area. We are also beginning to supplement these data with studies of 1) the potential impact of the local municipal wastewater treatment plant effluent on the Pine River, and 2) sediment bacterial populations themselves, determining whether the presence of resistance genes is leading to changes in the microbial flora of local streams and rivers.

109. Rebecca Allen, Calvin College **Microbiology**

(Co-Author: John Wertz)

The Possible Role of Bacteriophage in Inflammatory Bowel Diseases

Inflammatory Bowel Diseases (IBD), such as Crohns Disease (CD) affects many people around the world, and an estimated 1.4 million people in the US (CDC). It is believed these diseases are caused by dysbiosis; the irregular balance of “helpful” and “harmful” bacteria in the human gut. (Tamboli et al., 2004)We believe this dysbiosis could be due to bacteriophage, a virus that only infects bacteria. Recent evidence from patients with Ulcerative Colitis demonstrated a 100 fold increase in free bacteriophage versus healthy individuals. (Lepage et al. 2008)

110. Ryan Walsh, Ferris State University **Microbiology**

(Co-Authors: Caitlin J. Williams, James P. O'Donnell, Norman L. Lehman)

Expression of APC/C substrates in Glioma/Lymphoma cell lines

Cultured Lymphoma and Glioblastoma cell lines, (DEL, U87, LN18, T98G), were analyzed by western blot analysis with antibodies against specific APC/C substrates. Nine different antibodies were tested with the cell lines. This data can be used to target certain functions of the cell. For example, the protein Cdc-20, controls the anaphase promoting complex in the cell cycle, and helps initiate chromatid separation, the starting of anaphase. The regulation of APC/C substrates leads to growth factors misregulated with cancer. The APC/C, (anaphase promoting complex cyclosome) is the cyclosome which needs to be closely regulated and timed correctly to allow progression of the genome. The APC/C complex/ cyclosome is an E3 ubiquitin ligase which directs the cell cycle by controlling the ubiquitin-dependent proteolysis of the S- phase and mitosis factors. Aurora A and B are needed to successfully complete the mitotic process. Proper Aurora A function is necessary for the correct checkpoint mechanisms to occur that do not reflect cancerous activity of proliferation. Cells not going through the proper checkpoints show entrance into anaphase despite a defective spindle formation. Aurora B controls chromosome segregation and the attachment of the microtubules to the centromere.

111. Charlotte Du Laney, Calvin College **Neuroscience**

(Co-Authors: Dr. Loren Haarsma, Dr. Paul Moes, Daniel Evans, Nhu Pham)

Electrophysiological Analysis of Corpus Callosum - Layer V Synapses

In a normal brain, the corpus callosum (CC) serves as an information highway between the left and right hemispheres, allowing the two sides of the brain to communicate and coordinate. The purpose of our research was to study what kind of synaptic signals the CC uses to communicate from one side of the brain to Layer V neurons on the other side. This is the first stage in a larger project to compare normal brains to brains were the CC does not cross the midline but forms nerve bundles on either side in a condition known as Agenesis of the Corpus Callosum (ACC) with Probst's Bundles (PB).

112. Emily Leathley, Hope College **Neuroscience**

(Co-Author: Dr. Greg Fraley)

Interaction Between Galanin-Like Peptide (GALP) and Estradiol in the Control of Reproduction and Energy Homeostasis in Female Rats

Galanin-like peptide (GALP) is a known hypothalamic mediator between energy states and reproduction. The effects of GALP on physiology and behavior have been largely studied in male rats, thus there is a dearth of information regarding its actions in female rats. The purpose of these studies was to examine GALP's effects on physiology and behavior as well as mechanism of action. To accomplish ths, we ovariectomized adult female rats and implanted cannulas in the lateral ventricles that were then used for intracerebroventricular (ICV) injections. Each animal received estradiol (EB) replacement therapy in two groups: EB or no EB (Blank). We found that there were significant estradiol-dependant effects of GALP on food intake, hormone secretions, and body temperature, but not on other measures. GALP stimulates food intake over the first 30 min after ICV injection and has estradiol-dependent actions on hormone secretion. We also found that ERα- and GALP-immunoreactivity are not co-localized in the hypothalamus. Finally, we demonstrate that GALP-induced fos-immunoreactivity is significantly increased in the mPOA and Arc, but decreased in the VMN; the fos that is increased is also colocalized with ERα-immunoreactivity. These findings suggest that there is a GALP-estradiol interaction in the hypothalamic targets of female rats and that estradiol apparently regulates GALP neurons indirectly.

113. Julia Becker, Hope College **Neuroscience**

(Co-Authors: Dr. Greg Fraley, K. Castillo, G. Torres)

Resveratrol Ameliorates brain damage induced by surgical cannulae: potential for treatment of Parkinson's Disease

Advanced-stage Parkinson's disease (PD) patients resort to deep brain stimulation (DBS), a treatment in which electrodes are implanted into the subthalamic nucleus (STN). This treatment provides relief from the signs of PD. Side effects of DBS are due to lesions around the electrode that eventually lead to an ineffectiveness of DBS. Resveratrol (RESV) is an antioxidant found in grapes, specifically in red wine, that has protective effects against cellular degeneration. We previously found that RESV has neuroprotective effects to prevent brain lesions associated with the physical presence of cannulas in the brains of rats. RESV's estrogenic structure led us to test the estrogen receptor GPR30 to determine RESV's mechanism of action. We used estriol (E3), a known antagonist for GPR30. Peripheral treatments of RESV, RESV/E3, and blank capsules were implanted prior to surgery. All animals received a unilateral cannula into the STN. Rotorod tests and a gait analysis were used to quantify motor coordination. All rats that received blank or RESV/E3 treatments showed significant ($p < 0.01$) motor-deficits post-surgery. Histological techniques to assess neuronal damage demonstrated that E3 seemed to inhibit the neuroprotective effects of RESV. The control and RESV/E3 treatments showed increased gliosis, necrosis, and increased neuronal degeneration compared to RESV treatment. RESV may have neuroprotective effects and it may in fact be acting through the GPR30 receptor.

114. Genevieve Kendall, Aquinas College **Organism Biology/Physiology**

(Co-Author: Dr. Thomas Bahl)

Preferences for Socialization with Colony- or Non-Colony-Mate in Periplaneta americana (American Cockroach)

Truly social, or eusocial, insects such as bees, ants and termites display strong preferences for their home colonies. However, other insects are also found in colonies, albeit not as socially organized as eusocial insects. Benefits from life in a colony might include heat generation and protection from predators 1. Cockroaches are many times found in groups or "colonies" including all different life stages. There has been limited research as to colony-mate preference in cockroaches 2. This study aims to determine if the American cockroach, Periplaneta americana, displays a preference for individuals or small groups from its home (or familiar) colony over those from a different colony. In this study, an adult cockroach was given a "choice" between a colony mate or a non-colony mate. It was hypothesized that female cockroaches would prefer familiar animals, possibly retaining the scent of the home colony where her oothecae may have been deposited, rather than animals from a different colony. And male cockroaches might also prefer a colony-mate, but may possibly be pursuing new mates, thus might prefer unknown females. It was found that females chose to associate with familiar males ($p<.03$), and males more often chose familiar females ($p<.07$). Females did not show a preference for familiar versus unfamiliar females, and in a simulated colony situation, males did not show a preference for a "mini" home colony versus and unfamiliar one.

115. Olivia Brockway, Hope College **Organism Biology/Physiology**

(Co-Authors: Alexis Nickols, Dr. Greg Fraley, Moses Lee, Balaji Babu)

Toxicity Effects, Tumor Growth, and Survival of Mice Treated with Combretastatin Analogs

Combretastatin A4 (CA4) is a naturally occurring compound that has been shown to inhibit tubulin polymerization in human cancer cells.To develop an anticancer drug based on CA4,a synthetic analog that has better bioavailbility than CA4 in vivo,yet retains its anticancer activity is needed.Four CA4 analogs,LLB37,LLB63,BB179,and BB195,were synthesized and shown to induce microtubule depolymerization in vitro.These compounds exhibited cytotoxicity in the NCI's 60 human cancer cell line panel.Each drug was administered via an intraperitoneal(ip) route in doses of 0 mg/kg,10 mg/kg,25 mg/kg,50 mg/kg,and 75 mg/kg to healthy female DBA2 mice every 4 days for 20 days to determine the tolerated dose and the effect of the molecules on the animals.Vitals were analyzed to determine overall health.All four drugs were tolerated at the maximal dose.To determine the inhibition of the murine lymphoma L1210 cells,they were injected into the right flank of female DBA2 mice.In study 1,LLB37 and LLB63 were administered via an ip route every 4 days at 75 mg/kg.Tumor growth/day was not significantly lower than the untreated control.In study 2,LLB63,BB195,and BB179 were also administered via an ip route every other day at 75 mg/kg.Tumor volume was significantly reduced compared to the untreated control in the BB179 and BB195 groups.Metastasis appeared to be reduced in all drug groups.The BB179 and BB195 groups survived significantly longer than those in the LLB63 group or the negative control group.

116. Sioned Sitkiewicz, Hope College **Organism Biology/Physiology**

Tritrophic Effects of a Fungal Endophyte: Parasitoid Host Preference

My research involved a tritrophic interaction between the grass tall fescue, aphids, and their natural enemies, parasitoids. Specifically, my research targeted the host preference of the parasitoid based on the diet of their aphid hosts. Aphids were fed on tall fescue that either contained or was free of a toxic alkaloid producing fungal endophyte. Parasitoids that had never parasitized before and parasitoids given previous experience were exposed to both aphid treatment groups, and the frequency of parasitism in each group combination was recorded. Data show that non-experienced, or naïve parasitoids significantly prefer aphids fed on an endophyte-free diet (E- aphids). Also, data show a trend for parasitoids preferring E- aphids regardless of previous experience. It is important to establish a preference pattern in this interaction because upon its solidification, further research can be performed regarding the specific chemical cues taking place in the acceptance or rejection of a host (ie: tactile, or aromatic cues). This interaction is relevant to agriculture, as parasitoids serve as biological pest control and endophytes present in the forage grass, tall fescue, could have detrimental effects on the third trophic level.

117. Ferris Jumah, Grand Valley State University **Statistics**

Association Between Employment and GPA for Students

As the economy fluctuates during its recovery from the recent crisis, many families and individuals are losing sources of income. To help offset this, many students take up employment during their undergraduate education. It is necessary for students to evaluate what effect employment will have on that education. One measure for evaluating performance in students' studies is the grade point average. In this study we examined the relationship between students' GPA and the level of employment. Voluntary surveys containing questions about Fall 2009 were given to GVSU students in school Fall 2009 & Winter 2010. Data collected included related demographic variables, GPA, and level/type of employment. Multiple Regression analysis was then used to model the relationship between GPA and level of employment controlling for the other variables in the survey. This information has shed light on the association and will allow students' to make informed decisions regarding working while in school.

118. Ben Niewenhuis, Calvin College **Chemical Engineering**

(Co-Author: J. Aubrey Sykes)

Conversion of Polystyrene to Benzoic Acid

Polystyrene is a very common plastic in the modern world, typically associated with consumer packaging in its expanded form. Unfortunately, polystyrene is a sub-optimal product to recycle; conventional methods of recycling yield a product of significantly reduced quality. This project seeks to address this gap between disposal methods and the production of polystyrene waste through metal-bromide catalyzed autooxidation. In this process a catalyst facilitates the atmospheric oxidation of the polystyrene chain into benzoic acid, a chemical with commercial value, and carbon dioxide. Experimental results indicated yields ranging from -10% to +12% benzoic acid; unfortunately, error inherent in our analytical technique casts substantial doubt upon these calculations. Given the inconclusive nature of our results thus far, our hope is to continue research on this project at Calvin College, building upon the resources and knowledge gained this summer and bringing more precise analytical techniques to bear upon the problem.

119. Mark Stehouwer, Calvin College **Environmental Engineering**

(Co-Author: Professor David Wunder)

Fate of Antibiotics in Slow Sand Biofiltration and Batch Tests

Surface waters such as lakes and rivers have been found to contain low concentrations of antibiotics. These concentrations are minimal (ppm and ppb), however the environmental and health effects have not yet been fully investigated. Water treatment of surface waters by biofiltration is common in many European and developing countries, with increasing interest in North America. This research focuses on understanding the removal of antibiotics in biofiltration water treatment systems. Batch and column studies were conducted to develop antibiotic isotherm and breakthrough data for three antibiotics (Ciprofloxacin, Erythromycin, and Sulfamethoxazole. Results indicate that antibiotic loss in biofiltration systems can be predicted by considering both the charge and hydrophobicity of the compound. Antibiotics, and other acidic pharmaceuticals, that are positively charged and lowly hydrophobic have the greatest likelihood for removal in biofiltration systems.

120. Bonnie Robison, Calvin College **Environmental Engineering**

(Co-Author: Professor David Wunder)

Sorption of p-nitrophenol to Bagasse Charcoal: For Water Treatment in Developing Countries

Lack of available, affordable, clean water is a significant problem in developing countries today. It is essential to find and use water treatment methods that use renewable and available resources. The sorption of p-nitrophenol (PNP) to different types and sizes of bagasse charcoal was studied, comparing the method of production (oven vs. kiln) and performance relative to activated carbon. Batch tests were performed. Bagasse charcoal was first washed (to allow for desorption of organic compounds) prior to testing. Sorption isotherms were developed for varied amounts of charcoal in PNP solution. PNP was analyzed a ultra-violet visual spectrophotometer. Results indicate that the degree of sorption is not effected by temperature of pyrolization, and that bagasse charcoal shows promise for water treatment purposes.

121. Evan Timmerman, Calvin College **Biotechnology**

Search for a suppressor of Yersinia pestis' YopE effector protein using Saccharomyces cerevisiae as a model organism

The bacterium Yersinia is a deadly pathogen that is present worldwide. A major factor that contributes to its virulence is the Yop effector proteins that it injects into its host cell in order to disable the cell's various immune responses. YopE is one such protein, and its purpose is to disable the phagocytosis response of the host cell. Our goal was to find proteins capable of suppressing the expression of YopE by using Saccharomyces cerevisiae strain JGY4 as a model organism. Our experiments involved transforming JGY4 with seventeen different DNA libraries in the hopes of identifying any that were capable of suppressing YopE and creating subclones that contained certain genes of a plasmid called p2g8 that is a known suppressor of YopE in order to identify which the genes are responsible for this suppression.

122. James Gillies, Ferris State University **Biotechnology**

(Co-Author: Dr. Alexander Gow)

Importance of Claudin 11 in Neural Processing of Auditory Signals

Oligodendrocytes are the cells that make myelin in the central nervous system. Myelin acts an insulator for axons much like the rubber coating on the outside of copper electrical wires. Myelin increases resistance and speeds up transmission of electrical signals. Claudin 11 (CLDN11) codes for a tight junction protein within oligodendrocytes. It is believed to act as an adhesive glue between the layers of myelin but its exact function is still unknown. What is known is that it increases the resistance of the myelin and prevents electrical leaks along the axon. Through the use of auditory brainstem response (ABR) testing, previous studies have shown mice lacking CLDN 11 have slower nerve conduction in small and medium sized axons1. It is hypothesized that this slowed nerve conduction will have an effect on neural processing of auditory signals. If this is true, then it is believed that this may have links to schizophrenia, in particular the auditory hallucinations experienced by schizophrenics. Most current views on schizophrenia focus on the disconnectivity in the brain caused by serotonin and other neurotransmitters. It is thought the slowed nerve conduction caused by lack of CLDN11 will produce the same phenotypic effects. If confirmed, CLDN11 mutations may lead to new ways to look at schizophrenia.

123. Justin Phan, Ferris State University **Biotechnology**

Comparison of Prion Allele Frequency found in Suffolk and Targhee Sheep

Scrapie is a class of Transmissible Spongiform Encephalopathy that affects sheep and goats. The objective of this study was to compare genotypic and allelic frequencies among USSES Targhee and Suffolk sheep. A total of 122 sheep were genotyped for codon 171 with allele specific primers in 2 separate PCRs and 133 were genotyped for codon 136 with an RFLP. The RFLP detected if an individual had none, one, or two valine allele(s). Valine at codon 136 correlates with an increased susceptibility to scrapie. Chi-square tests were conducted to determine if there were differences in the genotypic and allelic frequencies for the prion codons 171 and 136 due to breed. Hardy-Weinberg tests were performed to determine if the prion codons were in equilibrium. No significant ($P>0.05$) differences were found between the breeds for genotypic and allele frequencies. Prion codon 136 was not in Hardy-Weinberg equilibrium for either breed but 171 was for both breeds. This result is not unexpected as USSES has been performing active selection against valine at condon 136 and only recently begun selection for Arginine (R) at codon 171. In conclusion, selection against valine at 136 has not changed allele or genotype frequencies among Targhee and Suffolk sheep but has changed Hardy-Weinberg equilibrium in both breeds, demonstrating that selection can reduce disease associated alleles.

124. Tara Bigorowski, Ferris State University **Biotechnology**

(Co-Authors: Simone Zauner and Christopher Benning)

Characterization of a Novel delta 4 Fatty Acid Desaturase in Chamydomonas reinhardtii

Algae produce unique lipids that can be used in a variety of different areas including biofuels and human nutrition. The green algae, Chlamydomonas reinhardtii , is used as a model organism for such types of research. Like all photosynthetically active organisms the galactolipids monogalactosyldiacylglycerol (MGDG) and digalactosyldiacylglycerol (DGDG) represent the major membrane lipids. The structure of MDGD is very unique in this organism because it contains Hexadecatetraenoic acid (16:4) at the sn2 position with double bonds found at positions Δ4, 7, 10 and 13. All desaturase genes involved in 16:4 synthesis have cloned and functionally characterized, except the putative Δ4-desaturase. A candidate gene was identified in a bioinformatics approach and characterized in this study. To characterize the gene, the following methods were used: silencing with microRNA constructs, an in vitro assay using the yeast Pichia pastoris, heterogeneously expression in Arabidopsis thaliana, and localization through a yfp fusion construct in tobacco leaves.

125. Alex Verseput, Calvin College **Physics**

Computer Controlled Digital Polarized Light Microscopy of Alkane Phase Transitions

Using the unique birefringent property of solid alkanes, a system and method was developed to measure phase transition temperatures. This was accomplished via computer interfaced temperature control, digital image acquisition, and polarized light manipulations on a microscope. Furthermore, using a simple pixel integration algorithm, the data became quantitative and could be analyzed using hyperbolic tangent fitting capabilities.

126. Andrew Mccubbin, Hope College **Physics**

(Co-Authors: Paul DeYoung and Graham Peaslee)

Ion Beam Analysis of Metalloprotein Stoichiometry

Particle induced X-ray emission (PIXE) spectroscopy is a non-destructive ion beam analysis technique well suited to determine the concentrations of heavy elements. Particle elastic scattering analysis (PESA) is a similar technique which measures the areal density of a thin target by quantifying the energy loss of the transmitted ions. A combination of PESA and PIXE has been developed to provide a quantitative technique for the determination of stoichiometric metal ion ratios in metalloproteins. About a third of all proteins are metalloproteins, and most do not have known stoichiometric compositions for the metals they contain. Current work focuses on establishing a standard method in which to prepare protein samples. Two methods of preparation are currently being investigated. The first involves spotting protein solutions on aluminized polyethylene terephthalate and allowing them to dry. The second uses the process of native polyacrylamide gel electrophoresis in order to separate proteins and then drying them to provide adequately thin samples. These methods are compared for several proteins to determine their respective effectiveness and to develop a standard model for running ion beam analysis of metalloproteins.

127. Annellee Eben, Calvin College **Physics**

(Co-Authors: V.Bunnell, E.K. Pease, Candance J. Goodson, S.C. Lee, S.K. Remillard)

Even and Odd Order Intermodulation Nonlinearity from Superconductive Microstrip Lines

When two or more frequencies are sent through a High Temperature Superconducting (HTS) resonator, intermodulation (IMD) and harmonic distortion is generated. Distortion is dependant on the physical properties of the microstrip lines, which were analyzed optically with a traveling microscope to determine their dimensions. Electromagnetic field simulations with IE3D from Zeland Software provided information about current distributions and the geometry factors of the microstrip lines. Multi-tone measurements can be performed to detect the distortion, of which the three-tone method developed at Hope College allows for simultaneous and synchronous measurement of even and odd order distortion currents. Contrary to earlier predictions of solely odd order distortion arising from HTS materials, both even and odd order non-linearity was observed, indicating Time-Reversal Symmetry Breaking (TRSB) in superconducting current. This is pertinent to current research in HTS in multiple ways: the distortion defines the limitations of microwave technologies and it reveals the fundamental physics of HTS materials. An observed catastrophic increase in the odd order IMD near the phase transition corresponds to the anticipation of the non-linear Meissner effect in HTS. A smaller observed catastrophe in the even order IMD has no current theoretical explanation, but the significant drop in the ratio of second to third order IMD at the phase transition indicates a decline in TRSB.

128. Caitlin Taylor, Hope College **Physics**

(Co-Author: Peter L. Gonthier)

Development of the Exact Relativistic Compton Scattering Cross Section in Strong Magnetic Fields

Resonant Compton scattering with relativistic electrons in the strong magnetic fields is an efficient mechanism to explain the recently discovered rapid rise above 10 keV in the X-ray spectra of Anomalous X-ray Pulsars (AXPs) and Soft Gamma-ray Repeaters (SGRs). The scattering cross section being used within the community incorporates the relativistic effects of strong magnetic fields with the average relativistic width of the resonance, which ignores the spin effects present in the virtual intermediate state. We would like to develop an exact cross section that incorporates the spin dependence of resonance width using the Sokolov & Ternov basis states, as discussed in Baring, Gonthier and Harding (2005). In addition to numerical checks, this project explores spin effects both near and far from resonance. This correct and exact treatment will be cast in compact and accurate analytical expressions for the astrophysics community to utilize. The objective is to develop numerical methods to support collaborators at Rice University and eventually the development of a Monte Carlo simulation code to describe the full magnetospheric scattering that produce the spectra observed in AXPs and SGRs. This project is supported by the National Science Foundation under NSF-REU Grant No. PHY/DMR-1004811 and NSF-RUI Grant No. AST-1009731, Hope College Physics Department endowed funds (Guess Fund), and by NASA Astrophysics Theory and Fundamental Physics Proposal 08-ATFP08-0180.

129. Dan Evans, Calvin College **Physics**

(Co-Authors: Professor Loren Haarsma, Professor John Ubels, Charlottoe DuLaney, Nhu Pham)

Long-Term Effects of Ultraviolet Light on Corneal Epithelial Cell Potassium Channels

The human eye has an outer protective layer called the cornea. Ultraviolet light damages cells on the corneal surface (HCLE cells) in several ways. One effect is that within 5 minutes of exposure to 80mV/cm2 UV-B, Potassium channels in the cell membrane become more active, opening more frequently, causing Potassium to leave the cell, sometimes resulting in cell death. We found that the K+ channels remain highly active more than 90 minutes after UV-B exposure, even though K+ levels in the cell typically return to normal 30 minutes after exposure.

130. Daniel Mcneel, Hope College **Physics**

(Co-Author: Dr. Jennifer Hampton)

A Study of the Uniformity of NiFe Electrodeposition on a Au Substrate

The layered deposition of magnetic metals on non-magnetic metals creates materials with giant magnetoresistance. Controlled electrodeposition may produce these materials more easily and affordably than current techniques. This research used three different techniques to analyze our control over the deposition process for NiFe alloys. The three techniques were: current data during deposition, the Scanning Electron Microscope (SEM) at Hope College, and the Atomic Force Microscope (AFM) at Calvin College. The effects of varying the initial potential and the deposition time were studied. The effects of using an initial potential of 0 mV versus an open circuit initial potential were studied using current data and SEM images. Electrochemical data showed that the deposit varied more due to change in solution than due to the variation in initial potential. The effects of changing the duration of deposition were studied using SEM and AFM. SEM images were used for visual comparisons of sample uniformity. The AFM data were analyzed for height scaling properties.

131. Eric Lunderberg, Hope College **Physics**

(Co-Authors: P.A. DeYoung and MoNA Collabration)

Analysis of Data from Neutron Detectors

The goal of this experiment was to find the level structure of 13Li. This isotope is of interest as it exists beyond the neutron drip line and is highly unstable. Gaining a better understanding of it will allow for more accurate modeling of the nuclear force. 13Li was formed through one-proton knockout from a beam of 14Be at the National Superconducting Cyclotron Laboratory impinging on a 470 mg/cm2 Be target. The 13Li is expected to decay through 12Li, ending in 11Li which is analyzed using the Sweeper magnet and detector array and two neutrons which are detected by the Modular Neutron Array (MoNA). Geant4 simulations were then performed to determine the response of MoNA to neutrons.

132. Katherine Shomsky, Calvin College **Physics**

(Co-Author: Stan Haan)

Double Ionization of Atoms by Lasers: Do Electrons Continue to Interact After Recollision?

We employ 3d classical ensembles to study the effects of post-recollision electron interaction in the ionization of atoms. Experimenters have suggested that this post-recollision interaction affects the final momentum, leading to "fingerlike" structures. Simulations testing this idea showed that there was very little effect when the e-e interaction was ignored after recollision. Our investigation as to why there was so little effect showed that in many cases, the electrons have such a large separation at the time of final ionization that there is really very little interaction anyway.

133. Nathan Danks, Calvin College **Physics**

(Co-Authors: S.L. Haan, and K.N. Shomsky)

Classical modeling of single electron helium: The effect of nuclear potential on sequential double ionization.

This research uses classical modeling to investigate the dynamics of single-electron helium in a high-intensity laser field. We have shown the possibility for a classical single electron to gain energy when exposed to an oscillating high-intensity laser field, and investigated how the energy is gained. These results have important implications on double ionization of helium and on classical modeling of atoms.

134. Nhu Pham, Calvin College **Physics**

(Co-Authors: Charlottoe Dulaney, Dan Evans, Dr. Loren Haarsma, Dr. John Ubels)

Recording K+ currents in lacrimal gland duct cells

We know from precious experiment by Ubels et al that K+ ions help protect the eyes from UV light. We want to develop a method for isolating duct cells and use this method to identify the specific type and characteristics of the K+ channels on duct cells using patch clamp technique. The method provides viable duct cells for patch clamp study; we have success showing that lacrimal gland duct cells have voltage-activated K+ channels that are sensitive to blockers TEA and 5 mM Ba2+, and some duct cells have an inward-rectifier K+ channel.

135. Rachel Boerner, Calvin College **Physics**

(Co-Authors: Nathan L. Meyers and Paul E. Harper)

Sucrose and Trehalose Sugars Have Similiar Effects on Lipid Behavior

Cell membrane research often explores the processes that involve the breaking and reassembly of cell membranes. Phospholipids are a key component of cell membranes and therefore form a useful model by which to study these cell membrane processes. Lipid-water systems exhibit phases transitions that require the tearing and reassembling of lipid membranes. Two of these phases are the Lα phase (bilayer structure) and the HII phase (hexagonal structure). We used a light scattering apparatus to detect this phase transition. We then compared the effects of different concentrations of sucrose and trehalose on the Lα-HII phase transition of lipid SOPE (1-stearoyl-2-oleoyl-phosphatidylethanolamine). We found that sucrose and trehalose both have diverse non-linear effects on lipid kinetics, but they have the same linear quantitative effect on the equilibrium transition temperatures. The equation for modeling the effect on the equilibrium transition temperatures that we found was T_LH=(-9±1)M+(57±1)

136. Sarah Prill, Hope College **Physics**

(Co-Authors: Paul DeYoung and Graham Peaslee)

Analysis of Honey using Particle Induced X-Ray Emission

Honey bees only travel about 2 km from their hive, collecting water and pollinating plants. Because of the small area they cover, honey could be a good indicator of environmental threats. Nine different honeys were collected from local honey farms, Meijer, and a honey farm in Indiana, and samples were prepared by burning honey at 550ºC for one hour. To analyze the honey ash, samples were hydraulically pressed into self-supporting targets for ion beam analysis. Proton Induced X-ray emission (PIXE) was used to find the trace elements present. The particle accelerator accelerates protons which excite electrons from the core shells of the target atoms. When these electrons fall back into their core states, x-rays of a particular energy that are characteristic of a particular element are emitted. These x-rays are detected and using their energy, the quantity of elements present in honey can be found in parts per million (ppm). It was found that these honey samples contain mostly aluminum, chlorine, potassium, manganese, iron, copper and calcium, although the concentrations of these elements vary greatly, and hopefully can be used to distinguish them and their environmental sources.

137. Scott Bleiler, Grand Valley State University **Physics**

(Co-Author: Brett Bolen)

Effects of Minimal Length on Quantum Mechanical Scattering

Quantum theories of gravity, such as String/M Theory and Loop Quantum Gravity Theory, set bottom limits on fundamental physical values of length and momentum. Applying this concept to the uncertainty principle generalizes the traditional form. We've solved the Schrödinger equation, modified by minimal length, for problems arising in quantum theory pertaining to Coulomb and "soft sphere" scattering. This ongoing research may have bearing on future observational data for astronomers, since modifications to scattering may affect dispersion relations.

138. Thomas Wilhelm, Calvin College **Physics**

(Co-Authors: Nathan L. Meyers, Paul E. Harper)

Lipid Kinetics are Modulated by the Monosaccharides Fructose and Glucose

Lipid-water mixtures form a variety of phases including the lamellar and inverted hexagonal phases. Transitions between these phases involve the tearing and reassembling of lipid membranes and so can serve as a model of cellular processes that re-arrange cell membranes. Using laser light scattering we've studied the effects of simple sugars. In particular, fructose and glucose affect the phase behavior of the lipid SOPE (1-stearoyl-2-oleoyl-phosphatidylethanolamine). We found that fructose and glucose change the transition temperatures in a similar but non-linear fashion, with small concentrations increasing the transition temperature but larger concentrations decreasing the transition temperature. Furthermore, the lipid kinetics are slowed down for both sugars.

139. Timothy Nagi, Hope College **Physics**

(Co-Authors: Kaitlynn Rethman, Kim Purtell, Autumn Haagsama, Casey DeRoo, Megan Jacobson, Alexander Peters, Steve Kuhn, Sam Stewart, Zach Torstrick, Mathieu Ndong, Rob Anthony, Hengzhi Chen, Alex Howe, Nicholas Badger, Matthew Miller, Brad Vest, Ben Foster, Logan Rice, Alegra Aulie, Amanda Grovom, Phillip Kasavan, Lewis Elliot)

Testing the Large-are multi_institional Scintillator Array (LISA) Neutron Detector

The 144 detector modules comprising the Large-area multi-Institutional Scintillator Array(LISA) were tested at each of the nine primarily undergraduate institutions. Each module is a 200 cm by 10 cm by 10 cm bar of EJ-200 organic plastic scintillator. LISA was constructed in the summer of 2010. LISA will be used to detect neutrons in the range of 0-100 MeV at the National Superconducting Laboratory in combination with the Modular Neutron Array (MoNA) and the Sweeper dipole superconducting magnet.

140. Herb Fynewever, Calvin College **Science Education**

(Co-Authors: Katie VanderHeide and Monica Turner)

Formative Assessment Cycle, Motivations, and Barriers

Formative assessment is a proven teaching tool. Most descriptions of the formative assessment cycle include: TARGET: communicating learning goals, MEASUREMENT: of student understanding, FEEDBACK: to and from students, and ADJUSTMENT: of teaching to meet students' needs.In this project, we conduct a case study of four professors to gain a better understanding of what good professors do that is consistent with formative assessment, why they do it, and what barriers they may face. The motivations and barriers between all the professors shed light on possible reasons for the implementation gap including perception that there is not enough class time to conduct effective formative assessment and the perception that students are too apathetic to pay attention to feedback. While there were many similarities in what these professors did and what motivated them, there were also some significant differences. By noting these differences it is possible for faculty to learn new strategies and consider new motivations.

141. Matthew LeaTrea, Grand Valley State University **Science Education**

(Co-Authors: Richard R. Rediske and James O'Keefe)

Development of a Derivatization Technique for Anatoxin-A in Recreational Water

Toxin producing cyanobacteria have been identified in Muskegon county lakes. Historically, levels of the cyanotoxin, microcystin, have been reported in Bear and Muskegon Lakes using LC/MS that exceed the WHO Guidelines for drinking and recreational water. Although cyanobacteria capable of producing the toxin, anatoxin-a, have been reported in these lakes, the compound has not been measured due the poor analytical performance and elevated detection limit of LC/MS. The purpose of this research was to evaluate methods for the determination of anatoxin-a that involved the formation of derivatives to improve the detection limit. Two methods for anatoxin-a were evaluated. An HPLC method involving the fluorescent derivative of anatoxin-a using 4-fluoro-7nitro-2,1,3 benzoxadiazole (NBD-F) was evaluated and a method detection limit of 0.29 ug/l was obtained. The NBD-F derivative could be formed in situ as part of the microcystin extraction and analysis procedure. A second method using pentafluoro benzyl bromide (PFB-Br) as the derivatizing agent and GC-MS for analysis required separate sample preparation and a higher detection limit than the NBD-F/HPLC procedure. Because of the lower detection limit and the ability to use the same extraction procedure as microcystin, the NBD-F was used to measure anatoxin-a in 12 water samples. Anatoxin-a was not detected in any of the water samples however a peak with a similar retention time was found on one occasion.

142. Ben Johnson, Calvin College **Computational Biology/Bioinformatics**

143. Elizabeth Porter, Calvin College **Biochemistry**

(Co-Author: Anand Divakaran)

Nanoparticle Biosensors

The goal of our research was to take an existing biosensor system and make it more robust. The system is comprised of Maltose Binding Protein (MBP) genetically altered to have a 5 His-tag. The His-tag allows the quantum dot (semiconductor nanoparticle) to bind to the protein. The final component of the system is a metal complex (electron donor). Depending on whether or not maltose is present, the metal complex will transfers an electron to the quantum dot. If the quantum dot is uncharged it will fluoresce and indicate the presents of maltose.