

## **M. Eng Abstracts**

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*Major:* Biomedical Engineering

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*Poster Title:* Neighboring arterioles do not dilate to increase collateral flow after the occlusion of a cortical penetrating arteriole

While, blood flow in the brain is carefully regulated through active dilation and constriction of cortical arterioles, there are conflicting reports about the role of acute vasodilation in modulating collateral flow after occlusion of a single cerebral artery (focal cerebral ischemia). The aim of this study is to determine if active vasodilation of neighboring vessels plays a role in regulating blood flow after occlusion of a single arteriole. To this end, we use two-photon excited fluorescence (2PEF) microscopy in anesthetized rats to measure the changes in vessel diameter of neighboring arterioles after the occlusion of a single penetrating arteriole (i.e. an arteriole that branches from the surface arteriole network, plunges into the cortex, and feeds the sub-surface capillary beds).

After occlusion of a single penetrating arteriole there is, on average, no acute dilation of neighboring surface or penetrating arterioles, with the post clot diameter equal to 101% +/- 5% (mean +/- SEM) of the baseline value (334 vessels across 25 clots in 25 rats). After application of acetylcholine, a vasodilator, the diameter of arterioles neighboring the occluded one increases by 17% +/- 5% of the baseline value, indicating that these vessels still have the capacity to dilate. These results indicate that active vasodilation of neighboring arterioles does not play a role in regulating collateral flow immediately after the occlusion of a cortical penetrating arteriole.

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*Name:* "Siddharth Khasnavis" <sidk1987@gmail.com>

*Group Members:* Vijay Sarathi and Matthew Russell

*Poster Title:* Magnetic Resonance Heating of a Vascular Stent

It is standard hospital practice to remove metallic objects from patients prior to MRIs. Since magnetic resonance imaging employs changing magnetic fields, even everyday items such as jewelry or keys run the risk of overheating due to induced currents leading to Joule heating. A potential problem arises, however, when the metal is subcutaneously located in the form of a medical implant. The present study evaluated this scenario by using finite element analysis to model a vascular stent under the influence of a standard MRI field. COMSOL Multiphysics software was used to conduct finite element analysis on two different stent sizes, each in the presence and absence of blood flow. The stents were modeled as stainless steel (type 316L) with internal diameters of 5mm and 8mm, length of 40mm, and wall thicknesses of 0.18mm and 0.22mm. The tests revealed that under the influence of blood cooling, the stents modeled did not overheat or cause arterial damage. Specifically, the large stent resulted in a maximum

temperature of 310.807 K and the smaller stent led to 310.230 K, each after 30 minutes of heating. In the unrealistic absence of blood flow, the large and small stents reached maximum temperatures of 318.851 K and 312.297 K respectively. Ultimately, given variance in blood flow the true solutions lie somewhere in between the blood perfusion and static flow models.

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*Name:* "Nicole Ceci" <ngc4@cornell.edu>

*Major:* CEE, BEE, MAE, SES, Hotel, PAM, and Anthropology majors

*School Status:* Undergrad and M. Eng/MS students

*Other group members:* The AguaClara engineering project team (there are 42 students on the team)

*Poster Title:* AguaClara

AguaClara is a project team that is improving drinking water quality through innovative research, open source engineering, and design of sustainable, replicable water treatment systems.

We have constructed one fully functioning water treatment plant in the town of Ojojona, Honduras. This plant is operational, and it is furthering AguaClara research via the data it yields. We are also currently working on two new projects. We are aiding the International Rural Water Association in retrofitting a dilapidated water treatment plant with AguaClara technology in the town of Marcala, Honduras, and the team's second plant is under construction in Tamara, Honduras.

The research done at Cornell University on water treatment processes, especially on flocculation, is the foundation for the design of the plants we have built. Our water treatment plants are designed to be clever, simple and affordable. They are gravity powered and made out of local materials to the greatest extent possible, and the design algorithms are structured to be scalable and replicable. These two factors combined with simple design make our plants physically sustainable.

As we move forward in our research we are testing variations of our existing flocculation model, including the relationship between velocity gradients and fluid mixing and floc formation. This research should make the AguaClara technology more efficient and less expensive to implement in future construction projects.

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*Name:* "Michael John Ranbom" <mjr282@cornell.edu>

*Major:* Biomedical Engineering

*Group Members:* Ranbom M, Krotscheck U, Rawlinson JJ

*Poster Title:* A Biomechanical Model of Canine Stifle Reconstruction

Previous studies have developed models of the human knee or canine stifle. Notably, Shahar and Banks-Sills developed a three-dimensional mathematical model of the canine stifle, incorporating the major ligaments and muscular action with kinematic data and articular geometry (Shahar, 2004; Shahar, 2006). We are developing a biomechanical model that incorporates the bony geometry and soft tissue structures - ligament, cartilage, and menisci,

inherent in the functional stability of the joint. Currently, we have created the three-dimensional geometry from magnetic resonance (MR) scans and mapped the ligamentous and major muscle insertion sites. These points dictate the lines of action of the joint stabilizers to calculate equilibrium during gait loadings. Concurrently, a theoretical model has been developed in MATLAB, using nonlinear least-squares algorithms, to determine joint reaction forces and displacement. Building on the basis of the theoretical model, the three-dimensional model will allow the simulation of surgical reconstruction of the canine stifle, comparison to clinical measures of joint stability, and calculation of the displacement and stresses occurring in the structures of the joint.

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## Undergraduate Abstracts

*Name:* Karin Holmberg kjh45@cornell.edu

*Group Members:* George Pins, PhD, Katie Bush (Worcester Polytechnic Institute)

*Poster Title:* Characterizing Diffusion Coefficients of Basal Lamina Analogs

Bioengineered skin substitutes have achieved some clinical success as wound therapies for damaged or diseased skin, but, suboptimal engraftment rates, prolonged healing times and mechanically-induced graft failure remain persistent problems. Our laboratory developed methods for creating skin substitutes with microtextured basal lamina analogs to promote therapid regeneration of a robust epidermal layer. The goal of this project was to conduct biological transport analyses through basal lamina analogs and to evaluate the effects of membrane crosslinking techniques on diffusion coefficients. Collagen membranes were crosslinked using 1-Ethyl-3-[3-dimethylaminopropyl] carbodiimide hydrochloride (EDC) or dehydrothermal (DHT) treatment and diffusion coefficients were compared to those of the uncrosslinked (UNX) membranes. Using a high-throughput diffusion device developed in our lab, diffusion coefficients through collagen membranes were calculated for three molecules of varying sizes. The results of these studies showed that the diffusion coefficients for glucose and albumin through UNX collagen membranes are comparable to those reported previously for collagen-based materials. Our studies also indicate that molecular diffusion through crosslinked membranes decreased significantly, relative to uncrosslinked membranes. Together, these findings provide valuable characterization data for the design of basal lamina analogs that facilitate nutrient transport and paracrine signaling, both of which are essential for the development of scaffolds that promote tissue regeneration.

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*Name:* Ankur Chaudhury ac392@cornell.edu

*Class:* 2008

*Major:* Biological Engineering

Our research group (under Prof. Stroock in the ChemE/BME department), is conducting research on the processes involved in vasculature formation in animals. We are trying to simulate and study these processes *in vitro*. To do so, we are working with common hydrogels in an attempt to develop a suitable extracellular matrix (ECM), which can be microfabricated, and which also has appropriate mechanics to support the processes involved with vasculature formation.

The formation of the vascular network of veins and arteries in vertebrates is a complex process, but one that can be described in two basic stages – vasculogenesis, and angiogenesis. During the embryonic stage of development, precursor endothelial cells spontaneously aggregate to form a network of capillaries in the process of vasculogenesis. During angiogenesis, the random capillary bed array matures and widens into an organized system of veins and arteries. It has been hypothesized that pressure gradients created by blood flow are the driving force in the latter process.

Vasculogenesis requires cells to invade into a matrix, proliferate, migrate, and eventually differentiate. To study this process *in vitro*, it becomes necessary to develop an artificial matrix where cells can carry out these activities and be studied. Our group has looked at a variety of materials as candidates for the extracellular matrix, and has achieved some success using a 1% collagen I hydrogel. We are currently experimenting with this material, attempting to obtain reproducible results. Eventually, a microfabricated network in collagen I hydrogel could be lined with cells, simulating the capillary bed. Fluid flow through this network would allow us to study how the capillary bed reacts to pressure gradients experienced during angiogenesis.

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*Name:* Tarun Chitra [tc328@cornell.edu](mailto:tc328@cornell.edu)

*Poster Title:* Use of  $^{19}\text{F}$  2-Fluorodeoxyglucose MRI in noninvasive determination of C6 glioma malignancy

Noninvasive malignant tumor determination is nearly impossible, even with today's modern and advanced imaging technologies. Brain cancers, the most malignant of cancers, are difficult to diagnose, as a surgeon needs to open the human skull to obtain a biopsy. MRI, or Magnetic Resonance Imaging, is an imaging technique utilizing the phenomenon of Nuclear Magnetic Resonance (NMR), is used for diagnosis of such tumors. The radiotracer 2-Fluorodeoxyglucose (FDG) is used to determine metabolic differences in radioactive Positron Emission Tomography (PET). In cancer research  $^{19}\text{F}$ -MRI using FDG can determine metabolic differences between tissue sections as malignant tumors tend to use up more glucose for energy to spread. This study uses FDG MRI in comparison to the clinical MRI tumor contrast agent Gadolinium-Diethylenetriaminepentacetate (Gd-DTPA), which has no metabolic activity.

To form a static MRI image for this study, the Arginine-Glycine-Aspartic Acid (RGD) peptide was used to suppress movement of glial tumors. In my previous research, the RGD peptide was successfully used to inhibit glial tumor motility. RGD interferes with integrin binding to the extracellular matrix limiting adhesion and movement. In the present MRI study, well-defined concentration differences were noted in the T2-rho-weighted MRI, showing a darker-colored tumor for more FDG exhaustion in malignant tumors. Out of 30 total tumors found (3 *in vitro*\*, 27 *in vivo*\*), 25 tumors were found to be malignant by FDG imaging. Further biopsies demonstrated that 27 tumors were malignant, with 92.5% accuracy in FDG malignant tumor determination. In FDG imaging concentration differences of 5%-10% can be obtained between malignant, benign, and normal tissues. These results are an indication that the FDG imaging method is more efficient in finding malignant tumors when compared to Gd-DTPA.

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*Name:* "Eric Su-Ming Chang" <[esc32@cornell.edu](mailto:esc32@cornell.edu)>

*Group Members:* Eric Chang, Max Kashdan, Andy Wong

*Poster Title:* Epicutaneous Heating Microbead Liquid Spray

Prevention of cold related injury, particularly frostbite, defined as the freezing and subsequent damage of skin tissue, is a particular concern to workers and athletes who must continuously endure cold and wet conditions. Conventional methods of insulating skin from cold damage can be bulky and restrictive. Several methods of providing unrestricting thermal protection in the

form of a liquid applicator or spray have been proposed but none of these ideas have been brought to the commercial market. This particular project involves the development of a portable aerosol spray system that applies a thin glycerol coating to exposed skin. Microbeads are suspended in glycerin, a non-evaporative, non-toxic, skin-safe fluid and will generate sufficient heat to maintain skin at a reasonable temperature in order to prevent the onset of frostbite or skin damage in cold environments. The microbeads will be composed of a thin polymer shell, encasing a mixture of compounds that generate heat through an exothermic reaction. The exothermic reaction is triggered by an electric current in the aerosol dispenser at the time of application. The microbeads will be denser than the suspension fluid and will sink down into the fluid layer on the skin forming a layer that directly coats the surface of the skin. The heating effect will be sustained for an extended period of time by varying the polymer or glycerin coating thickness to control varying time release of heat from the microbeads.

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*Name:* "Elaina Griffo" <laineebabe08@aol.com>

*Class:* 2009

*Major:* Biological Engineering

Radiation therapy is one of the most widely used cancer treatments. Nevertheless, the treatment of certain malignancies remains problematic and the unwanted side effects (developing up to months or years after radiotherapy) caused by free radicals formed through ionizing radiation may be severe enough to compromise optimal radiation dose delivery and significantly reduce the quality of life of treated patients. Therefore, selective or preferential protection of normal tissues is an attractive potential approach to improve radiotherapy. Researchers at M.D. Anderson Cancer Center Orlando in collaboration with Dr. Sudipta Seal's laboratory at the University of Central Florida Advanced Materials Processing and Analysis Center are investigating new approaches to free radical scavenging and radioprotection using nanotechnology. We have identified that cerium oxide nanoparticles (free radical scavengers) protect normal but not cancer cells from radiation, which leads to a novel approach to increase the efficiency and decrease the side effects of radiation therapy for cancer patients. Preliminary studies show that the use of a cerium oxide nanoparticle, nanoceria, confers protection to normal cells against radiation-induced cell death. The current research plan investigates the ability of cerium oxides doped with neodymium (Nd) and Europium (Eu) to more effectively protect normal cells from radiation induced damage than undoped nanoceria. Nd and Eu-doped cerium oxides were tested in a number of biological systems and were shown to increase radiation sensitivity in a variety of human cancer cells and are currently being tested in an orthotopic murine model of human pancreatic cancer. In the end, we hope to show that the use of nanoparticles (i.e. doped cerium oxides) can provide a tool to intervene with biological functions that may enhance the radiation treatment and confer radiation protection to normal tissues in cancer patients treated with radiation.

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*Name:* "Scott Jordan Pilla" <sjp48@cornell.edu>

*Class:* 2008

*Major:* Biology major, concentration in Genetics and Development

*Poster Title:* Epigenetic effects of the Y Chromosome on Position Effect Variegation in *Drosophila melanogaster*

Position effect variegation (PEV) is the differential silencing from cell to cell of a gene brought near to a euchromatin/heterochromatin boundary. This study seeks to determine the extent of variation in PEV generated by natural variation in the *D. melanogaster* Y chromosome. This will be accomplished by quantifying the expression of genes undergoing PEV across a background of 92 Y-replacement lines which have Y chromosomes from widely distributed natural populations but are otherwise genetically identical. Because the Y chromosome does not contain genetic modifiers of PEV, all variation seen is due to epigenetic effects. We will test whether observed variation is associated with the overall amount of heterochromatin present on the Y chromosome or *trans*-effects due to local chromosomal interactions by comparing the expression of two or more variegating genes at different X chromosome sites. If the ratio of expression of both genes is consistent across lines, the effect of gross heterochromatin level is responsible for the variation seen. Otherwise, variation is likely due to *trans*-sensing effects that contribute to the sites of the two variegating genes differently. Subsequently, we will quantify the Y heterochromatin of each Y-replacement line by TaqMan assays and test for association with PEV variation.

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*Name:* Jacquelyn Cafasso

*Class:* 2008

*Major:* Biological Sciences (program of study in microbiology)

*Group Members:* JACQUELYN CAFASSO (Cornell University, Ithaca, NY 14853) MARK CHANCE AND BABU MANJASETTY (Brookhaven National Laboratory, Upton, NY 11973).

*Poster Title:* Crystallization and Preliminary X-ray Crystallographic Analysis of the Archaeal Tryptophan Regulator, TrpY

The TrpY protein from the archaeon *Methanothermobacter thermautotrophicus* is a transcription regulator of the metabolically expensive tryptophan biosynthetic pathway. Although the *trp* genes in *Bacteria*, *Archaea*, and eukaryotes share a common ancestry, diverse mechanisms regulate their expression. The TrpR repressor in *E. coli* has been extensively studied, but the structure and mechanism for repression by the TrpY regulator from archaea remains unknown. Furthermore, TrpY shows very little sequence homology with the TrpR tryptophan regulator in *E. coli*, and although bioinformatics studies indicate that the fold is conserved among other archaeal transcription regulators, the sequence similarity to TrpY is nonetheless very low. Native crystals of TrpY were successfully grown in 0.1M sodium acetate and 1.6M ammonium sulfate at room temperature using the hanging-drop vapor diffusion method. Initial diffraction tests and the search for a suitable cryo-protectant were performed at beamline X3A of the National Synchrotron Light Source (NSLS). X-ray diffraction data was collected at beamline X29 of the NSLS to 2.9 Å resolution. Preliminary data analysis revealed that the crystals fall in the tetragonal space group with cell parameters  $a=b=87\text{Å}$ ,  $c=147\text{Å}$ . Methods to solve the structure of TrpY using heavy atom derivatives are currently underway. Using crystallographic X-ray analysis to solve the structure is important to gain insight into the TrpY mechanism of repression as well as important features of transcription regulation and evolutionary history in the Archaea.

This project is a small portion of a larger project under investigation in collaboration with the Department of Microbiology at The Ohio State University.

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*Name:* "Paul clerkin" <paulclerkinemail@yahoo.com>

*Poster Title:* Movement of Sub-Adult Striped Bass (*Morone saxatilis*) within an Estuarine Ecosystem

I compared the movements of sub-adult striped bass, *Morone saxatilis* with that of the adults in the Mullica River-Great Bay estuary in southern New Jersey. I used ultrasonic telemetry, both mobile and fixed listening stations to track fish tagged with acoustic transmitters. The movement of sub-adult bass's was not similar to that of adults. Sub-adults occupied different areas of the Mullica River-Great Bay estuary from adults. The spatial separation by age with this species seems unrelated to water temperature or salinity. Geography (i.e., river vs. bay) appears to be the sole correlate of the age segregation of this species. This suggests a behavioral, rather than physiological explanation of the age separation, in which older, larger fish exclude, smaller, younger fish from prime feeding habitats. Such competitive exclusion based on dominance of prime territory by adults would effectively separate the species into two-habitat utilization patterns based on age. Given that the diet of younger bass differs from that of adults, and that only after two years are striped bass considered fully piscivorous, spatial separations could have diet related variables as well. Further investigation is warranted.

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*Name:* "Michelle Cheng Tong" <mct44@cornell.edu>

*Class:* 2010

*Major:* Biology

*Poster Title:* Rac Effector Protein and the Activation of Nuclear Cap-binding Complex

Rac is a small G-protein that is a member of the subfamily Rho-GTPase, which is part of the superfamily of Ras. The ongoing project was to explore and attempt to find the Rac effector protein which couples Rac with a signal transduction pathway which ultimately impacts nuclear RNA processing through activation of the nuclear cap-binding complex (CBC). This will be accomplished by observing which mutations within the effector loop of Rac attenuate the signal propagation to the CBC. We will be able to learn more about Rac by observing the effect of specific mutations on the signal transduction pathway. Whether a particular mutant causes the pathway to discontinue may also give clues as to which direction to take when looking for the next protein of interest.

The effect of the mutants can be observed through the activation state of proteins downstream in the CBC signaling pathway. The activation of these proteins in cells (e.g. the phosphorylation state of S6 kinase and mTOR) indicates that the pathway was not obstructed whereas an inactivation indicates that that particular mutant caused the pathway to be blocked. The specific mutation can then help one locate the crucial step in the pathway. Data as to whether or not these proteins are activated can be determined by transfecting different Rac mutants into cells, and then observing the phosphorylation state of the proteins of interest by Western blotting lysates collected from these cells. The mammalian cancer cell line, HeLa, was used in the study,

and maintained through routine cell passage techniques. In summary, the project attempts to identify the Rac effector which is a critical component of a novel signaling pathway to the CBC using cell culture, Western blots, and other techniques.

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*Name:* "Matt St. Cyr" <mks42@cornell.edu>

*Class:* 2009

*Major:* Chemical Engineering

*Poster Title:* Swarming of \*Proteus mirabilis\* Across Anhydrous Surfaces

Bacterial swarming is of particular relevance in medicine, especially infectious disease control. For example, *Proteus mirabilis* are able to swarm onto urinary tract catheters and subsequently form biofilms that cause infection. The standard laboratory protocol for assaying the swarm patterns of *P. mirabilis* is on a hydrated agar surface.

It has been suggested that water activity regulates the morphological cycle of *P. mirabilis* – the transition from the cell replication state to the swarm state. As the colony depletes water that diffuses through the agar, the cells increase in size and hyper flagellate in order to advance rapidly to hydrated areas. Swarming, therefore, is initiated by low water concentration. It has been observed in medical studies that *P. mirabilis* is able to traverse silicone catheters, but how far can the colony swarm under such anhydrous conditions?

To answer this question, we will construct ceramic bridges that connect agar zones and attempt to observe growth on the opposite side of the bridge. Based on the water-dependent model, growth across the bridge should be nonexistent. *Proteus mirabilis* will be able to traverse the bridge because the increasing cell density at the boundary will force the colony to attempt a crossing or perish. We will test this idea using various bridge types and sizes coupled with optimized growth conditions (1.5% LB agar plates, 30 °C) that we have previously determined.

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*Name:* "Andrew Adam Davis" <aad43@cornell.edu>

*Class:* 2009

*Major:* Biological Sciences, Neurobiology & Behavior concentration

*Group Members:* Nozomi Nishimura, Brian Lee, Marina Debra Ramirez, Moonsoon Jin, and Chris B. Schaffer

*Poster Title:* Femtosecond laser-based optoporation for DNA transfection in single, targeted cells

Current transfection techniques for inserting exogenous DNA into cells offer high throughput but little or no targeting capability. Furthermore, no technique allows for the possibility of selective membrane perforation for transfecting single cells *in vivo*. We use femtosecond duration laser pulses to optoporate the membrane of a specifically targeted cell to allow normally membrane-impermeable material, such as DNA, to enter into the cell. To evaluate optimal laser conditions, we relied on uptake of ethidium bromide (EtBr) dye after optoporating cells *in vitro*. We found that we could transiently disrupt the membrane of a specifically targeted HeLa cell, allowing the EtBr into the cell. The cell membrane rapidly resealed, leaving the cell intact. Using best-choice laser parameters determined from the EtBr experiments, we optoporated cells in the presence of

a DNA plasmid that coded for the production of green fluorescent protein (GFP). Two-photon microscopy images confirmed that optoprated cells were healthy and found to express GFP 24 hours after optoporation, while non-targeted cells showed no expression. In addition to *in vitro* experiments, we have further demonstrated transient membrane permeabilization in targeted neurons in mouse brain, opening the door to targeted transgene expression *in vivo*.

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*Name:* "Sungsoo Lee" <sl453@cornell.edu>

*Class:* 2009

*Major:* Materials Science & Engineering

*Poster Title:* Spray-Deposited Organic Solar Cells

Currently, the world depends on fossil fuels to gain most of its power. However, burning fossil fuels releases an enormous amount of carbon dioxide, which causes air pollution, greenhouse effect, and global warming. Furthermore, the supply of fossil fuels is limited. The challenge is to find a non-hostile, alternate source of energy that has a high or unlimited supply with a low cost to be accessible even for developing countries. Among the renewable energies being used, solar energy is the most underused source. Currently, more than 85% of the photovoltaic (PV) cells involve silicon. Despite its high efficiency of over 20%, silicon-based PV cells costs too much in production and lack flexibility. Thus, researchers are focusing on organic semiconductors to create flexible, lightweight, and inexpensive PV cells.

Organic PV (OPV) cells have advantages because they can be coated on plastic materials, not just glass. OPV cells are composed of electrodes and semiconducting layers that are either spin-coated or deposited via thermal evaporation. However, spin-coating can only be done on small surface areas, and thermal evaporation is complicated for mass production. Early this year, I have proposed an alternate method of spray-coating, which is well suited for manufacturing large area cells. The new method will also offer the possibility of using spray cans to make large solar cells anytime and anywhere, even in emergency situations like a hurricane where power is needed in damaged areas.

During the Fall semester of 2007, I was able to identify suitable conditions to produce the organic semiconducting film by spray-coating deposition, with a power conversion efficiency of 2.15 %. Continuous research is needed to improve the efficiency. Furthermore, in order to spray-coat a complete OPV device, more work is necessary to determine suitable conditions to spray-coat the other layers of the device. I am also working on fabricating a completely new device structure of OPV cells, while incorporating the spray-coating method.

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*Name:* "Ben" <bds46@cornell.edu>

*Group Members:* Benjamin Solomon, Jeffrey Mills, Margaret Bynoe Cornell University, Veterinary Medical College, Department of Microbiology and Immunology, Ithaca, NY 14853

*Poster Title:* The Immunosuppressive Effects of Neuropilin-1 in a Mouse Model of Multiple Sclerosis

Experimental autoimmune encephalomyelitis (EAE) serves as an animal model for the CNS inflammatory disorder multiple sclerosis (MS). These diseases are characterized by uncontrolled attack of the body's own CD4<sup>+</sup> T cells on the myelin sheath of neurons, leading to impaired cognitive and motor function. We have previously shown that mice epicutaneously immunized (ECi) with myelin oligodendrocyte peptide (MOG), the same peptide used to induce EAE, prior to disease induction are protected from disease pathogenesis. To determine the cause of this protection, we performed microarray analysis on such ECi mice in order to identify altered gene expression. Of the most differentially regulated genes was neuropilin-1 (*Nrp1*), a well known neuronal receptor. While *Nrp1*'s role in axon guidance is well defined, its potential role in immune regulation has only recently been noted. To this end, we sought to further elucidate the role of *Nrp1* in EAE. We confirmed our microarray findings through RT-PCR, additionally showing that *Nrp1* expression in ECi mice was even higher than that of T<sub>reg</sub> cells. Additionally, we found that mice altered to overexpress *Nrp1* in CD4<sup>+</sup> cells were protected against EAE and in mice lacking *Nrp1* EAE progression was consequently more severe. Furthermore, we observe increased CD4<sup>+</sup> cell infiltration into the CNS of conditional knockout mice compared to wild type. Taken together, *Nrp1* appears to play an important role in the suppression of autoreactive CD4<sup>+</sup> cells and may represent a novel target for future treatment of MS.

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*Name:* "Naweed Paya" <nap33@cornell.edu>

*Class:* 2009

*Major:* Electrical & Computer Engineering, Biological Engineering

*Poster Title:* Microelectromagnetic Cell Positioning On Active Electrode Array

Neuronal function and cellular release mechanisms are of great importance in understanding human health and certain neurological diseases including Parkinson's disease. Various types of devices have therefore been developed so far to study such release mechanisms. Although these compact on-chip systems allow for fast, repeatable biological experiments at low cost with only a small amount of biological sample, one of their main difficulties is positioning and manipulating the individual sample cells with high precision at the microscopic scale. The techniques currently in use for single-cell isolation and manipulation include optical tweezers and dielectrophoresis. However, these techniques are far from ideal; one has a tendency to damage the cell surface, while the other introduces excessive signal noise.

In this project, we demonstrated the concept of using a microelectromagnet matrix to magnetically manipulate paramagnetic beads. The device consists of an array of lithographically defined Platinum wires on a glass substrate. Passing sufficient amounts of current through these wires creates localized magnetic field patterns that can be configured to precisely manipulate beads at the microscopic scale. The device can theoretically control almost any kind of particle with a magnetic moment, including biological cells attached to paramagnetic beads. In future, such a device can be integrated with on-board electronics, such as electrodes and amplifiers, which would allow for simultaneous positioning of cells as well as real-time measurements of cellular activity. In addition, it can also be used to assemble artificial tissues and investigate intercellular communications.

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*Name:* "Yemsrach Kasegn Tekletsadik" <ykt2@cornell.edu>  
*Class:* 2010  
*Major:* Biological Engineering

Differentiation into a multicellular organism is the product of both cell growth and cell division. The determinants of this include extrinsic signals such as nutrients and growth factor as well as intrinsic signals produced by the actions of evolutionarily conserved multiprotein complexes involved in the decoding, propagation, and transmission of these signals. The current research project focuses on how yeast Iqg1p and mammalian IQGAP1 coordinate cell growth with cell division. Previously we have shown that Iqg1p is required for axial budding and interacts with other proteins to control cell polarity and cytokinesis (Osman MA et al, 2002). Dysfunction of such signal-controlled processes leads to developmental errors and a myriad of pathological conditions. Thus, studies on these important signaling networks that aid in regulating cell polarity and cytokinesis in yeast may lead to the development of more efficacious or novel drugs for the treatment of relevant diseases such as cancer, diabetes, inflammation, obesity, aging and schizophrenia.

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*Name:* "Samantha Nicole Passman" <snp23@cornell.edu>  
*Class:* 2010

*Major:* Civil and Environmental Engineering

*Group Members:* Passman SN\*, Ducharme NG\*\*, Rawlinson JJ\*\* \*Civil and Environmental Engineering, College of Engineering \*\*Clinical Sciences, College of Veterinary Medicine

*Poster Title:* Mechanical Testing of Equine Laryngeal Cartilage

Upper airway obstruction caused by recurrent laryngeal neuropathy is a common cause of poor exercise performance in horses. A common surgical correction for the collapse of the arytenoid cartilage is prosthetic laryngoplasty, a tie-back procedure that loops a suture through the arytenoid and the cricoid cartilage in the larynx. Clinical failure, the inability to maintain abduction, is often due to local failure within the cartilage as the suture can loosen or tear. We are calculating the tissue properties of the cricoid cartilage with confined compression and flexure tests in an electromagnetic test frame. The tissue samples are harvested from various regions within the larynx to obtain a spatial map of the equilibrium modulus and bending stiffness. Initially, these values will provide input for structural models of airway support and data for comparative testing with human laryngeal research. Failure testing will then allow for the tissue-implant interaction to be modeled with greater accuracy.

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*Name:* "Adam Shai" <ass42@cornell.edu>

*Class:* 2009

*Major:* Biological and Environmental Engineering

*Group Members:* Jong Bum Lee

*Poster Title:* Three Dimensional Structure, Thermal and Energetic Properties of Engineered DNA

DNA is the basis of modern biology and genetics. However, in recent years advances in chemistry and engineering has allowed for the use of DNA as a generic structural material instead of a genetic material. This new frontier is already seeing major practical uses in many fields such as DNA computing, biosensors, drug delivery systems, and various other nanotechnological devices. In order to delve further into the field of nucleic acid engineering, a complete and thorough understanding of the basic structural motifs of engineered DNA, Y-shaped, X-shaped, and dendrimer-like-DNA, is needed. In this study we explore the three dimensional structure and thermal properties of these motifs using fluorescence resonance energy transfer techniques. In addition, combining concepts from molecular dynamics, ab-initio quantum methods, and the nearest neighbor model for DNA energetic, will allow for a novel governing energy equation for engineered DNA. This new energy model will take into account structural differences in DNA which have up until now been completely neglected from any equation of DNA energetics. Using this new equation will allow computer simulations involving any engineered DNA along with other know materials to be carried out, as well as shedding light on the complicated behavior of these new materials.

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*Name:* "Ho-Jun Suk" <hs284@cornell.edu>

*Class:* 2008

*Major:* Electrical and Computer Engineering

*Poster Title:* Spatial Manipulation of HeLa cells using Reusable Electrodes fabricated on Printed Circuit Board

Numerous research projects have shown that spatial manipulation, discrimination, separation, and fractionation of neutral particles, especially cells, can be easily achieved using dielectrophoresis. By applying non-uniform AC signals to electrode patterns fabricated on a glass substrate, regions of high and low electric field are created. These regions of electric field either attract or repel the cells and ultimately lead to an adhesion of cells onto the edges of the electrodes or glass substrate, forming desired patterns. Unfortunately, methods used in the previous studies are not practical for multiple experiments, because cells that are attached to the electrodes or glass substrate are difficult to remove, making the biochip unusable after a single experiment. Furthermore, electrode fabrications on glass substrates require much time and effort. In this paper, a novel method of spatial manipulation of HeLa cells is demonstrated. In order to prevent the HeLa cells from attaching to the electrodes, very thin glass coverslip is placed on top of the electrode patterns. The glass coverslip, with a PDMS open-well attached on top, serves as an adherent surface for HeLa cells that are suspended in a low conductivity medium. Even though glass attenuates the effect of dielectrophoretic force, with large enough AC signals, it is shown in this paper that HeLa cells rapidly form desired patterns. Since the cells adhere to the glass coverslip instead of the electrodes, multiple experiments can be easily performed by simply replacing the old coverslip with a new coverslip. It is also demonstrated that electrode patterns fabricated on printed circuit boards work perfectly for dielectrophoresis experiments. Since electrode fabrications on printed circuit boards are much easier and faster than electrode fabrications on glass substrates, the new method demonstrated in this paper is more practical than the methods used in previous research projects.

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*Major:* Geology and Evolutionary biology

*Poster Title:* ESCALATORY INCREASE IN DUROPHAGOUS PREDATION DURING AN EXTINCTION EVENT

A Late Pliocene extinction event in tropical American marine ecosystems selected against seagrass-associated gastropods with narrow or thick-lipped apertures (Vermeij and Petuch 1986). Our work examined a seagrass-associated predatory snail *Phyllonotus* (Muricidae) from the middle Pliocene Tamiami Fm., the late Pliocene Caloosahatchee Fm., the early Pleistocene Bermont Fm., and the late Pleistocene Fort Thompson Fm. Fossilized *Phyllonotus* show trace fossil evidence of predation attempts by crabs, octopi, and other gastropods that change frequency through the extinction period. We measured body size and analyzed predation trace fossil data for 1591 *Phyllonotus* shells. Data from each interval were organized into two shell length classes (class 1: 20-40 mm, class 2: 40-60 mm), so that trends within larger or smaller classes could be examined independently.

Octopus drill holes decrease through the extinction from 17% in the Pinecrest to 11% in the Caloosahatchee, 6% in the Bermont, and 3% in the Fort Thompson. This decrease in octopus drilling attacks on *Phyllonotus* is consistent with a decrease in selection by enemies, but patterns of shell repair are not. Shell lip repair increases from a frequency of 9% in the Pinecrest to 32% in the Fort Thompson. Siphonal canal repair scars show a similar increase, with 10% of shells scarred in the Pinecrest increasing to 16% in the Fort Thompson.

Increased repair from durophagous predators could mean that snails became more proficient at surviving attacks (or predators became less adept at prey handling) after the extinction. However, *Phyllonotus* snails also decreased in size and thickness (i.e., became more poorly defended) after the Pliocene. A more likely explanation is that attacks by durophagous predators actually intensified after the extinction. Similar trends in repair frequencies in other gastropod lineages suggest to us that this pattern of escalation during an extinction is real and a pervasive feature of this event.

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*Name:* "Caroline Marie Berglund" <cmb249@cornell.edu>

*Class:* 2010

*Major:* Biological Engineering

*Group Members:* Berglund, Polacheck, Lee, Gleghorn, Bonassar, Kirby

*Poster Title:* Synthesis of Photocrosslinked Alginate Hydrogels for Tissue Engineering

Alginate hydrogels are an ideally suited material for designing tissue scaffolds because they are biodegradable, biocompatible and serve as a convenient 3D matrix for a number of cell types. Typically, these alginate hydrogels are formed via ionic crosslinking with the addition of calcium ions. While this method has its benefits, the required use of calcium limits user flexibility in terms of fixed charge density, calcium concentration, and the kinetics of polymerization. Photocrosslinking, common in many materials such as PEG-dimethacrylate, is a potential alternative means of gel fabrication that provides more user flexibility. These methods can be limited, as acrylate materials are not biodegradable and most photoinitiators are cytotoxic to

mammalian cells. To address these limitations, we have developed a photocrosslinked alginate hydrogel matrix that combines the biodegradability of alginate with the flexible kinetics of photopolymerization, and identified a photoinitiator that can be used with approximately 85% viability for primary bovine chondrocytes. In this method, the alginate backbone is modified with the addition of methacrylate groups in place of secondary alcohols. With the addition of an azo photoinitiator and exposure to ultraviolet light, the hydrogels are crosslinked via free radical polymerization of the methacrylate groups. We have successfully synthesized methacrylate-modified alginate gels and are able to adjust their modulus by varying UV exposure time and photoinitiator concentration. These modified hydrogels have been shown to be biocompatible, having viabilities in the range of 85%-90% for primary bovine chondrocytes. This novel technique of photocrosslinking alginate hydrogels has many potential applications, such as in studying the role of modulus and the effects of streaming potentials in cell-seeded tissue constructs.

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*Name:* "Kenneth J. Sauer" <kjs55@cornell.edu>

*Class:* 2008

*Major:* Biological and Environmental Engineering

*Poster Title:* Block Copolymer Synthesis with Fuel Cell Applications

Fuel cell technologies are emerging as a means of efficiently converting energy into electricity, which is especially crucial today given the declining global supply of fossil fuels. Any improvements on fuel cell catalysis – which largely governs fuel cell efficiency – could carry significant implications in the future energy scheme.

Kenneth Sauer (Department of Biological and Environmental Engineering, '08) is working with graduate student Morgan Stefik and Professor Uli Wiesner (both in the Department of Materials Science & Engineering) to develop innovative materials for fuel cell electrodes derived from block copolymers, a class of macromolecules that can be fashioned through a combination of two or more chemically distinct polymer blocks (a polymer block is a linear series of identical monomers). The connected, individual polymer blocks are oftentimes thermodynamically incompatible with one another, leading to block segregation on the molecular scale of 5-100 nanometers and thereby producing astonishingly complex nanostructures.

Recent advances in synthetic chemistry have exposed a new opportunity for combining multiple blocks that would theoretically generate molecular architectures fit for producing exquisitely structured materials for fuel cell electrodes. The structures would be endowed with tailored mechanical, electrical, ionic, barrier, and other physical properties, each of which would improve catalysis in fuel cells and, therefore, increase overall fuel cell efficiency.

Using these newfound techniques, the project at hand seeks to modify commercially available ABA triblock copolymers so that another block can be grown from each end, resulting in a CABAC pentablock terpolymer after a single polymerization. Several of these polymers with varying weight fractions are being manufactured and combined with transition metal oxides such as titania, niobia, etc. Since the C block is polyacrylonitrile, the resulting materials could be turned into conducting carbon/transition metal oxide composites with porosity. This would

combine materials with electrical conductivity with materials that enhance catalytic activity, yielding electrodes with theoretical efficiencies exceeding those of current technologies.

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*Class:* 2009

*Major:* Biological Engineering

*Poster Title:* Sequencing the Genome of the Ithaca Crow Pox Virus

The avian pox is a disease that infects birds. It is caused by the *avipoxvirus* and can have mild to severe effects. Symptoms indicating that the pox virus may be present include weakness, emaciation, breathing and vision problems, and lesions that occur on the unfeathered parts of the body. Three common strains of the *avipoxvirus* have been identified: fowl pox virus, pigeon pox virus, and canary pox virus. This research study focuses on isolating a new strain of the virus: crow pox virus. In Ithaca, crows have been identified lesions characteristic of avian pox. The overall goal of the study is to sequence the genome of the virus found in crows with pox lesions in order to determine whether it is the same as any existing *avipoxvirus* strains or a new strain altogether. To achieve this goal, chicken embryos are inoculated with the suspected pox virus in an attempt to grow it in the chorioallantoic membrane. This tissue is then harvested and the DNA extracted for PCR which uses the fowl pox vaccine as a positive control for the virus. Once PCR confirms that pox virus has grown successfully, the genome will be sequenced and compared to other *avipoxvirus* strains.

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*Class:* 2009

*Major:* Biological and Environmental Engineering

*Poster Title:* The Role of Periostin in the Progression of Atherosclerosis

Periostin is an extracellular matrix protein that undergoes dramatic upregulation in a many cases of vascular disease. Its role in atherosclerosis is not completely understood. This research project is interested in the effect of periostin deficiency on the progression of atherosclerosis. Our hypothesis is that periostin deficiency would result in the delayed onset and reduced severity of the disease. Our experiment begins with breeding Apolipoprotein E (ApoE) null mice with periostin null mice to create mixed genotypes. (ApoE null mice are currently the standard model for atherosclerosis research.) These offspring are then given a high fat/ high cholesterol diet that models a typical North American diet. At around thirty weeks, these mice are sacrificed so that histology can be performed. Cross sections of the heart valves and the aorta from each genotype will be compared to determine how periostin contributes in the progression of this prevalent disease. Understanding the role of periostin can lead to new methods of treatment for atherosclerosis through targeting this matrix protein.

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*Class:* 2009

*Major:* Biological and Environmental Engineering

*Poster Title:* Purification and Production of ICAM1-D1 and I Domain complex

In autoimmune-related diseases, cell adhesion molecules such as integrin are important therapeutic targets in autoimmune-related disease. Integrins consist of subunits with multiple modular domains which one or two domains serve as ligand-binding sites. Integrins exhibit allosteric conformation induced by ligand binding to integrins via outside-in signaling. In this research, inserted ligand binding domain, or I domain with a ligand ICAM-1 is extensively studied in order common colds caused by human rhinovirus. A binding site for rhinovirus in ICAM-1 is limited to N-terminal domain, D1 which is by itself not stable. With identified mutations that enable the production of D1 from bacterial expression system, ICAM-1 was shown to be effective in preventing rhinovirus infection. Its instability and its high cost of production using mammalian cell is improved by mutations and low-cost and large-scale production from bacteria in a complex with I Domain. The goal of this research is to use this D1 for obtaining a high-resolution structure of rhinovirus bound with D1 to facilitate developing small molecule drug that inhibits rhinovirus infections. Using version of D1 produced previously that contains the mutations: Q1M T2V T23A I10T P38T P63V S67A T78A, with I domain mutant F252S/F292A, both proteins are cloned into pET20b. ICAMD1 transformed into BL21 DE3 cells and I Domain is transformed into BL21 DE3 cells in order to form a purified protein.

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*Name:* "Peter Asciello" <pja9@cornell.edu>

*Class:* 2008

*Major:* Biological and Environmental Engineering

*Poster Title:* Rapid prototyping of polymer microchannels with application in the development of micro-total analysis systems for pathogen detection

A method to reproduce microfluidic devices inexpensively is essential in the development of disposable micro-total analysis systems ( $\mu$ TAS) to be used in pathogen detection. Polymer biosensors were produced by hot embossing poly(methyl methacrylate) (PMMA) with a copper template on which raised channel features were electroplated using a thick KMPR resist mask as a pattern. This template served as a much better alternative to silicon templates, releasing easily from PMMA during de-embossing and reducing embossing time by 75%. The copper template also held up well and did not fracture during de-embossing, which is a common problem with silicon. The utilization of the copper template allowed for the rapid, inexpensive production of PMMA microchannels. Microchannels produced by this method were used to successfully isolate mRNA from *Cryptosporidium parvum*, a waterborne protozoan parasite. Currently, we are working towards the amplification of this mRNA by nucleic acid sequence based amplification (NASBA) and electrochemical mRNA detection in the same channel. The combination of sample isolation, amplification, and detection on a single, disposable, microfluidic chip will produce a micro-total analysis system that will be faster and easier to use than current laboratory methods and can be utilized in the field for on-site pathogen detection.

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*Name:* "Viraj Mehta" <vjm8@cornell.edu>

*Class:* 2008

*Poster Title:* Bacterial Artificial Chromosome: A novel method for recombination-mediated genetic engineering (Recombineering)

Recombineering is a powerful method for manipulation of a mouse genome. Recent advances in bacterial artificial chromosome (BAC) transgenesis have permitted a more efficient method of genomic manipulation than traditional artificial promoter constructs. BACs utilize very large genomic sequences of 100kb to 200kb, which ensure that extensive regulatory elements of the gene of interest are included and allow for effective expression of the gene of interest in a mouse. This project utilizes a BAC that codes for the Acta2 gene, ie the gene that codes for alpha-Actin, a cytoskeletal protein found in muscle cells. The Acta2 BAC is engineered through homologous recombination to include a sequence that codes for the fluorescent protein, GFP, which has been altered to only fluoresce in the presence of calcium ions. The benefits of this transgenesis are many. Once successfully incorporated into a mouse genome, specific smooth muscles will be fluorescent under a specific wavelength of light and in specific concentrations of calcium. Calcium ions are use in intracellular signaling. This study will help further the understanding of vascular smooth muscle development.

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*Name:* "Ajinkya Rane" <aar38@cornell.edu>

*Class:* 2009

*Major:* Biological Sciences

Heart disease is one of the leading causes of death in today's age. Using the latest equipment, it is being attempted to find a cure for Hypoplastic Left Heart syndrome and other congenital heart diseases. Chick and Quail hearts will be used for the initial testing. In order to do so, an egg-less chick culturing system was developed. Thus, in vitro modification of the heart will be performed in embryos in which congenital heart diseases are induced. The research is 3-fold, using micro CT, ultrasound, and a titanium sapphire laser. The laser will be used for imaging at the micron scale. It will also be used for cardiac aberration of tissues as a viable treatment. This can lead to changes in the developmental pattern of the heart. Ultrasound in conjunction with micro CT will then be used to model the changing blood flow and cardiac volumes. The ultimate goal is to transfer such technologies to human embryos to cure congenital heart diseases.

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## Miscellaneous Abstracts

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*Poster Title:* Progress Toward a Platform for Studying Neural Coding of Vision: Recordings from a Flexible, Transparent Multielectrode Array

This work is related to the efforts of the Boston Retinal Implant Project to develop a sub-retinal prosthesis to restore vision to the blind. The specific purpose of this work is to develop and characterize a flexible recording electrode array capable of transmitting a substantial fraction of incident light energy. This array has been used for acute *in vitro* experiments, and will be used chronically as part of a telemetry system reporting retinal ganglion cell output in free-roaming animal studies. A polyimide microfabrication process was used to create a flexible, freestanding array matrix within which indium tin oxide (ITO) electrodes were embedded. Patterning was performed by forming a sacrificial amorphous carbon layer on top of the ITO film, creating the array structure photolithographically, etching the carbon mask layer, and then transferring this pattern into the underlying ITO by Ar ion milling at 500V DC bias. The recording array has folding umbrella-like sections and a central retinal tack hole. Substantially transparent ITO conductors have been formed into 420-electrode, 9 mm diameter flexible prototype recording arrays for acute studies (see Figure; 16 sites were connected in this design) and for future chronic epiretinal placement. The device is intended to be used for recording in awake animals in conjunction with a subretinal stimulating electrode array to study the correlation between artificial percepts resulting from coded electrical stimuli, and those arising from naturally occurring visual inputs. In conclusion, part of a flexible platform for studying the neural code for vision has been developed in the form of a flexible, mostly transparent epiretinal recording electrode array that subtends a substantial visual angle. The arrays have been used for *in vitro* experiments, and will potentially be used in free-roaming animal studies.

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*Group Members:* Adrien Phalen (General Biology, 2008), Ron Wexler (General Biology, 2008), and Ned J. Place M.D., Ph.D.

*Poster Title:* Modulation of Uterine Development by Day Length in Siberian Hamsters.

In Siberian hamsters, day length is a significant modulator of uterine development. Photoperiod-induced differences in uterine size are inferred to result from decreased estradiol (E2) levels in short days (SD), because a longer duration melatonin (MEL) signal suppresses gonadotropin release. However, investigators have reported higher E2 levels in SD hamsters, with particularly high levels at 4wk of age. Therefore, we validated a radioimmunoassay to measure serum E2 in hamsters, and found no difference in circulating levels in long day (LD) and SD females at 4 wk. At this same age, mean uterine mass was significantly greater in LD than in SD (30.3 and 14.1 mg, respectively). Because E2 stimulates uterine growth, we are investigating why the uterus is smaller in SD than in LD. There was no major difference in estrogen receptor-alpha (ER $\alpha$ )

expression by immunohistochemistry in 4 wk-old LD and SD uteri. Since serum E2 concentration and differential ER $\alpha$  expression may not explain differences in uterine size, the inhibitory effect of MEL on ER $\alpha$ -dependent DNA transcription is being considered as a possible mechanism. MEL is secreted in higher concentrations and for longer durations in SD, and this is a plausible mechanism by which E2-dependent growth is mitigated.

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*Group Members:* Christopher T. Cheng, Donald L. Bartel

*Poster Title:* THE EFFECT OF DIRECTIONAL MECHANICAL PROPERTIES ON LOAD TRANSFER DISTRIBUTION—A FINITE ELEMENT STUDY

Aseptic loosening is a serious complication in elbow arthroplasty that can lead to failure of the bone-implant system. The likelihood of failure can be reduced by optimizing the load transfer distribution of the system. It may be possible to influence load transfer by employing new laminar manufacturing techniques to control mechanical properties along the length of the implant in the radial and longitudinal directions. The goal is to maintain natural bone loading by maximizing axial load transfer in the region near the joint and minimizing load transfer in the region away from the joint. To investigate the effect of mechanical properties on load transfer, a 3D idealized planar-symmetric finite element model of a stemmed humeral component for an elbow replacement was created. Because load transfer is also affected by the overall implant geometry, a parametric study was performed to investigate the effects of varying the axial Young's modulus of the implant in conjunction with other design variables such as stem length ( $SL$ ), diameter ratio ( $\alpha$ ), and thickness of the porous layer ( $t$ ). The preliminary results show that stem length has a greater influence on load transfer than the Young's modulus of the porous layer.

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*Group Members:* Jennifer Shum, Nozomi Nishimura, Joseph Fetcho, Chris Schaffer

It still remains a difficult task to determine how neural circuitry encodes behavior. A common method is to lesion neurons and then observe the functional consequences. However, removing entire neurons can have far-reaching and difficult to interpret effects; killing a neuron removes a node from a highly interconnected network, abolishing all information flow into and out of the neuron. A more precise intervention would be to snip individual wires in the neural circuit, blocking information transmission at specific cut-points without killing cells. We accomplish this using femtosecond laser ablation as an *in vivo* light scalpel with submicrometer precision. In zebrafish larvae, a transparent vertebrate animal model, we have successfully cut the lateral dendrite of the Mauthner neuron while leaving the neuron functional. The Mauthner neuron is a cell that triggers a fast start escape behavior, causing the zebrafish to swim away from a threatening stimulus with reaction times of less than 10ms. By studying changes in the escape behavior after cutting the lateral dendrite, we can determine the mechanisms by which this cell incorporates stimulus information and triggers an escape response.

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The ability to produce industrially significant platform chemicals from renewable resources is incredibly important. One such chemical is 3-hydropropionic acid, a chemical that has several useful derivatives including acrylates. By producing 3HP acid in a recombinant platform host, *E. coli*, products such as the polymers used to make contact lenses can be produced without using petroleum. However, wild type *E. coli* demonstrates a significant decrease in specific growth for extra cellular 3HP acid levels over 10 g/L. This study uses High Performance Liquid Chromatography to examine 20 *E. coli* clones that exhibited increased 3HP acid tolerance in continuous flow selections. The extinction coefficients and retention times were found for nine fermentation products of *E. coli*. These were then used to identify and analyze the products produced by the 20 clones. Additionally, a transport study was conducted on the 20 tolerant clones to determine if there was an increase in transport ability over a time course. A number of clones were identified as good candidates for future study because they behaved significantly different from the vector.

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\* Biological and Environmental Engineering, College of Engineering

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Poster Title: A Biomechanical Model of Equine Laryngeal Support

In horses, recurrent laryngeal neuropathy and the subsequent muscular dysfunction cause airway collapse during exercise as the arytenoids fold into the opening to the larynx. We developed three-dimensional computer models to investigate the biomechanics of laryngeal cartilage. Seven consecutive magnetic resonance (MR) sequences of an equine larynx were obtained for increasing levels of arytenoid abduction. Each separate level of abduction was modeled using medical reconstruction software and then analyzed using kinematic analysis within a computer-aided design package. We calculated the amount of arytenoid motion for these levels of abduction at three anatomical landmarks and mapped the path of motion. These data will provide quantitative comparisons to clinical endoscopic measurements. Furthermore the model is being transformed to a finite element mesh with the goal of determining the amount of cartilage deformation and articulation.

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Name: "David Slottje" [dfslottje@gmail.com](mailto:dfslottje@gmail.com)

For the past two years I have been assisting Chris Wilson, a graduate student in the Cornell Neurobiology Department, with his doctoral research into Bdelloid rotifers. These microscopic creatures are among the world's smallest animals. They are also exceptional in two ways which are relevant to our research: they have reproduced asexually for tens of millions of years, and they are capable of entering into a dormant state, known as anhydrobiosis, when the water in their local environment evaporates.

The chief aim of our research is to explore the effect of anhydrobiosis on the relationship between the Bdelloids and their parasites, a genus of fungi known as Rotiferophthera. Last semester we discovered that the fungi can survive a brief period of desiccation along with the rotifers. This semester we will be exploring the effects of longer dry spells (ranging from one to ten weeks). We will also be researching the dispersal capacity of the anhydrobiotic rotifers and their parasites using a wind tunnel.

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While recent studies have shown how blood flow redistributes following the occlusion of individual cortical arterioles and capillaries, changes in circulation that result from the occlusion of an individual venule are poorly understood. We have developed optical techniques that allow us to study effects of individual venule occlusion in live, anesthetized rats. Vascular topology and blood flow was visualized with two-photon excited fluorescence microscopy of intravenously injected fluorescein-dextran. Blood flow velocity was determined by tracking the motion of red blood cells. Venule occlusions were induced in individual vessels by focusing high intensity, femtosecond laser pulses into the targeted vessel, perturbing the vessel lumen and initiating the natural clotting cascade. Measurements taken before and after the occlusion of an ascending venule i.e. a venule that connects cortical capillaries to surface veins, showed a reduction in blood flow in the underlying capillaries. After the clot, blood flow was maintained in the capillaries through a reversal in flow direction in at least one of the branches off the ascending venule (observed in 13 clots in 13 rats). For capillaries one to four branches upstream from the clotted venule, flow decreased to 61% +/- 10% (MEAN +/- SEM;  $p < 0.0001$ ) of the baseline value on average. This drop in blood flow speed suggests that venular occlusions perturb microvascular flow in adjacent capillaries. Such cerebral dysfunction could underlie the brain damage and cognitive disturbance associated with cortical vein thrombosis.

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*Poster Title:* Deregulation Of Cap-Mediated Initiation Plays A Role In The Malignant Transformation Of Cells

Deregulation of eukaryotic translation machinery has been implicated in several malignancies. Eukaryotic translation takes place through both Cap-dependent and Cap-Independent mechanisms. 5'Cap is a modified guanosine attached to the 5' end of eukaryotic mRNA which serves as a binding site for the initiation factor eIF4E. The Cap dependent mechanism, which is responsible for translation of 95-97% of all cellular mRNA involves scanning of mRNA for start codon nearest to the 5'cap. A mathematical model of cap-mediated translation initiation pathways was developed. The model parameters were chosen to mimic physiological time-

profiles for species in the initiation pathway and the system of equations was solved using ODE15s routine. Sensitivity analysis was also performed on the system to identify important or fragile reactions and species. Sensitivity analysis predicted that the majority of sensitive parameters involve pathways involved in the regulation of TOR kinase phosphorylation of eIF4E-BP. These findings are consistent with Bjornsti et al., who report that activation of TOR kinase is responsible for formation of many human carcinomas. Thus, sensitivity analysis in combination with mechanistic modeling of translation initiation was able to correctly discern sensitive mechanisms in the TOR kinase activation pathway whose deregulation is linked with several human cancers.

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*Group Members:* Georgette Tzatzalos, Mingxiao Deng, Rasa Zarnegar, and C. C. Chu

*Poster Title:* Poly (ester amide) Microspheres Conjugated With Lysine for Tumor Localization

Rapid advances in imaging technology have allowed physicians to detect non-palpable tumors at early stages. Tumor localization procedures for guidance during operation are difficult in various primary and metastatic cancers. As of today, biodegradable biomaterials have been explored as wound closure biomaterials, drug and gene carriers, surgical meshes for hernia and body wall repair, bone plates for fractured bones, and dental application. The objective of this work was to fabricate a novel class of biodegradable biomaterials to be used in the development of new diagnostic techniques to assist clinicians and surgeons in the management of small tumors. In this study, the biomaterial was composed of poly (ester amide) conjugated with lysine (PEA\_Lys). Hydrogels in the shape of microspheres were fabricated using the double emulsion technique where the oil phase of PEA\_Lys in chloroform was immersed into an aqueous solution of polyvinyl alcohol. This technique yielded particles with an average diameter of 500nm, and particles with the lowest tested lysine concentration (5%) had the most uniform morphology. During *in vitro* trials, PEA\_Lys microspheres conjugated with NHS-Fluorescein showed an affinity to human thyroid papillary, follicular, and anaplastic carcinoma cell lines. In addition, the toxicity of these particles to the cells was negligible. This process has potential to precisely identify tumor cells for subsequent margin excision of the tumor.

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*Name:* "Jae Youn Sarah Lee" <jyl35@cornell.edu>

*Group Members:* Jae Youn Lee, William Polacheck, Caroline Berglund, Jason Gleghorn, Lawrence Bonassar, Brian Kirby

*Poster Title:* Biological Characterization of Chondrocytes Seeded in Photocrosslinked Alginate Hydrogels

Tissue engineering involves seeding cells into engineered scaffolds that mimic the *in vivo* cell environment. Examination of cell-environment interactions in engineered scaffolds provides insight into cellular function in tissue and can inform the development of biomedical tissue therapies. Tissue scaffolding must be biocompatible to sustain cell viability and biodegradable to allow artificial matrix to be replaced with natural biosynthetic matrix. Our group has developed a protocol for synthesizing hydrogel tissue scaffolds by covalently crosslinking alginate through photopolymerization. This method integrates the biocompatibility and biodegradability of

alginate with the flexible kinetics of photopolymerization<sup>1</sup>. Although photopolymerization has been shown to be an effective technique for synthesizing hydrogel tissue scaffolds, little previous data exists on the behavior of chondrocytes in photopolymerized alginate scaffolds. In this work, we evaluate the performance of this scaffold seeded with primary bovine chondrocytes to examine the utility of these photopolymerized alginate scaffolds. Chondrocytes cultured in tissue scaffolds for varying durations were characterized using two methods: quantitative assessment of the viability with calcein AM and ethidium bromide staining, and visualization of the distributed GAG with safranin O histological staining. Our preliminary data demonstrates high cell viability in seeded alginate tissue scaffolds, and furthermore cells exhibit characteristic chondrocyte phenotype. We plan to continue our study to evaluate the behavior of chondrocyte tissue constructs when subjected to dynamic environmental stimuli such as applied stress.

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Cartilage, a connective tissue made up of collagen, proteoglycans, and chondrocytes (cartilage cells), has a slow response to injury. This often leads damaged cartilage to fill with fibrous scar tissue. Insulin-like growth factor-I (IGF-1) has been shown to improve cartilage repair *in vivo*. It stimulates the synthesis of various glycosaminoglycans (GAGs), encourages cell proliferation, and inhibits the degradation of proteoglycans in chondrocytes. KPLHALL, a peptide sequence derived from IGF-1 Binding Peptide, has been shown to non-covalently bind with IGF-1. The peptide was grafted to alginate, a low toxicity hydrogel, in an effort to encourage IGF-1 retention around the chondrocytes. In a three-week cell culture study, alginate beads containing chondrocytes were assayed for GAG and DNA at 1-week time intervals. The assays showed that increased peptide concentrations directly influence the production of GAGs, a sign of cell growth, metabolism, and the production of extra cellular matrix (ECM). In addition to the three peptide concentrations, the effect of five different IGF-1 concentrations was examined. While there is a slight positive correlation between IGF-1 concentration and GAG production, the trend is not as strong as that of peptide concentration and GAG production. Another clear trend is that of increasing GAG/DNA ratio over time for each peptide concentration. A repeat study to minimize variation and verify these correlations is currently underway.

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*Group Members:* Kalpana Pathak

The Cayuga Lake watershed has shown peaks of fecal coliform levels in the past several years, which has caused concern among the community. In order to address these concerns, a group of students from the ESW class at Cornell University formed a research team. The team goal is to devise an accurate and cost-effective method to determine the potential animal-sources of the fecal coliform peaks. This fall the microbial source tracking method used was DNA end-point polymerase chain reactions combined with gel electrophoresis. The investigation is being done in cooperation with various community groups: the Community Science Institute, the Cayuga Lake Watershed Network, and two of its subgroups, Fall Creek Watershed Committee and

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Salmon Creek Watershed Group. The efforts of the project are presently focused on Salmon Creek, a tributary within the northeast section of the Cayuga Lake watershed. The Salmon Creek community is concerned with contamination in their drinking wells, and human and cow are being investigated as the potential contamination sources. The results of the DNA analysis and re-evaluation of previous antibiotic resistance analysis (ARA) of the fecal contamination in the Cayuga Lake watershed will be presented.

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*Poster Title:* Vertically oriented germanium nanowires grown from biotemplated gold nanoparticle catalysts

In recent years, one-dimensional nanostructures, such as semiconducting nanowires (SCNWs) have been actively investigated due to their potential applications in field- and quantum-effect nanoelectronic devices. However, to realize the potential of SCNWs in such applications, ultrahigh-density SCNWs arrays with monodispersed diameters and spacing must be created and integrated into various device architectures. Biotemplating –a process that takes advantage of the structural specificity of biological systems to create various types of micro/nanostructures– allows parallel fabrication of extremely small feature sizes (<50 nm) with controlled diameters and without the slow throughput of conventional ion/e-beam lithography and the high cost of X-ray lithography. Two dimensional surface layer (S-layer) protein lattices from *Deinococcus radiodurans* were employed in the fabrication of linear and honeycomb-like patterns of gold nanoparticles (AuNPs) for the spatially controlled growth of germanium nanowires (GeNWs) grown via a vapor-liquid-solid mechanism. S-layer protein templates were adsorbed on Ge(111) substrates and further used for the controlled immobilization of AuNPs catalysts of different diameters. SEM characterization showed that under the CVD conditions and substrate surface treatment employed, epitaxial growth of GeNWs with uniform diameter (~20nm) and length (1.5µm) were achieved. The vertical <111> epitaxial growth direction was strongly preferred for GeNWs grown from biotemplated 20nm Au colloids. This contrasts to GeNWs grown with AuNPs adsorbed on the bare Ge surface under the same conditions but without protein templating where all four available <111> epitaxial orientations are populated. Epitaxial growth of GeNWs along the <111> directions with a preference for a vertical growth morphology was also observed for NWs grown from AuNPs of 5nm and 10nm size. Currently, different CVD parameters and sample preparation are being explored to faithfully transfer the highly-ordered array structure of the S-layer-patterned catalysts into that of the synthesized NW arrays. We envision that vertical growth will allow the three dimensional integration of more complex structures such as room temperature ultraviolet NW nanolasers and vertical field-effect-transistor arrays.