

Summer 2015

# Enhancing Global Research and Education in STEM at Spelman College: Abstracts 2015

Spelman College G-STEM

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**ABSTRACTS**  
**Summer 2015**  
**Fall 2015**

# Summer 2015

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## **Impact of Ecotourism on Residents of Monteverde, Costa Rica**

Written by: Gabriela Atsepoyi

Sustainable tourism is an environmentally centered approach to travel. However, few studies discuss the effect it has on local communities from the perspective of members in the community. Local conservation efforts helped create a healthy ecotourism economy for Monteverde, Costa Rica. In this project, the impacts of ecotourism on Monteverde were examined and the perspectives of residents were documented through video interviews and questionnaires. Two populations were represented: those that had lived in Monteverde over 30 years and those that who had not. In general, conservation was important to all participants interviewed. Since the start of ecotourism, locals have become engaged and have an increased gratitude for biodiversity protection. Ecotourism led to notable positive change in economy, environmental education and conservation programs. Ninety percent of participants agreed that ecotourism had positively impacted their lives. However, when asked to differentiate between positive and negative impacts of conservation, residents voiced a concern about the upsurge in trash and sought government programs to help offset effects of increased trash and recyclables. Concern over loss of community and culture was recorded in 89% percent of surveys. The presence of drugs and crime was mentioned in 54% of surveys, though many were reluctant to talk about crime. Businesses expressed interest in donating to conservation programs if they received certification for their participation and, all of those who agreed said they would donate more if they were recognized.

**Keywords:** ecotourism; sustainability; conservation; Monteverde; Costa Rica; travel; tourism

## **The Development of an Eye Tracking Program to Examine Working Memory during Gameplay**

Written by: Brygette Bagley

The fluctuation in Alpha and Beta neural oscillations and the cognitive abilities of participants were investigated in correlation to eye movements during gameplay to study the relationship between working memory, brain activity and game performance. The purpose of this experiment is to give insight into the causes of differences in individual working memory performance. The subjects sat in a shielded room with Electroencephalography (EEG) electrodes placed along the frontal bone to target occipital lobe activity. The subjects' Alpha and Beta waves were monitored during closed eye rest, open eye rest and gameplay. The subjects' eye movements were tracked during gameplay using an original program paired with the Eye Tribe Eye Tracker monitoring device. The program was written in C++ and developed in Visual Studio. The program received and stored gaze coordinate data during two, three minute gameplay sessions. My specific role was to create the code used in the eye-tracking program. The code effectively captured the participant's eye position up to 45 frames/second.

**Keywords:** Electroencephalography, visual planning, working memory, C++, occipital lobe, eye tracking, visual analytics

## Numerical Method for a Confined Atomic System

Written by: Deleonne Clark

Quantum confinement is a relatively new subject matter in quantum mechanics. Quantum confinement traps the atom in a cavity whose dimensions are small enough to alter its properties. Some physicists have used the time-*independent* Schrodinger equation to obtain exact results for confinement problems. But this paper focuses on the dynamic of a hydrogen atom when it is moved from captivity. The goal of this project is to study and understand different methods used to predict solutions that cannot be obtained analytically which was done by relying on methods that approximates solutions. To do this, a differential equation with boundary conditions was manipulated with the computer programs C++ and Eclipse using Runge-Kutta, B-Splines, and the Schrodinger equation. While the Runge-Kutta method was utilized as a basis for the boundary problem, its simplicity was not viable for this research which contained so many complex variables. Instead, B-Splines were used to solve the time-dependent Schrodinger equation. B-Spline functions are designed to generalize polynomials for the purpose of approximating arbitrary functions. By taking the summation of the time-*independent* Schrodinger equation, we obtained our desired results for the time-dependent Schrodinger equation.

**Keywords:** time-independent Schrodinger equation, time-dependent Schrodinger equation, B-Splines, sudden approximation

## **Pro-Inflammatory Effects of Extracellular Vesicles from Foam Cells on Endothelial Cells, In Vitro, in Normal and Hyperglycemic Conditions**

Written by: Shelley Cobb

Diabetes and certain cardiovascular conditions such as atherosclerosis put people at higher risk for cardiovascular disease. Often, elevated levels of circulating microvesicles in addition to inflammation have been found to be common characteristics of cardiovascular disease and cardiovascular related diseases. The purpose of this study is to test whether the microvesicles released from the plasma membrane of macrophages have pro-inflammatory effects on human umbilical vein endothelial cells in a normal glycemic environment as compared to an increased pro-inflammatory effect on those in a hyperglycemic environment. THP-1 monocytes were differentiated into macrophages and plated. Lipoproteins were separated from human plasma using sequential density gradient ultracentrifugation, and a sample of each was taken to be oxidized. The formation of foam cells from macrophages was induced by adding very low density lipoproteins (vLDL), oxidized very low density lipoproteins (ox-vLDL), low density lipoproteins (LDL), and oxidized low density lipoproteins (ox-LDL). The amount of microvesicles released from the foam cells upon the addition of lipoproteins was counted using flow cytometry. The different samples of microvesicles were added to endothelial cells existing in normal glycemic conditions and hyperglycemic conditions. The amount of reactive oxygen species present and the expression of adhesion molecules on the cell surface were measured. A ROS assay showed that there were less reactive oxygen species produced by cells treated with lipoproteins than the control cells which were untreated, though not a statistically significant difference. A flow cytometry run showed that there was a visible increase though no statistical significant difference in expression of ICAM-1 and VCAM-1 adhesion molecules on the cell surface of endothelial cells existing in hyperglycemic conditions in comparison to those in normal glycemic conditions. The results do not fully indicate that microvesicles released from foam cells in hyperglycemic conditions elicit more of a pro-inflammatory response



in endothelial cells than those in normal glycemic conditions. Microvesicles could have a protective or detrimental effect on endothelial cells. Results suggest intensifying hyperglycemic conditions may affect endothelial cell inflammatory response to microvesicles.

**Keywords:** atherosclerosis; inflammation; lipoprotein; macrophages; microvesicles



## Caenorhabditis elegans as a Model for Alcohol Addiction Studies

Written by: Brean Derrett

*Caenorhabditis elegans* is a microscopic nematode with a very simple nervous system of only 302 neurons, which makes *C. elegans* a great model organism for the study of the neurological effects that alcohol and other drugs can have on the nervous system. The behavioral consequences of these effects were under investigation during this experiment by determining how different times and concentrations of ethanol exposure, during development from egg to adulthood, can alter the wildtype responses and behaviors of these nematodes. *C. elegans* was exposed to the 50mM, 250mM, 400mM, and 500mM concentrations of ethanol by placing them on pre-treated plates in a long term exposure group and in Eppendorf tubes with the concentrations of ethanol in the short term exposure group. The worms were counted after 48 hours in the long term exposure group in each life cycle stage to observe developmental effects. Their spontaneous reversals, pharyngeal pumps and response to touch was also observed to study the affect that the ethanol treatment may have had on their normal behavior, and a choice assay experiment for ethanol preference was performed on both the long term and short term groups. In the long term exposure group the worms in the 250mM, 400mM and 500mM groups had a much slower rate of development to the L4 stage than the control. Decreased activity level in the short term group in terms of pharyngeal pumping, spontaneous reversal body movement, and response to touch was observed as the concentrations of exposure ethanol got closer to 400mM and 500mM concentrations. In the long term exposure group this decrease in activity was less drastic and may be indicative of ethanol tolerance with prolonged exposure. Choice assay data showed little preference for ethanol for the short term and long term ethanol exposure groups, but the long term exposure group a higher Chemotaxis Index value than the short term, which shows more preferential behavior to ethanol than the short term exposure group. These results indicate that the longer and more concentrated the exposure to ethanol, the more effect it may have on *C. elegans* developmentally and behaviorally.

**Key Words:** *C. elegans*, ethanol exposure, behavior, development, preference, tolerance, chemotaxis

## **Life Cycle Assessment of Renewable Energy Driven Prototypes**

Written by: Sanura Dewa

For this project, the goal is to identify any environmental impacts that might have been present during construction and operation of TRANSOL and Oikos prototypes, and this goal will be achieved within the scope of energy usage and the amount of materials used. The tool that can be used to analyze this is called the Life Cycle Assessment (LCA) and this process is beneficial because the user is able to quantitatively assess the amount of raw materials, energy, and pollutants (atmospheric, water, and solid) that are being generated throughout the life of the product. Two assessments were conducted, the first will be a house, Oikos, made from sustainable materials and regulates the temperature in the house based on the weather outside that was designed and built at the Centro de Automática y Robótica (CAR) lab facility in Madrid, Spain; the second, which is also a prototype built at the same facility, is a solar powered locomotive system named TRANSOL. By conducting these assessments, we found that there were certain areas in which the prototypes had significant impacts; TRANSOL had a major impact on the water resources while Oikos had a major impact on the soil. However, due to the use of solar panels and underground geothermal storage tanks, Oikos and TRANSOL did not use a large amount of energy.

**Keywords:** life cycle assessment (LCA), cradle to cradle, cradle to grave, life cycle inventory (LCI), raw materials, waste management, renewable energy, greenhouse gases (GHG), and solar energy.

## Group Actions: Symmetric Spaces

Written by: Victoria Doctor

Group theory is a branch of Abstract Algebra that describes symmetries of mathematical objects using the concept of group actions. In this project we study specifically finite homogeneous spaces (transitive actions) in terms of the Orbit-Stabilizer theorem. The first example we consider involves background knowledge from Linear Algebra, as the action studied is given by matrix multiplication. We then specialized to symmetric spaces. In particular, using the Correspondence Theorem we show that a cyclic group  $Z_n$  has a symmetric space  $Z_n // H_m$  if and only if  $n = 2m$ .

**Keywords:** groups, group actions, homogenous space, symmetric space

## **An Aptitude for Attitude Neural Bases of Multisensory Perception Correlate to Variations in Human Personality Type**

Written by: Jasmin Eatman

A synesthetic experience is characterized by the automatic stimulation of several divisions of cognitive processing by an inducer, followed by unique cognizance of an imagined object that incorporates multiple qualities. These perceived elements, collectively named the concurrent, include specific colors, sounds, textures, tastes, and spatial positions that are associated with the imagined object or figure. Synesthesia is a form of multisensory perception oftentimes described as a blending of the senses. The purpose of this study is twofold: to explore neural patterns of multisensory perception, as well as to identify the correlation between synesthesia type and personality profile. Personality types we anticipated would be positively correlated to time-space synesthesia were industriousness, and task planning while extraversion and fantasy proneness would be the strongest personality predictors of grapheme-color synesthesia. Openness was expected to be predictive of both synesthesia types whereas agreeableness would be negatively correlated to both grapheme-color and time-space synesthesia. This study included participants who self-identified as synesthetes as well as those who did not report any subtype of synesthetic experience (N=318, Mean age=36). Survey research included the Bergen questionnaire, and further identified personality traits using the Big Five Personality Inventory, Creative Experience evaluation, and Conscientiousness subscale. In order to conduct a comparative examination of self-reported personality qualities and synesthestisia type, Pearson's correlation and hierarchical regression analyses were utilized in multilevel liner analysis. Statistical comparisons revealed that Openness ( $r=.17$   $p<.002$ ), and Industriousness ( $r=0.14$   $p<0.02$ ) are the strongest predictors of time-space synesthesia,

while Task Planning ( $r=-.12$   $p<.03$ ) is negatively correlated to number-space synesthesia. Consistently frequent reporting of openness and industriousness by number-space synesthetes point to several advantages of multisensory perception. Synesthesia research is a significant building block in the construction of public health and education policy, allowing for a more in-depth understanding of the interface between individuals and their communities through an analysis of sensory processing on an individual level. In view of the correlations between synesthesia and personality, there are implications for synesthesia research in monitoring neuropsychological health throughout human development.

**Keywords:** synesthesia, cognitive neuropsychology, and multisensory perception

## **A Robust Protocol for Viral Nucleic Acid Extraction from Food Products Using an Internal Control**

Written by: Ebony Gaillard

Food products can potentially be hosts of food-borne viruses such as single-strand RNA viruses. The contamination of food products potentially cause viruses such as Hepatitis B and E to spread throughout populations. Feline Calicivirus (FCV) is a respiratory disease that infects cats and is used as a process control in this study due to its similar nature to other single-strand RNA viruses. Currently, methods are being developed to efficiently test food products for the presence of enteric disease but there is not a standard control to test different methods of RNA recovery from food products. The purpose of this study was to create a robust protocol for the detection of viral RNA in food products. In this study, we studied the presence of viral RNA in canine liver tissue samples spiked with FCV. The three methods used to break up the liver tissue are as followed: dicing with a scalpel, shredding utilizing the QIAshredder, and mashing with a pestle-like instrument. These methods were evaluated to find the best way to recover viral RNA from the canine liver tissue. By completing downstream applications such as polymerase chain reaction (PCR) and gel electrophoresis, it was found that each method successfully recovered viral RNA. A Nanodrop spectrometer was used to measure the concentration of recovered RNA in each spiked liver sample and it was concluded that mashing via the pestle instrument was the most efficient method to recover the most RNA. Additionally, a virus dilution experiment was conducted and found that sensitivity up to 1:1000 for detection in gel electrophoresis results. The results should be considered in further assessment of strategies useful in viral nucleic acid extraction from food products.

**Keywords:** Single-Strand RNA viruses; FCV; RNA Extraction; PCR; Gel Electrophoresis

### **Mechanics of a Heavy Chain or Rope**

Written by: Micah Henson

Most introductory physics courses taught around the world cover how to calculate the movement of the 1-pendulum using Newton's laws. However, once you move beyond the 1-pendulum, calculating the movement becomes much more difficult. Studying the movement of pendulums can be very useful for understanding phenomena in other scientific disciplines. The goal of my research is to calculate the movement of the the  $n$ -pendulum so it can be used as a model for heavy ropes and chains. In order to reach this goal, I seek to gain a better understanding of Lagrangian mechanics by applying it to the 1-pendulum and 2-pendulum. I calculate the kinetic energy,  $T$ , and the potential energy,  $V$ , to form the Lagrangian,  $L = T - V$ . Then, I calculate the Euler-Lagrange equation of motion,  $\frac{d}{dt} \left( \frac{\partial L}{\partial \dot{\theta}} \right) - \frac{\partial L}{\partial \theta}$

$$\frac{d}{dt} \frac{\partial L}{\partial \dot{\theta}} - \frac{\partial L}{\partial \theta}$$

using these values.

Then, I simplify the Lagrangian to a form useful for Matlab and use the built-in ode45 function to create a simulation of the movement of the  $n$ -pendulum. This requires the input of the function that we derive in this report and initial conditions. MatLab then approximates the solution and creates a video of the simulation. The approximated solutions of the function for the  $n$ -pendulum heavily models the natural movement of a heavy rope or chain. This research focuses on building a model. However, it could



potentially be applied to more than just the movement of a heavy chain or rope. For example, the application of the 2-pendulum to DNA has already been studied.

**Keywords:** pendulum,  $n$ -pendulum, Lagrangian mechanics, differential equations

### **The Overtaking Procedure of the Autonomous Vehicle using Bezier Curves**

Written by: Jaycee Holmes

This research assists in determining the path trajectory of an autonomous vehicle using Bezier curves. This research uses the MATLAB scripting language to find the optimal distance between control points of a fifth degree Bezier curve. This was found by finding the integral of the second derivative of the Bezier curve's curvature. The results of this research indicate an increasing linear dependency between the distance of the six control points and the length of the vehicle's trajectory, assuming that the width remains constant. The approximated correlation derived from the generated program will assist in finding a precise relationship between the two variables and will reduce the time in which the autonomous vehicles plans its path.

**Keywords:** Path Planning, Curve Theory, Bezier Curves, 5<sup>th</sup> Degree Bezier Curves, Curvature, Parametric Curves

## Texture and Color Graph-Based Image Segmentation

Written by: Courtney Lett

This paper introduces a method of image segmentation of an image file based on color and texture variability. The approach described has the ability to recognize real world objects in an image similar to how human perception would perceive them using ppm images. The program implemented employs a texture descriptor that captures the texture patterns in a local neighborhood. Color for each pixel is described by extracting and smoothing the *RGB* color value using a Gaussian filter. Each pixel is then assigned a four dimensional vector using its texture descriptor and color value as parameters. For a local neighborhood, Euclidean distance between each vector is calculated to serve as edge weights in an image graph representation. A predicate is applied using given thresholds to determine if the graph's connected components should be combined or separated by a boundary based on the texture and color variability of each component. The results yield a set of components separated by boundaries, which serves as the final segmentation. The program takes in five parameter arguments:  $\sigma$  for the Gaussian filter,  $k$  value for the threshold function, *min\_size* component size, the ppm (portable pixmap format) file to be segmented, and the output file of the segmented image. Larger *min\_size* and  $k$  proved to result in larger components. Still, each image should be treated as

completely separate as slight changes to the parameters can result in a completely different segmentation. The approach works as intended and the results can be seen in this paper with the corresponding values for  $\sigma$ ,  $k$ , and  $min\_size$ . The approach works best for smaller images with smaller textures. Larger images and larger textures can cause the program to group pieces of the same texture as separate objects. Images with simple textures are used.

**Keywords:** Image segmentation, texture descriptor, image graph

### **Brassinosteroid Signaling in Arabidopsis PP2A-C Mutants**

Written by: Akeela Lewis

Arabidopsis thaliana genome codes for a protein phosphatase (PP2A) that is composed of catalytic subunits responsible for the regulation of brassinosteroid activity. Catalytic subunits, PP2A-C2 and -C4 have been proven to alter the brassinosteroid related phenotype of Arabidopsis thaliana. It is believed that PP2A activity is required for BR-induced gene expression. Brassinosteroids are hormones whose main functions are to promote plant growth and regulate physiological processes related to plant development. They support cell expansion and division, pollen development, regulate senescence, and help determine a plant's response to environmental signals. PP2A can be broken down into the catalytic C subunits, and the regulatory subunits A and B. The B subunits are considered to be responsible for substrate specificity and cellular localization of PP2A. There are 3 A subunits and 17 of B subunits B, B', and B". By examining the phenotypes of mutant plants, the B' subunits' role in brassinosteroid signaling can be accessed based on plant growth. The experiment focuses on a triple mutation composed of a mutation in the PP2A -C2 and -C4 genes as well as a mutation in the B' subunits. Arabidopsis plants containing a double mutation in the PP2A-C2 and -C4 families have displayed dwarf, BR related phenotypes. A triple mutation had yet to be examined. Results suggest a mutation

in the b'B subunit slightly restores the activity of the protein phosphatase subgroup 2A and allows for normal plant growth with minor changes to leaf development.

**Keywords:** Arabidopsis thaliana; brassinosteroids: PP2A; B' subunit; protein phosphatase

### **Voronoi Diagrams: Properties and Applications**

Written by: Prenessa Lowery

A Voronoi Diagram is a set of 'sites' (points) and a collection of regions that divide the space containing the sites. Each region corresponds to one of the sites, and all the points in one region are closer to the corresponding site than to any other site. Voronoi diagrams in 1D, the  $n$ -Post Office Problem Image Compression: an Application of Lloyd's Algorithm, and Voronoi Diagrams in 2D are studied. Use of the Applications of Voronoi Diagrams and known relationships between integration, derivatives, and computational math allow researchers to determine and achieve the minimum cost required for the sites at the center of mass of the Voronoi cells (regions).

**Keywords:** voronoi diagrams, image compression, Lloyd's Algorithm, optimal location

## **The Beta-Pen: A Hand-Held Device To Investigate Beta Contamination**

Written by: Ebone Monk

Silicon Photomultiplier (SiPM) detectors are examined throughout the world as a suitable replacement for the traditional vacuum based PhotoMultiplier Tube (PMT), used in dated technology to detect radiation of various types. However, the use of SiPM detectors are enabling applications otherwise not possible with PMT detectors due to size, operation voltage requirements, production cost, and quantum efficiency. Recent progress in the development of SiPM detectors, are pushing the boundaries in energy and time resolution as well as photon detection efficiency and active surface area. In this study we report on the performance of a novel beta radiation detector, called the Beta-Pen, comprised of the latest generation SiPM detectors from KETEK coupled with plastic scintillation material. 2mm x 2mm x 5mm scintillation material is optically coupled to the 2mm x 2mm active plane of the KETEK PM 2250 silicon photomultiplier. During this study, we produced a hand-held device, currently dubbed the Beta-Pen, to identify beta-radiation at short range with applications ranging from food monitoring to novel ways of radio-guided surgery in mind. This project comprised of identifying and testing a novel

combination of scintillating material with small area photon detection system to prove the feasibility of this approach and provide a pilot study of its uses.

**Keywords:** Silicon Photomultiplier (SiPM), Geiger Mode Photodiodes, Silicon, Beta Spectroscopy, Scintillation Detection, Strontium-90, KETEK GmbH

### **Protein Purification and Crystallization of AKTI**

Written by: Krista Montgomery

The transport of ions in plant membranes establishes a pH and ion homeostasis which establishes the key physicochemical parameters for cellular function. Abiotic stress unbalances cell ion homeostasis and plants tend to re-adjust it by regulating different ion channels and transporters. These macromolecules share with their animal homologues the transmembrane transport machinery but display plant specific large regulatory cytosolic domains. These structures are constituted by different subdomains, which develop specific functions related with the regulation of the ion transport. Atomic level examination of these multi domain structures would provide the molecular mechanism underlying the function and regulation of these major channels and transporters and would be central to the generation of new plant varieties with enhanced properties to resist environmental stresses. Protein production and crystallization of these channels and transporters constitute the limiting step in structure determination by X-ray diffraction. Enhancing the crystallization of these molecules could be achieved by the optimization of protein constructs to remove unstructured

regions or by the isolation of the proper subdomain fragments. Accordingly we have dissected the cytosolic domain of the Arabidopsis thaliana AK.TI potassium channel. Using His Tagged column purification methods these components were separated for crystallization and further analysis of the structure. Construct 2, 8 and, 11 and were successfully purified and construct two was used to set a crystallization plate, which was unsuccessful.

**Keywords:** AK.TI ; Purification; Crystallization; cyclic nucleotide; construct

### **Monitoring the Quality of European Hake (*Merluccius merluccius* L.) Fillets at Different Freezing Conditions Known to Inactivate *Anisakis* Larvae**

Written by: KayCeI Moton-Melancon

*Anisakis simplex* is a parasitic nematode, which can infect humans that consume raw or undercooked infected fish. Freezing fish is one of the methods that inactivate *Anisakis* larvae, but it is important to define, with precision, at which point the parasites are no longer infective. A treatment that is too short may lead to health problems; however, an extensive treatment may cause quality problems and economic losses. The objective of this work was to study the quality of hake (*Merluccius merluccius* L.) muscle as affected by freezing conditions previously found sufficient to inactivate *Anisakis*. Fillets were frozen at three different freezing rates up to  $-20$  °C in the thermal center. They were kept at this temperature and analyzed after 24 hours and 7 days. Low-Field Nuclear Magnetic Resonance and Water Holding Capacity were monitored as measurements of fish quality. *Anisakis simplex* viability of artificially infected fish treated under these freezing conditions was also evaluated. For that, pepsin digestion, ultraviolet light

recovery, mobility of larvae, and agar penetration test were monitored. Finally, a sensory analysis was performed using the triangle test method where the assessors' ability to distinguish between fresh and frozen fish were tested. In conclusion, results showed faster freezing rates maintained the quality of the fish while effectively eliminating the *Anisakis*. There were significant differences between fresh and frozen fish, so that at least 22% of the population can distinguish this difference with a 95% confidence level. These results can be used to improve current EFSA recommendations and increase marketability of *Merluccius merluccius*.

**Keywords:** *Anisakis*; parasites; freezing; fresh; Hake; *Merluccius merluccius*

### **Analysis of Variable for the Monitoring of Biological Processes Involved in the Treatment of Organic Residues**

Written by: Nacarri Murphy

Advancements in physical and biological sciences within recent decades have had a large impact on the amount of experimental data available (Cooley & Lohnes, 1971 ). The purpose of this study was to apply statistical models to a data set which contained 24 variables related to the treatment processes of organic waste, or compost. Statistical methods that utilize multivariate analysis allow for the reduction of data by the reduction of dimensions to develop the data used in this study, a physico-chemical characterization of the composted waste was performed to identify the most influential variables of the chemical, and physical characteristics of the compost. The data in its raw form was applied to the functions of the factor analysis, Principal Component Analysis (PCA). The PCA results show the multivariate data can be reduced to show relationships between eight variables aligned in four groups. These groups are total kjeldahl nitrogen (N-TKN) and ammoniacal nitrogen (NH<sub>4</sub>-N); volatile solid (VS), organic matter (OM), and oxidizable organic carbon (OOC); and total carbon soluble (TC) and total organic carbon soluble (TOC). One variable can be extracted from each group to



describe the correlation between the variables and the principle components in reference to the sample. The results of this research can be used to evaluate the efficiency of organic waste to create more eco-friendly compost.

**Keywords:** multivariate analysis; dimensionality reduction; Principal Component Analysis; physical-chemical characterization

### **Heat Treatments of *Anisakis simplex* in *Merluccius merluccius*, L**

Written by: Sky Myers

*Anisakis* infection in fish is highly regarded by fishery sectors and food safety legislators. These parasite nematodes, reach sexual maturity in marine mammals; fish and cephalopods act as secondary intermediate hosts for the third stage larvae (L3). Consumption of L3 larvae by humans, in raw and undercooked fish and cephalopods, may cause gastro allergic symptoms and allergic sensitization. *Anisakis* L3 are moderately resistant to heating, from here the importance of having proper food safety protocols. This study aimed to analyze the effects of heating treatments and final temperatures to find the minimal thermal treatment needed to kill *Anisakis simplex* in hake (*Merluccius merluccius* L.) fillets. Thermal treatments at 50, 60, and 70 degrees Celsius were conducted to heat isolated larvae and artificially infected fillets. UV emission was used to find the larvae in the muscle, and the viability was monitored by the larvae's mobility.. Additionally, the oxygen consumption rates of the larvae were measured using a respirometer. The in vitro agar penetration test, which included a small layer of gastric juice was used to identify the infectivity potential of the surviving larvae. Our data shows that larvae were more likely to be viable in thermal experiments

conducted at 50°C. Parasites at 60°C and 70°C treatments did not penetrate the solid agar. This result shows that these heat treatments, killed/inactivated the *Anisakis* L3, reducing the chances of getting infected. Although some parasites were viable in 50°C treatments, the levels of oxygen consumption were significantly lower than the control parasites sample. In conclusion, the data validates the legislation recommendation of cooking fish products at a core temperature of 60 degrees Celsius for 1 minute to inactivate L3 *Anisakis*.

**Keywords:** Parasites, marine life, food science, Anisakiasis

### **How Does Probiotic Effect Immunological Function in Zebrafish?**

Written by: Chezlyn Patton

The collapse of ecosystems is partially prevented through the maintenance of relationships, many of which are symbiotic. Symbiosis accounts for the thriving of many species. Interactions taking place in the microbiome of complex eukaryotic organisms are remarkable examples of successful symbiotic relationships. The microbiome, consists of various strains of bacteria, some being commensal, some pathogenic, and others beneficial. Beneficial bacteria administered to boost immunological function are called probiotics. These bacteria impact immunology by outcompeting pathogenic species, while benefiting from the habitat provided by the host. Probiotics were fed to zebrafish embryos in order to provide more insight into how they affect the immune system. A series of experiments were conducted in order to confirm probiotic presence, and then measure how the immune system was affected. Fluorescent imaging and agar medium plating were used to confirm probiotic absorption, while histology staining, PCR, and microinjection with pathogenic bacteria were utilized in an attempt to measure

any immunological response. Because probiotics are beneficial bacteria, it is expected that they will positively affect immunity. Though somewhat inconclusive, our preliminary results provide information about how probiotics containing *Bacillus* could affect immunological function. These new insights could aid in the advancement of aquatic animal health and ecosystems.

**Keywords:** microbiome, probiotics, *Bacillus*, immunity, aquaculture, zebrafish

## **Enzymatic Activity and Preliminary Crystallographic Analysis of a Fungal Catalase**

Written by: Asia Payne

Catalases are enzymes found in nearly all living organisms, from bacteria to fungi, plants or animals, exposed to oxygen. Catalases catalyze the decomposition of harmful hydrogen peroxide into water and oxygen, thereby protecting the cell from the oxidative damage caused by reactive oxygen species. Fungal and yeast enzymes are particularly interesting from the biotechnological and industrial perspectives, since they often exhibit robust catalytic and stability properties. Several fungal catalases have been structurally characterized by X-ray crystallography from organisms such as *Penicillium vitale* and *Micrococcus lysodeikticus* (Diaz, et al., 2012). More recently, the structure of *Hansenula polymorpha* catalase has been reported but much remains to be known about the structure and activity of catalases from fungal sources (Peña-Soler, et al., 2011). *Pichia pastoris* is a model methylotrophic yeast in peroxisomal research and biotechnology with applications ranging from food to pharmaceutical industry. In order to fully

understand the enzymatic activity and structure of the *P. pastoris* catalase (*PpCAT1*), we have cloned, overexpressed and purified *PpCAT1*. To further our knowledge on the structure-function relationship of fungal catalases, we set out to crystallize *PpCAT1* and determine its three-dimensional structure by X-ray crystallography. Crystals were diffracted in the ALBA synchrotron light source. The best crystals diffracted to 2.35 Å resolution and the complete structure determination is in progress. In conclusion, the enzymatic activity and structural results found will provide further biological knowledge about the *PpCAT1* as well as provide information for future industrial applications.

**Keywords:** Catalases, *Pichia Pastoris*, X-ray Crystallography

### **The Interaction of CIS-Acting Replication Element with Host CeO Influences**

Written by: Jessica Sainyo

The genomic RNA of the hepatitis C virus (HCV) is a good model for investigating about conserved structural units using current methodologies. The genomic RNA of the hepatitis C virus (HCV) contains functional domains, defined by highly conserved structural RNA motifs, mostly located in the 5'-untranslatable regions (5'UTRs) and 3'UTR, but also occupying long stretches of the coding sequence. Subsequent RNA replication strongly depends on the 3'UTR folding and is also influenced by the 5' end of the HCV RNA. This review summarizes current knowledge about functional RNA domains within the HCV RNA genome and provides an overview of the control exerted by direct, long-range RNA-RNA contacts for the execution of the viral cycle. Advances in novel bioinformatics tools have allowed for the extensive search of evolutionarily

conserved RNA domains, resulting in the identification of domains distinct from those present in the UTRs. Analyses of numerous HCV isolates sequences revealed an unusual conservation in the 5' end of the core protein coding sequence. Interestingly, this conservation could not be explained only by the preservation of the amino acid sequence since synonymous substitutions were suppressed. The current methodologies used will undoubtedly improve the identification and validation of functional RNA domains in the near future.

**Keywords:** Hepatitis C virus (HCV), 3'UTR

**The Effect of PP2A-C Mutants on Brassinostcroid Signaling in *Arahidopsis thaliaua* Plants**

Written by: Taylor Tanner

The effect of mutations in B' and C subunits of PP2A on brassinosteroid signaling was investigated. *Arabidopsis thaliana* seedlings of parents B 'a and Z24, their offsprings, and col wild type were sterilized, planted, and DNA extracted from the leaves of each sample for further analysis. The DNA was used for PCR and gel electrophoresis in order to provide insight into the genotypes of the plants. This allows for the identification of offspring that are triple mutants in the b'a, C2, and C4 subunits which are expected to experience adverse effects on plant growth. The phenotypes of the triple mutants were also taken into account. Results revealed two offspring, 23 and 37, that were triple

mutants. While triple mutant offspring 37 appeared to be stunted in growth, triple mutant 23 appeared to have a normal phenotype. Offspring that were only double mutants for the C2 and C4 subunit, offspring 11 and offspring 17, were compared to the triple mutants. Both appeared normal. This confirmed the role of the *B'a* subunit in producing variable phenotypes. This also confirmed the complexity of the brassinosteroid signaling system as there was no set correlation between the triple mutants exhibiting adverse effects on plant development such as dwarfism, reduced fertility, and abnormal stomatal development. Thus there is no way to pinpoint a single aspect of the brassinosteroid signaling system through PP2A to explain, but understanding that complex interactions among brassinosteroids and various components of the signaling pathway play a role in the genotype and phenotype of the plants.

**Keywords:** brassinosteroids (BR), brassinosteroid signaling pathway, PP2A, subunits, *B'a*, C2, C4

### **Identifying the presence of bacteria/viruses in freshwater and domestic water systems**

Written by: Javonna Willaims

Identifying bacteria/viruses present in water sources allows for immediate actions to provide safe/healthy water for consumption for all forms of life. Identification of bacteria and viruses present in freshwater and domestic water systems (bottled water, kitchen faucets, water in Glasgow fountains) was investigated. Are the freshwater and domestic water systems in Glasgow, Scotland safe for all forms of life to consume? Water samples were taken directly from a river at two locations (upstream and downstream) and bottled water from a local grocery store kitchen faucets, and water fountains. The water samples were prepared on four types selective agar allowing bacteria to grow at two different temperatures (22°C and 37°C). Select bacteria were later involved in PCR and bacteriophage assays and growth on blood agar to determine the bacteria, if

viruses were present, and if the bacteria causes human pathogens. Results suggest that most samples were contaminated with bacteria. *Bacillus megaterium*, *Bacillus lichenformis*, *Pseudomonas*, *Shewanella putrefaciens*, *Aeromonas salonicida* were a few of the bacteria to be identified in the water samples. Further, some of these are possible human/opportunistic pathogens (*Shewanella putrefaciens*, *Pseudomonas*, *Bacillus lichenformis*) were a few of the identified bacteria to grow on blood agar plates. One of the samples from bottled water (trial 2) had no contamination. None of the samples contained viruses. Based on these results, in normal conditions bottled water and tap water are safe to drink.

**Keywords:** polymerase chain reaction; bacteriophage assay; 16s rRNA sequence, bacteria, drinking water quality

## **Study of Interactions Between Cis-Acting Replicating Element of Hepatitis C Virus and Host Cell Factors**

Written by: Martine Williams

The Hepatitis C virus is single-stranded positive sense RNA virus with diverse functional domains within its genome. One of these is the cis-acting replicating element that has been previously reported to negatively regulate viral translation and is necessary for a correct viral translation. The aim of this work has been to study the interaction between cellular host factors, specifically with translational machinery, and the cis-acting replicating element. To this end, the Hepatitis C virus subgenomic region that contains the cis-acting replicating element was in vitro transcribed. Subsequently, chemical probing of CRE element was performed to analyze the binding of translational machinery by Selective 2'-hydroxyl acylation analyzed by primer extension with a fluorescently labeled primer. This process was conducted in three steps: treatment of cis-acting replicating element from Hepatitis C virus genome with NMIA reagent,

reverse transcriptase-mediated primer extension, loading in capillary electrophoresis and informatics data analysis with quSHAPE. Map reactions were set in the presence or absence of previously purified eukaryotic 40S ribosomal subunit from the Huh7, human Hepatoma cell line. Additionally, cloning of two eukaryotic host proteins, previously suggested as CRE interacting factors, was performed. DNAs corresponding to mRNA sequences for heterogeneous nuclear ribonucleoprotein A1 and T-cell intracellular antigen related protein were obtained by retro-transcription and specific polymerase chain reactions. Although cloning of the T-cell intracellular antigen related protein was not completed, heterogeneous nuclear ribonucleoprotein A1 was successfully cloned. Results of the Selective 2'-hydroxyl acylation analyzed by primer extension reactions were positive and are currently under study.

**Key words:** Hepatitis C virus genome, SHAPE modification, CRE element, 40S subunit, hnRNPA1, TIAR, Huh7

## **Mass Balance Change At Engabreen**

Written by: Qaasimah Alexis Lang

### **Abstract**

The purpose of this research is to identify trends in ablation and accumulation in Engabreen, a glacier in the Svartisen Ice cap in Norway. This paper looks at what factors have contributed to Engabreen having a positive mass balance most years since 1970 while many other glaciers in the region are retreating. The variables collected for this study are overall mass balance, annual and seasonal precipitation, and summer temperatures. Engabreen's mass balance measurements were acquired from several journals from *Glaciological Investigations in Norway*. Mass balance values were acquired by the Norwegian Water and Energy Directorate through the use of stakes, probe measurements, and snow coring. The



precipitation and temperature data was collected from the Norwegian Meteorological Institute. Engabreen is located over the Svartisen Subglacial Laboratory. The results have shown that precipitation over Engabreen has increased over time by 0.0015% and that the mass balance of Engabreen has gotten less positive by 0.015% over the past 40 years. Summer temperatures have seen a rise of 0.0166% while winter temperatures are increasing twice as fast at a rate of 0.0428% annually. Analysis of the results has shown that though Engabreen is growing, as temperatures continue to rise they will cause an increasing amount of ablation. Looking at data compiled from 1970-2010 it is clear that while the glacier Engabreen is indeed still advancing, the rate of accumulation and positive mass balance is decreasing by 0.015% with each year and may eventually cease to advance. Although Engabreen is predicted to see more precipitation in the coming years (113% increase by 2100), increased temperatures will likely cause more ablation than accumulation and Engabreen will begin to retreat like many glaciers around the world, losing on average anywhere from 0.5 to 1 meter in ice thickness annually.

**Keywords:** mass balance; accumulation; ablation; cryosphere; Svartisen; glacial retreat

