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UNDERGRADUATE RESEARCH ABSTRACTS

Poster Session - September 6, 2012

10 a.m. – 2 p.m.

Student Center Atrium

Supported by the Office of the Provost

A Secure Medical Communication System for Android Smartphones

Ahuja College of Business

Department of Computer and Information Science

Student Researcher: Ben Andow

Faculty Advisor: Haodong Wang, Ph.D.

Abstract

The use of smartphones within the medical field can be beneficial in numerous ways. As an example, smartphones can be used by medical professionals to allow quick access to a patient's medical record in emergencies or as a general tool to improve communication between medical professionals. For this project, a secure medical communication system for Android-based smartphones is designed by formally defining an application layer communication protocol and access controls to ensure authentication, authorization, confidentiality, integrity, and accountability. Furthermore, the communication protocols and access controls ensure that the application prototype is compliant with HIPPA regulations.

Curating and Commemorating the City: Research, Oral History, and Mobile Publishing

College of Liberal Arts and Social Sciences

History Department

Student Researchers: David Braunlich; Gabriella Halligan-Taylor; Kelsey Smith

Faculty Advisors: Mark Souther; Mark Tebeau

Abstract

Our research team recorded, analyzed, processed, and extracted digital clips from more than 50 oral history interviews in support of two major centennials--those of Shaker Heights and the West Side Market. In addition, they created Cleveland Historical mobile phone app content, including two new sites as well as adding oral history clips to enrich previously completed sites. They also conducted, archived, and clipped oral histories in support of two other ongoing partnerships with Cleveland Metroparks and FutureHeights in Cleveland Heights. In doing so, they learned important historical skills while working in a dynamic team and contributing to a major public and digital history project.

Reconstructing Ohio's Ancient Past One Pot Sherd at a Time

College of Liberal Arts and Social Sciences

Department of Anthropology

Student Researchers: Mack Cline; Caitlin Jones; Anthony Magnone

Faculty Advisors: Phil Wanyerka; Paul Aspelin

Abstract

The primary focus of our research was to analyze, conserve, and reconstruct ancient prehistoric pottery from the Cramer Village Site, a Fort Ancient-era (AD 900-1200) site located on the west bank of the Scioto River in Union Township, Ross County, Ohio. By examining several key diagnostic features, such as surface treatment, temper, and cord-marking, we were able to positively determine the age and cultural affiliation of the Cramer Village pottery housed in the Department of Anthropology. As part of this research, more than 2,500 prehistoric ceramic sherds were carefully examined, cleaned, sorted, and matched in an attempt to reconstruct specific vessel shapes and forms. Some 45 diagnostic rim sherds were identified and most of these sherds closely match and correspond to known early Fort Ancient ceramic types. These sherds revealed many interesting surface features including incising, cord-marking, and even painted surfaces. Our analysis of the Cramer Village ceramics should significantly contribute to a more precise understanding and interpretation of Fort Ancient ceramic typology, thus shedding new light on Ohio's ancient past.

Benefits of and Limitations to Public Transit in American Cities

College of Liberal Arts and Social Sciences

Economics Department

Student Researchers: Scott Carson; Sabina Able-Thomas

Faculty Advisor: Subhra B. Saha

Abstract

This project examines if public transit generates spillovers on private employment and if population density is a limitation to the viability of public transit in American cities. To estimate the spillover benefits of public transit on employment, we take data from 2000 Decennial Census and relate share of private employment to public transit usage in different cities. We find that public transit usage has *little or no effect* on private employment. However, it has a *positive and significant* association with the share of college graduates and high skill workers in a city. This association persists even when large cities are dropped from the estimation sample. To examine if population density is a limit to transit, we create a unique dataset of Greater Cleveland Regional Transportation Agency (GCRTA) bus service by census tracts of Cleveland in 2010. Surprisingly we find that public transit (in Cleveland, OH) depends more on share of minority population and availability of jobs in the different census tracts compared to their population density. The results stand in contrast to the estimates of population density from macro studies based on urban areas or counties but are in line with the motto of GCRTA.

Getting to the Root of Dengidëk: A Preliminary Investigation of *Fagara xanthoxyloïdes* and Treatment-Seeking Behavior in Dakar, Senegal

College of Liberal Arts and Social Sciences

Department of Anthropology

Student Researcher: Dick Powis

Faculty Advisor: Barbara G. Hoffman, Ph.D.

Abstract

In Senegal, "traditional medicine" typically refers to the syncretism of Wolof or Serer medicine and Islamic beliefs, and includes not only consumables and procedures that fight off physical or mental ailments, but also spiritual acts to fight off sorcery. This research focuses on one botanical source of Wolof folk medicine that is *Fagara xanthoxyloïdes* (also known as *Zanthoxylum zanthoxyloïdes*, *Zanthoxylum polygonum*, and *Fagara senegalensis*), which is a tree that is autochthonous to the Senegambian coast that stretches from the Casamance to just south of Dakar, as well as much of much of West Africa south of Senegal. In Dakar, the plant is usually referred to by its Wolof name, *dengidëk*. Chewing sticks derived from the tree are used, not only as toothbrushes, but also as an aid to those afflicted with sickle-cell anemia in an effort stave off the pain of clotting. This is a preliminary investigation of the local and traditional knowledge that surrounds dengidëk, in particular, while assessing a rudimentary model of treatment-seeking behavior.

The Fourteenth Century Meets the Twenty-First: An Engaged Learning Experience in Historical Geography

College of Liberal Arts and Social Sciences

History and Religious Studies Departments

Student Researcher: Monica Ward

Faculty Advisor: Stephen Cory

Abstract

Our goal was to develop an application that would enable students to use the Map Walk to "walk" through world traveler Ibn Battuta's itinerary of his trips throughout the Muslim world between 1325 and 1354. As students follow Ibn Battuta in his travels, they will be able to access additional background information on each of the sites that he visited.

In order to achieve this goal, Monica read Ibn Battuta's book describing his travels and selected thirty sites from Africa, Asia and the Middle East to include in the History blog. She conducted background research on all thirty of these sites and wrote short entries of three or four paragraphs for each site, providing historical and contemporary information on the site as well as stories from Ibn Battuta's experiences when he visited there. She posted these blogs along with pictures of the sites and then created and placed QR codes on the maps corresponding to each site. On the day of the Map Walk, students will be able to use their smart phones to access the blogs and follow Ibn Battuta on his travels around the world.

To see the blogs, visit the following link: **http://mapwalk.clevelandhistory.org/**

A Study on How Creative Geography Affects Spatial Presence

:FR:AMES (Film Research: Advanced Methods for Empirical Study)

College of Liberal Arts and Social Sciences

School of Communication

Student Researchers: Jeffery Allen; Kara Rader with Matt Egizii; Alex Farmer; Seth Kopchu

Faculty Advisors: Kimberly Neuendorf, Ph.D.; Paul Skalski, Ph.D.

Abstract

Reality TV viewers expect a naturalistic environment in which relatively ordinary people interact with each other. However, much of reality TV is contrived by producers, and the extent to which they manipulate it can shape viewer responses. One common manipulation in film and television is the geographical accuracy of the environmental setting. "Creative geography" is a term from film scholarship (Kuleshov, 1974) referring to the editing of different spaces together to make them seem contiguous. For this study, we shot a reality TV game show, providing a rich set of materials with which we will creatively manipulate the geography, including (a) amount of geographical information (e.g., use of long shots/establishing shots or just close-ups; use of 360-degree shots), and (b) accuracy of geographical information (i.e., whether the space is altered in editing). Multiple versions of the video will be created, and differential participant reactions will be gauged by posttest instrument; differences are predicted based on (a) and (b) above. Further, we expect that the participants' spatial presence, or sense of "being there," along with other variables, will change depending on whether they have been to the manipulated location. Findings will inform scholarship on reality TV, creative geography, and spatial presence.

Color Grading: How it Affects the Emotional Reaction of Viewers

:FR:AMES (Film Research: Advanced Methods for Empirical Study)

College of Liberal Arts and Social Sciences

School of Communication

Student Researchers: Alex Farmer; with Jeffery Allen; Kara Rader

Faculty Advisor: Kimberly Neuendorf, Ph.D.

Abstract

Color is an important aspect in just about every facet of life. Color tends to be interpreted variably by individuals based on the context in which the color is presented. Colors elicit certain emotions when they are by themselves, but would that change when the context of a moving picture is added? For the purpose of this study, six colors including red, yellow, blue, green, orange and purple are used to color grade several sequences from the film *Garden Paths* (2012), to test whether color can affect the viewer's emotional reaction to the scene. Participants for the study will be asked to watch a series of video clips that either have or have not been color graded. Then after each viewing, the participants will be asked their emotional status via questionnaire. It is predicted that the color grading of each scene will significantly change the participant's emotional reaction from their initial reaction to the original footage. The data collected by this study have the potential to aid business and advertising by showing how the color grading of moving images can affect the emotional status of the viewer in order to sway them in a desired direction.

Subtitling and Dubbing: Methods for Film Translation and Their Effects on Audiences

:FR:AMES (Film Research: Advanced Methods for Empirical Study)

College of Liberal Arts and Social Sciences

School of Communication

Student Researchers: Kara Rader with Alex Farmer; Jeffery Allen

Faculty Advisors: Kimberly Neuendorf, Ph.D.; Paul Skalski, Ph.D.

Abstract

Using subtitles or dubbing to translate a foreign film is a topic that most industry professionals see as a financial question, but researchers have varied opinions on the topic. A vast amount of the literature looks at basic problems facing translators (e.g., translating spoken word to written word and translating cultural references). A number of studies used eye tracking systems to establish that participants automatically read subtitles and that participants rarely look at non-verbal cues. Participants will be shown the Italian film *Life is Beautiful* (1997). One group will be shown the subtitled version, while the other will view the dubbed version. After the film, they will be given a post-test questionnaire that will test their enjoyment, presence, and comprehension. Background questions will cover their knowledge of a foreign language, religion, interest in film, any prior preferences between subtitling and dubbing, among many other questions. Further research will utilize the ASL Eye Tracker to measure the attention paid to visual information during the two different versions of the film. The results are predicted to show no difference in comprehension, and that the participants' presence, and thus their enjoyment, will be lower while watching the dubbed version of the film.

Your Future Depends on It! Exploring Youth Engagement in Inquiry and Action toward Educational Change

College of Education and Human Services

Student Researcher: Jacqueline Lamb

Faculty Advisor: Anne Galletta, Ph.D.

Abstract

The purpose of our research was to explore how youth involved in participatory action research (PAR) understood PAR and their role in the research. A central principle of PAR is that knowledge construction toward the study of social problems and the formulation of solutions benefits from involving those most impacted by these problems. Data collection occurred over a period of four months during after-school sessions with the youth and an intensive two-day research camp. Participant observation was used as the method of data collection, with field notes and video footage as data sources. Initial findings suggest youth saw themselves as involved in something significant in terms of its potential to improve education. Also evident was their engagement and demonstration of agency, particularly in their development of film products addressing issues in education. Informed by critical social theory, our discussion considers the analytical use within PAR of history and policy to more fully explore with youth the conditions they experience in their schools. This work promises to offer new insights within education and psychology concerning youth engagement in school change, research methods that are participatory and action oriented, and understanding lived experience in relation to historical and structural conditions.

Synthesis and Characterization of Chain-End Functionalization of Glycosaminoglycans

College of Science and Health Professions

Department of Chemistry

Student Researchers: Nikola Paulic; Jacob Weingart

Faculty Advisor: Xue-Long Sun, Ph.D.

Abstract

Chondroitin sulfate (CS) is a glycosaminoglycan (GAG) composed of two alternating sugars, glucuronic acid and *N*-acetylgalactosamine, with varying patterns of sulfation determining its type. Found in connective tissue extracellular matrices and on cell surfaces proteoglycans and is involved in a multitude of biological and chemical signaling events such as CNS development, coagulation, and cellular signal transduction. TM is a glycoprotein and its CS-containing domain contributes TM's thrombin binding and stability and plasminogen activation activities. Previous research has concluded that CS can inhibits the coagulation process by enhancing the binding affinity of the integral membrane protein thrombomodulin to thrombin 10- to 20-fold, subsequently activating Protein C and downregulating clotting Factors Va and VIIIa. We hypothesized that incorporation of CS into recombinant thrombomodulin (rTM), the active domains 4-6 of the native protein, should enhance the binding affinity to thrombin creating a more effective antithrombotic. This presentation reports the CSU Summer Undergraduate Research project, which is the synthesis and characterization of chain-end functionalized CS derivatives, which will be used to investigate various bio-orthogonal conjugation reactions in attempt to create a novel CS-rTM conjugate.

Derivatization of Free Glycans for Glycan Sensor and Glyco-Functionalization Applications

College of Science and Health Professions

Department of Chemistry

Student Researcher: Rhonda Jones

Faculty Advisor: Xue-Long Sun, Ph.D.

Abstract

Glycans, especially, cell surface glycans acting as receptors, are involved in a wide range of biological processes. Analysis of the cell surface glycans provides a basis for understanding the molecular mechanism of glycan-mediated biological process. For various studies of glycan functions, it is necessary to obtain their homogeneous glycoforms and re-present them in a bio-assay system. In this CSU Undergraduate Summer Research Project, we aimed to develop a direct derivatization of free glycans for glycan sensor and glyco-functionalization applications. Briefly, lactose (model sugar) was subjected to 2-azidobenzohydrazide in the presence of acetate buffer pH 5.5 with 5% aniline as a catalyst and thus, was derived to an azide functionalized lactose that was characterized by ^{1}H NMR. This azide functionalized lactose was then immobilized on a DBCO modified glass slide *via* copper free click chemistry at pH 7.4. The lactose immobilized glass slides were incubated with lectin (*Arachis hypogaea,* labeled with FITC), which binds specifically to galactose at pH 7.4, then protein binding was evaluated. The ability to modify natural glycans while retaining their natural binding affinity is very important. The present method can be applied in derivatizing sugars from natural sources for glycan sensor and glyco-functionalization applications.

Comparison of Responses in Proactive vs. Reactive Balance Control

College of Sciences and Health Professions

Student Researcher: Christina Sadowski

Faculty Advisor: Debbie Espy, PT, Ph.D.

Abstract

Even though recent research suggests reactive balance training (unexpected, external perturbations) has more effective, long term results than proactive training (self-initiated actions), the latter is used most often in a clinical setting due to its affordability and convenience. This pilot study sought to develop a safe, affordable, and easily portable perturbation-inducing device to be used for reactive balance training. In addition, this device was used to determine how well skills gained under proactive conditions transferred to reactive conditions. A comparison was also made to determine whether proactive training skills were comparable to skills gained under reactive conditions. METHODS: A non-electric perturbation inducing device called the Slip-Trainer was developed by MASS Rehab in Dayton, Ohio. A stopper, harness, and weight stack were also designed and used in concurrence with the Slip-Trainer to safely induce subjects to slip. PROCEDURE: Thus far, four subjects have participated in this study. Three subjects completed two Slip-Trainer exercises of up to 30 slips which were divided by a one hour break. The other subject completed one half hour of Xbox with Kinect video game play and one Slip-Trainer exercise also divided by a one hour break. Kinematic data was collected by the 8-camera motion capture system in the Motion Lab. RESULTS: The Slip-Trainer device allows for safe and cost effective reactive balance training. We also finalized a workable protocol by improving some aspects of the procedure. CONCLUSION: Due to the positive results obtained from the subjects tested thus far, we intend to assess the effectiveness of the Slip Trainer and revised protocol on older adults in the future.

Anti-cancer drug screening of dual tubulin and Hsp27 inhibitors with 2D and 3D lung cancer cell assays

College of Sciences and Health Professions

Student Researchers: Janine M. Naim; Rati Lama

Faculty Advisor: Bin Su, Ph.D.

Abstract

Cancer is the leading cause of death worldwide. Metastatic lung cancer is the most common cancer among men and women in United States. National cancer society has estimated 1.6 million deaths and 2.2 million new cases of lung cancer in the United States in 2012. The current treatment options available for lung cancer are limited and have drawbacks such as poor bioavailability, numerous side effects, poor efficacy and drug resistance. Therefore, there is a need for development of new agents for anti-cancer therapy. Two-dimensional (2D) monolayer cell culture is most widely used for anti-cancer drug screening purposes. Three-dimensional (3D) cell culture models are symmetrical cellular aggregates that mimic *in vivo* tumor characteristics. It has been demonstrated that the 2D monolayer cell assay for drug screening is a very artificial model and cannot represent the characteristics of 3D solid tumors. The multi-cellular tumor 3D spheroid model is of intermediate complexity, and can provide a bridge to the gap between the complex in vivo tumors and simple in vitro monolayer cell cultures. A series of tubulin and Hsp27 dual inhibitors were developed in our research group, and have been preliminarily investigated for the anti carcinogenic activity with breast cancer cells. In the current project, the compounds were further screened with 2D monolayer lung cancer cell culture. Several compounds from the library were identified to have potent anti-tumorigenic activities. These compounds were tested on 3D lung cancer platform and the activities of the compounds on monolayer cell culture were compared with those in 3D tumor spheroids. Because of the pathophysiological resemblance of *in vitro* three-dimensional spheroids with tumors *in vivo*, the compounds with better activities in spheroid models can be expected to have better potency in animal models as well. Drug screening with 3D tumor spheroids eliminates the compounds that show artificial good potency in two-dimensional models. 3D model serve as a novel approach for drug screening purposes and the evaluation of compounds in the platform can help identify potent compounds for further *in vivo* xenograft studies.

Biological evaluation of Cyclooxygenase-2 inhibitor Nimesulide derivatives as anti-agents

College of Sciences and Health Professions

Student Researchers: Amandeep Singh; Snigdha Chennamaneni

Faculty Advisor: Bin Su, Ph.D.

Abstract

Cyclooxygenase-2 (COX-2) inhibitor nimesulide inhibits the proliferation of various types of cancer cells mainly via COX-2 independent mechanisms, which makes it a good lead compound for anti-cancer drug development. A series of new nimesulide analogs were evaluated with cell proliferation assay based on a non-small lung cancer cell line H292. The results showed that several derivatives were very active to against H292 cell growth with IC50s of sub nano mole. These results suggest the possibility of using these nimesulide derivatives as chemo preventive agents. It has been proved that these compounds bind to tubulin and Hsp27 in the tumor cells, which presumably explains the potent anti-cancer activity of the compounds. However, it is still unclear either tubulin or Hsp27 mainly contributed to the anti-cancer activity. It is also possible that these two molecular targets of the compounds exhibited synergistic effects. Further investigations are needed to elucidate the molecular mechanism of the novel anti-cancer agents.

Key Players in Reverse Cholesterol Transport: The Plasma Enzyme LCAT

College of Sciences and Health Professions

Department of Chemistry

Student Researcher: Christopher Pechura

Faculty Advisor: Valentin Gogonea

Abstract

Lecithin cholesterol acyltransferase (LCAT) is a plasma enzyme that remodels nascent high density lipoprotein (HDL) into a mature form called spherical HDL. The impeding of this critical step in reverse cholesterol transport (RCT, the transport of cholesterol from periphery cells to liver), leads to atherosclerosis. Our goal is to use computational chemistry and molecular modeling tools to build molecular models for LCAT and its complex with nascent HDL. The molecular models are constructed from low resolution structures of LCAT and LCAT-HDL complex obtained by small angle neutron scattering (SANS) with contrast variation. Ultimately, we combine various experimental data (SANS data, hydrogen-deuterium exchange tandem mass spectrometry, other biochemical data) with computational techniques (bioinformatics, molecular modeling, SANS modeling, protein-protein docking, molecular dynamics simulation) to produce a molecular model for LCAT and its complex with nascent HDL. The model will be used in the future to map the amino acid residues from LCAT and the protein component of nascent HDL (apoA1) involved in mutual interaction, and to identify LCAT residues interacting with the lipid phase of nascent HDL.

Understanding the Structure of High Density Lipoprotein

College of Sciences and Health Professions

Department of Chemistry

Student Researchers: Dimitriy Parshakov; Kayla Tran

Faculty Advisor: Valentin Gogonea, Ph.D.

Abstract

The high-density lipoprotein (HDL), the carrier of 'good cholesterol', transports cholesterol from periphery cells to liver for catabolism, a process termed reverse cholesterol transport. HDL particles are complexes of amphipathic proteins (e.g. apoA1/apoA2/apoE) with various lipids (phospholipids, cholesterol, cholesterol ester, and triglycerides). Physiologically, it is important to know in detail the structure of HDL so its lipid transport properties can be restored in case of adverse effects. Our approach to solving the structure of HDL is to use a combination of biophysical techniques like small angle neutron scattering, mass spectrometry crosslinking, hydrogen-deuterium exchange mass spectrometry to analyze samples of HDL particles of various sizes. In this project we focused on obtaining and characterizing HDL particles. We expressed the wild-type and N-terminus truncated forms of apoA1, as a regular and deuterated protein in *E. coli*, purified the protein and used it to prepare nHDL particles reconstituted with various lipids (POPC, DMPC, cholesterol). The nHDL preparations obtained are heterogeneous (particles of different sizes). Next we will separate the particles using size-exclusion chromatography and characterize them by employing: electrophoretic gel analysis, light scattering, and lipid composition analysis (to determine the ratio of protein to lipids).

Task Difficulty and the Spatial Structure of Movement in Young Adults

College of Sciences and Health Professions

Department of Psychology

Student Researcher: Patrick Byrne

Faculty Advisor: Andrew Slifkin, Ph.D.

Abstract

Studies using a variety of experimental tasks have established that when humans repeatedly produce an action, the amount of variability in system output is distributed across a range of time scales or frequencies. A finding of particular interest is that fluctuations in the output of cognitive systems are the highest at the lowest frequencies with fluctuation magnitude (power) systematically declining as frequency increases (e.g., for a review see Gilden, 2001). Such time-series structure—captured by spectral analysis—is termed *pink noise.* (In contrast, *white noise* has equal amounts of power at all spectral frequencies.) However, the appearance of pink noise is limited to tasks where action is executed in the absence of external, action-related feedback (e.g., Gilden, Thornton, & Mallon, 1995; Gilden, 2001). A few studies have shown a white-noise structure for action executed in the presence of sensory feedback (e.g., Miyazaki et al., 2004). Here, we sought to determine if movement amplitude (MA) time-series structure would vary with variations of movement difficulty, viz., the index of difficulty (ID) [$\log_2(2A/W)$ (Fitts, 1954)]. The current task required young adults ($n = 16$) to generate long sequences of cyclical hand movements over different movement amplitudes requirements (A) to targets that varied in their width (W). Levels of A and W were combined to produce different levels of ID. Visual feedback of movement was always available. Given that increases in ID are known to induce increased reliance on the available visual feedback (e.g., Flowers, 1976) we predicted an ID-induced shift in time-series structure from pink to white noise. In other words, at low IDs movement should mainly be controlled by internal information processes—with minimized visual feedback processing—and pink noise should result; however, as ID requirements increase there should be increased reliance on visual feedback and time-series structure should shift toward white noise. Indeed, as ID requirements increased there was shift in MA structure from pink to white noise.

YEAST 2-HYBRID SCREEN FOR *T. BRUCEI* TIN2- AND RAP1-INTRACTING PROTEINS

College of Sciences and Health Professions

Department of Biological, Geological, and Environmental Sciences

Student Researcher: Miao Wang; Fan Wu

Faculty Advisor: Bibo Li, Ph.D.

Abstract

Telomeres are DNA-protein complexes located at the ends of linear chromosomes. Acting like a cap, they protect chromosome ends from degradation and rearrangement, maintaining genomic stability. *Trypanosoma brucei* is a protozoan parasite, causing sleeping sickness in humans and nagana in cattle. To evade host's immune response, *T. brucei* cells switch their major surface antigen, Variant Surface Glycoprotein (VSG) regularly. *VSG*s are expressed exclusively from *VSG* expression sites, which are found at sub-telomeric regions. Hence, understanding the *VSG* regulation by the telomere complex would help in developing means to eliminate this parasite.

Our lab has identified several *T. brucei* telomere proteins, including TRF (TTAGGG Repeat-binding Factor), TIN2 (TRF1-interacting Nulcear Protein 2) and RAP1 (Repressor Activator Protein 1) homologs. We have previously shown that TbRAP1 is required for subtelomeric VSG expression regulation, and our preliminary data also indicate that both TbTRF and TbTIN2 play important role in regulation of VSG switching frequency. To better understand the functions of telomeres in antigenic variation, we intend to identify factors that interact with TbTIN2 or TbRAP1 through yeast 2-hybrid screens. In this study, using TbTIN2 or TbRAP1 as bait, we screened a normalized *T. brucei* cDNA library. In both screens, several promising candidates have been identified. We are currently verifying the interactions between the new candidates and TbTIN2 or TbRAP1.

Status of the state-endangered mussel, Ligumia nasuta, in the upper Cuyahoga River

College of Sciences and Health Professions

Department of Biological, Geological, and Environmental Sciences

Student Researchers: Rachel Andrikanich; Stephanie Sredniawa

Faculty Advisor: Bob Krebs, Ph.D.

Abstract

The primary objective of our research was to assess population size and range of *Ligumia nasuta*, the Eastern Pond mussel in the Cuyahoga River watershed. This region had not been examined since the early to mid 1990's, and no records exist for the East Branch Cuyahoga River. The headwaters of the Cuyahoga, predominantly the West Branch and East Branch Cuyahoga River, flow from the Geauga county highlands south into Portage County where mussel abundance was expected to rise as river size increased. Surveys at 29 sites were conducted using tactile techniques and visually where water levels were low. Mantle clippings of *Ligumia nasuta* were taken from all live specimens observed in preparation for genetic comparison to populations outside Ohio (results pending). We found only 17 live *Ligumia nasuta* of 372 mussels observed throughout the study. While whole shells and valves were also collected of *Ligumia nasuta*, it should be noted that all 35 valves were classified as long-dead. We conclude that the Eastern Pond mussel may be all but gone from the East Branch and West Branch Cuyahoga Rivers, but may persist in better numbers in Portage County. Further studies are required before the sustainability of this species can be fully assessed.

Size and Shape Characterization of Salt Dependent Thermoreversible Micelles Synthesized from Elastin-Like Polypeptides

College of Sciences and Health Professions

Student Researcher: Kaitlin Vandemark

Faculty Advisors: Kiril A. Streletzky, Ph.D., Department of Physics; Nolan B Holland, Ph.D., Department of Chemical and Biochemical Engineering, T. Hugel, Technical University Munich

Abstract

Environmentally responsive nanoparticles synthesized from Elastin-Like Polypeptides (ELP) present a promising system for applications such as biosensors, drug delivery vehicles, and viscosity modifiers. These nanoparticles undergo a transition from a soluble state at room temperature to micellar aggregates above the transition. The ELP micelles have been found to be sensitive to various outside stimuli including pH, salt concentration, and solvent. Light Scattering Spectroscopy and Atomic Force Microscopy (AFM) were used to characterize size and shape of the ELP nanoparticles. The apparent radius and molecular weight of micelles had a strong dependence on salt concentration with three apparent regimes. At low salt (0-15mM), largely spherical micelles were found with Rh=15nm, and molecular weight of 3000-4000kg/mol. At the intermediate salt (15-30mM), the observed particles are transitioning from spherical micelles to significantly elongated particles. At high salt (30-60mM), the elongated micelles can be modeled by semi-flexible cylinders with a radius of 15nm and a length of 350-500nm having an apparent molecular weight of 55000-85000kg/mol. Further research has been done measuring Cross-Linked micelles with AFM at room temperature.

Light Scattering Study of Elongated Particles: From Inorganic Nanorice to Polypeptide Micelles

College of Sciences and Health Professions

Student Researcher: Phil Dee

Faculty Advisors: Kiril A. Streletzky, Ph.D., Department of Physics; Nolan B Holland, Ph.D., Department of Chemical and Biochemical Engineering

Abstract

Utilizing the powerful experimental technique of Dynamic Light Scattering (DLS) for size characterization of anisotropic particles can be extremely misleading. Unfortunately, this point is often not realized by researchers who strive for particle sizing of nanoparticles in suspensions. The first goal of this study was to highlight the ambiguities of the DLS experiment on elongated particles. The second goal was to demonstrate the power of Depolarized Dynamic Light Scattering (DDLS) in probing the anisotropy of different types of nanoparticles. Both goals were realized by studying two very different systems: inorganic FeOOH nanorice and elastin like polypeptide (ELP) micelles. The difference between the two systems is fundamental as FeOOH particles are solid, contain no water, and, therefore, are easily imaged using SEM, TEM, and AFM. Polypeptide micelles are soft particles filled with water, and, therefore, not easily imaged by abovementioned techniques. Perfecting DDLS on a system like FeOOH would allow less ambiguous interpretation of light scattering experiments on ELP micelles. We present a consistent analysis of DDLS results on FeOOH nanorice and outline the potential difficulties and challenges of DDLS application for polypeptide micelles.

Obtaining a Pure Protein Using an ELP-Tagged TEV Protease

College of Sciences and Health Professions

Student Researcher: Teisha Mullins

Faculty Advisors: Kiril A. Streletzky, Ph.D., Department of Physics; Nolan B Holland, Ph.D., Department of Chemical and Biochemical Engineering

Abstract

Elastin-like polypeptides (ELPs) reversibly aggregate and phase separate above and solubilize below a specific transition temperature (T_t). ELPs are composed of repeats of the structural sequence of the elastin protein, Gly-Xaa-Gly-Val-Pro $(GXGVP)_n$. Xaa is a "guest residue" in the sequence and can be any amino acid, with the exception of proline, P, in order to alter the temperature response. ELPs can then be attached to recombinant target proteins as a tag to facilitate protein purification.

We present here use of GLGVP for tagging and purifying a gadolinium binding protein domain. Leucine is used as the guest residue in order to lower the T_t below room temperature, enabling purification to take place over a more manageable temperature range. After protein purification, it is ideal to remove the ELP tag from the target protein. To accomplish this, a tobacco etch virus (TEV) protease cleavage site was inserted between the target protein and the ELP tag. The TEV protease is also tagged with an ELP so that after proteolytic cleavage the ELP tag from the target protein, a single round of thermal cycling can remove both the free ELP tag and the ELP-tagged TEV protease, leaving the purified target protein.

Extending Newton's Apsidal Theorem: Effective Angular Momentum

College of Sciences and Health Professions

Department of Physics

Student Researcher: Cameron Tuckerman

Faculty Advisor: Ulrich Zurcher, Ph.D.

Abstract

Apsidal Shift, or the angular displacement of the orbital apses, is an important quantity in the study of the orbits of planets, starts, and other celestial bodies. The apparent lack of shift of our nearby planets is that on which Sir Isaac Newton based his assumption of the inverse-square relationship in Universal Gravity. The extremely small shift in the orbit of Mercury is one of the many measurements that was used to support Albert Einstein's General Relativity.
Potentials of the form $\mu r^{-(2-n)}$ are of great importance to current and historic scientific research, the Kepler Potential being an example where n=1 (μr^{-1}). The shape of an orbit, while normally thought of as a conic section, only is a conic section for orbits in the Kepler Potential.

To approximate the Apsidal Shift in these power-law central forces, Newton derived his Theorem of Revolving Orbits, also known as Newton's Apsidal Theorem, which states: $\Delta\theta = 2\pi n^{-0.5}$, in the limit that the eccentricity goes to zero (circular orbits). We generalize the method used to correct Mercury's Orbit from General Relativity by approximating the potential as Keplerian with an effective angular momentum. The effective angular momentum defines a rotating reference frame in which we approximate the shape of the orbit as an ellipse. We are able to find excellent approximations for the Apsidal Shift and use our results to generalize Newton's Apsidal Theorem.

Urban Lake Shoreline Characteristic Assessment in Cuyahoga County

College of Sciences and Health Professions

Department of Biological, Geological, and Environmental Sciences

Student Researcher: Kathryn Johncock

Faculty Advisor: Julie A. Wolin, Ph.D.

Abstract

More than 100 mid-size inland lakes and reservoirs (greater than 2.5 acres) are located in highly urbanized Cuyahoga County. Surrounding development, along with poor management and neighboring land-use practices, can greatly influence the water quality of these aquatic ecosystems. Runoff, caused by an increase in impervious surface or a lack of shoreline vegetation, results in excess nutrients entering lakes and is a leading cause of eutrophication. Eutrophication, or over-enrichment by nutrients, stimulates excessive algae and macrophyte (submerged plant) growth. When these organisms die, they settle onto the sediment where they decompose and often create low-oxygen environments, compromising the health of the freshwater community. We assessed shoreline characteristics, macrophyte cover, and algal presence for 35 inland lakes within Cuyahoga County to determine whether there is a correlation between shoreline characteristics and the presence and abundance of algae and submerged plants.

Lake Erie Water Assessment Study

College of Sciences and Health Professions

Student Researchers: Brandon Schaefer; Bill Weber; Buck Depew; Brett Kuharik

Faculty Advisor: Fasong Yuan, Ph.D.

Abstract

Lake Erie's water chemistry is ever-changing and depends primarily on the waters that comprise its 58,800 sq. km drainage basin. Large rivers, such as, the Detroit, Maumee, and Cuyahoga are fed by smaller tributary streams from the surrounding watershed, this amount of inflow accounts for over 90% of the water in Lake Erie. With such a large volume of the lake water coming from rivers that collect surface run-off, it is likely to assume that hypertrophication occurs more rapidly at river mouths, therefore, these spots would not provide an accurate depiction of the lake chemistry. Instead, 2 locations further off shore (3+ miles) and 1 location near shore (river mouth) were used to gather data. Tests using an ion chromatograph unit (ICS-1500), liquid water isotope analyzer (Picarro L2120-i), and a discrete multi chemistry analyzer (AQ-2) were taken to obtain chemical and isotopic analysis for the different lake samples. The relationship between the Cleveland site compared to the other 2 sites is unique by their differences. The Cleveland data is in concert with most river data collected along the Cuyahoga while the other 2 sites are similar to Lake Erie data.

Differential protein expression in *Polystichum acrostichoides* due to metal exposure

College of Sciences and Health Professions

Chemistry Department

Student Researchers: Paul Ilkanich; Pratheek Koneru

Faculty Advisor: Robert Wei, Ph.D.

Abstract

Plants are considered the most cost effective and environmentally sound way to clean up the soils and water contaminated with toxic metals. We focused our studies on the fern species *Polystichum acrostichoides*. One major aim of this project was to determine whether *P. acrostichoides* was capable of hyperaccumulating arsenic and two other toxic metals, lead (Pb) and cadmium (Cd). Another aim was to learn important biochemical changes that occur when the plant is subjected to stress by the toxic metals. Six-eight week old plants were purchased from a local green house and were grown hydroponically for seven days, then ground in liquid nitrogen and stored at -80C upon harvesting. Proteomic analysis and metal uptake measurements were performed using two different concentrations (150 & 300 µM) of metal ions. The determination of metal uptake was performed using HNO3 digestion (USEPA method 3050B) followed by Inductively Coupled Plasma spectroscopy (ICP). The proteomic analysis was performed using polyethelene-glycol fractionation (PEG) followed by one (SDS-PAGE) and two dimensional gel electrophoresis (2-DE) technique. A total of 17 protein spots were up regulated and 3 proteins were down regulated upon various metal exposures, and are arranged to be subjected to liquid chromatography-tandem mass spectrometry for further identification.

Analysis of crossover interference in yeast

College of Sciences and Health Professions

Student Researcher: Hanna Morris

Faculty Advisors: G. Valentin Börner, Ph.D.; Jasvinder Ahuja

Abstract

Meiosis is one type of cell division that produces germ cells. In Meiosis I, the DNA in a diploid cell is doubled and homologous chromosomes separate. In Meiosis II, each pair of sister chromatids are separated, resulting in four haploid daughter cells. The proper segregation of chromosomes is reliant on the homologs pairing up and forming a structure called the synaptonemal complex. This structure holds the two pairs of chromosomes in close proximity through Meiosis I, thus aiding in successful segregation going into Meiosis II. The synaptonemal complex also plays a large role in recombination, holding the chromosomes in place while crossovers are formed along the length of the homologs. The crossovers, or overlapping of chromosomal arms, can result in the recombination of DNA and genetically variable offspring.

Under normal conditions, crossovers form during a stage of Meiosis I called pachytene. It is thought that the synaptonemal complex limits where and how many crossovers occur by causing interference along the chromosomes. The goal of this project was to determine whether specific incubation conditions affect the timing and distribution of crossovers.Three chromosomes containing four unique markers were studied to observe the recombination frequencies of the intervals between any two adjacent markers. The nine intervals were analyzed under several conditions and the number, timing, and distribution of crossovers was determined. Results and their compatibility with current models of synaptonemal complex functions will be discussed.

Role of histone modifications in meiosis

College of Sciences and Health Professions

Student Researchers: Mason Allen; Neeraj Joshi

Faculty Advisor: G. Valentin Börner, Ph.D.

Abstract

Meiosis I is characterized by events taking place between homologous chromosomes called crossing over in which double stand breaks (DSB) are formed and repaired using the homologous chromosome as a template. This ensures genetic diversity and is an important part of gamete viability. DSBs can be repaired using two different templates one being the homologous chromosome while the other is the associated sister chromatid. Repair using the sister chromatid is not favored in meiosis (unlike mitosis). Completion of meiotic DSB repair is controlled by a series of checkpoints that prevent meiotic progression when recombination is defective. Previously, two genes have been identified as important meiotic checkpoints, Gene A and Gene B. The functions of Gene B were identified and the hypothesis is that Gene A must share similar functions prompting the question what is the role of Gene A in meiotic double strand break repair? Research done with *S. cerevisiae* (budding yeast) showed that Gene B had no effect on wild-type spore viability as a single mutant but when combined with mutant Gene C resulted in a drastic decrease in spore viability. This was thought to show that these two genes operate on two parallel paths to control DSB repair in chromosome segregation, with one taking over when the other one was non-functioning. To see if Gene A shared the same role as Gene B, double mutants were created to test chromosome segregation and DSB repair as compared with Gene B deletions. The spore viability of double mutants and their potential implications will be discussed.

Identification of novel meiotic genes via a genetic screen

College of Sciences and Health Professions

Student Researchers: Steven Zimmerman; Rima Sandhu

Faculty Advisor: G. Valentin Börner, Ph.D.

Abstract

Proper segregation of chromosomes in Meiosis I requires proper function of the Synaptonemal Complex (SC), a zipper-like protein structure that facilitates recombination events and segregation of homologous chromosomes. In yeast, Zip1 is the gene that codes for the SC. Zip1C1 is an allele with 33 missing amino acids on the C terminus of the gene whose phenotype is cell arrest in Meiosis. We are conducting a multicopy suppression screen in an effort to discover genes which, when overexpressed, can rescue the cell arrest phenotype of Zip1C1. The screen requires the reproduction of all genes in the yeast genome overexpressed in single colonies and testing for suppression of our mutant phenotype. Candidates which suppress the phenotype show sporulation and fluorescence on media, and have higher spore viabilities compared to our Zip1C1 control.

Structure-Function of U11 snRNA in the minor splicing pathway

College of Sciences and Health Professions

Department of Biological, Geological, and Environmental Sciences

Student Researchers: Mark Biro; Jagjit Singh

Faculty Advisor: Girish C Shukla, Ph.D.

Abstract

In human, the majority of protein coding genes are interrupted by dispensable intervening sequences (introns). These introns are removed by nuclear precursor (pre) mRNA splicing process to produce a mature mRNA needed for productive protein production in the cell. We are studying the splicing of minor class or U12-type introns which are spliced by U11, U12, U4atac, U5 and U6atac snRNAs. U11 snRNA binds to the 5' end or splice site of the intron by RNA-RNA base-pairing to initiate the splicing process. U11 snRNA has been predicted to form an intramolecular clover leaf like RNA structure, which is presumably essential for splicing. However, the existence of the proposed structure and its functional implication still not clear. In this study, we have developed an *in vivo* assay to study structure-function of U11 snRNA. Using a first site mutation suppressor assay we have developed second site mutants of U11 snRNA. These mutant snRNAs were tested for their function by activating the splicing of an artificial minigene in cultured mammalian cells. Our results show the functionality of the genetic mutation suppressor assay in establishing the role of U11 snRNA in nuclear pre-mRNA splicing.

Kinetics of running on arboreal versus terrestrial substrates in Siberian chipmunks

College of Sciences and Health Professions

Student Researcher: Eliza J. Dorsey

Faculty Advisor: Andrew R. Lammers

Abstract

Many mammals travel on both tree branches and flat ground in their natural habitat. Branches are narrow and cylindrical in shape whereas the ground is not; therefore we expect to find differences in the way an animal moves on arboreal versus terrestrial substrates. Force is a good way to measure such differences. We trained five Siberian chipmunks (*Tamias sibiricus*) to run across two different trackways. We filmed them running on a cylindrical trackway (2 cm diameter) as well as a flat trackway (10 cm wide), emulating both arboreal and terrestrial conditions. A portion of each trackway measured force in vertical, fore-aft, and side to side directions. We found that the peak vertical force of the forelimbs was always greater than that of the hindlimbs. We also found that there was generally a shorter step duration time for both limbs on the terrestrial trackway, which could be due to a quicker pace while traveling on a flat surface. Forelimbs were found to have the dominant role in braking on both substrates, while hindlimbs had the dominant role in propulsion on both substrates. However, the forelimb aided in propulsion more so than the hindlimbs contributed to braking on both substrates.

Functional Morphology of Rat Hands and Feet: Correlation with the Ability to Grip Tree Branches During Locomotion

College of Sciences and Health Professions

Student Researcher: Jessica E. Fonce

Faculty Advisor: Andrew R. Lammers

Abstract

Anatomy and function are usually closely related. Since locomotion on tree branches is common among mammals, we expect to find that the anatomy is well adapted for gripping narrow cylindrical branch-like substrates. We hypothesize that the ability of rats to grip arboreal supports relies on musculature responsible for adducting the first digit (thumb and big toe) and opposing medial-most and lateral-most digits. We dissected the hands and feet of four rat cadavers. There is a substantial muscle believed to be responsible for the flexion/adduction of the thumb in the hands. We believe that this muscle is equivalent to the opponens pollicis and/or adductor pollicis in the human hand. We also found lumbricals as well as dorsal and palmar interossei. These lumbricals are probably responsible for flexing metacarpophalangeal joints as necessary for gripping. The palmar interossei are believed to be responsible for the adduction of the rat digits just as they are responsible for adduction of fingers in humans. Foot anatomy looked very similar to that of the hands. Based on the anatomy alone, rats are built for locomotion across cylindrical branches as well as terrestrial substrates.

Are conscious perception and action guidance dissociable in whole-body movement?

College of Sciences and Health Professions

Student Researchers: Laura Elias; Jessica Willesch

Faculty Advisor: Naohide Yamamoto

Abstract

Summary: Conscious recognition of an object ("what") and guidance of action toward it ("how") have been identified as two dissociable processes of perception in visual, auditory, and somatosensory systems. The current study investigated whether the two dissociable processes of perception can also be observed in whole-body movements that encompass not only somatosensory (proprioceptive) inputs but also vestibular inputs. In two experiments, blindfolded participants walked along linear paths (2-10 m) with or without wearing a backpack. At the end of each path, participants faced the starting position and pulled a length of tape that matched the walked distance. They then gave a verbal estimate of perceived distance walked. Motoric tape-pulling responses were based on "how" processes and verbal estimation was mediated by "what" processes. It was predicted that tape-pulling and verbal responses would be affected differently by the backpack, if "what" and "how" processes were dissociable in nonvisual walking. Contrary to this prediction, results showed that both types of responses were not modulated significantly by the backpack, suggesting that the "what" versus "how" dissociation may not be clearly made in whole-body movement.

A Low Cost Motion Analysis System Based on Kinect

Fenn College of Engineering

Student Researchers: Tracy Jennemann; Sam Yokoyama; Vitaliy Sinyuk; Jonathan Cardinale

Faculty Advisors: Wenbing Zhao; Nigamanth Sridhar; Ann Reinthal

Abstract

The project focused on the validation of using the Kinect sensor to build a low cost motion analysis system for physical therapy and rehabilitation, and the identification of the types of the motions that cannot be captured well by the Kinect sensor and are in need of inertial sensors. The validation of the Kinect sensor accuracy is done by comparing the joint positions reported by Kinect and those captured by an 8-camera high-end motion analysis system installed in the Motion Analysis Lab at the School of Health Sciences. The results show that the Kinect sensor reports very accurate positions for moving joints and relatively accurate positions for stationary joints. The use of aggressive smoothing technique can improve the accuracy of the stationary joints positions. However, for motions involving subtle rotations, it is beyond the capability of the Kinect sensor and the inertial sensors have to be used. This limitation is important because to characterize the quality of the exercise, it is essential to identify places where transverse plane rotation is needed or should be avoided.

Steering Adaptation in a Driving Simulator

Fenn College of Engineering

Department of Civil and Environment Engineering

Student Researcher: Brian Moran

Faculty Advisor: Jacqueline Jenkins Ph.D., PEng.

Abstract

Steering adaptation in a driving simulator occurs when participants, who possess the skills necessary to control a vehicle, modify their use of the steering controls to successfully interact with a driving simulator. Addressing adaptation in driving simulation experiments is important because of the need to produce quality data, in an economical fashion, while maintaining ethical practices. Adaptation is generally addressed by having participants drive a practice scenario of a fixed length or fixed time, or by having them drive until they feel comfortable controlling the vehicle. To ensure adaptation has occurred, quantitative methods have been proposed to analyze measures of accuracy and efficiency.

This study was focused on examining the improvement in the accuracy of a steering task while the efficiency of the task remained constant. Twenty five participants were asked to perform a target acquisition task while maintaining a constant travel speed of 25 miles per hour. As expected, the accuracy of the steering task improved over time and could be used to infer whether participants had adapted. This approach is sensitive to individual driving styles, as it is free of any threshold, criterion, or benchmark value and can be applied to any steering task at any driving speed.

Simulation and Control of an Intelligent Prosthetic Knee with Biogeography-Based Optimization

Fenn College of Engineering

Department of Electrical and Computer Engineering

Student Researcher: George Thomas

Faculty Advisor: Dan Simon

Abstract

Traditional, passive leg prostheses for transfemoral amputees require the user to produce unnaturally large actuations in order to walk. The resulting motions can cause joint degeneration and arthritis. To avoid this, a semi-active prosthetic knee using hydraulics to store and release energy has been developed. This prosthesis can potentially reduce the compensative forces and torques that the user must supply at the hip. The hydraulic knee actuator of this prosthesis is controlled using electronic valves, and the nonlinear nature of human body dynamics means that it is difficult to control these valves to achieve gait. Because of the nonlinearity of this system, this problem is well suited to tuning with biogeography-based optimization (BBO). In our work this summer, we have improved upon a previous simulation model for this leg, and we have developed preliminary valve control results in this simulation software with BBO.

Microcontroller Based ECG Amplifier

Fenn College of Engineering

Department of Electrical and Computer Engineering

Student Researcher: Berney Montavon

Faculty Advisor: Dan Simon

Abstract

A microprocessor that reads ECG data and detects heart arrhythmias can help keep people safe while working in high-risk environments. Mining professionals, firefighters, and athletes have strenuous jobs that would benefit from non-invasive ECG monitoring. We use a Microchip Peripheral Interface Controller (PIC) for serial peripheral interface (SPI™) communication with a Texas Instruments ADS1298 development board. The ADS1298 is an 8-channel analog-to-digital converter (ADC) that is configured to record ECG data at a rate of 250 samples per second. The PIC is a master to the ADS1298 slave and is responsible for writing registers, receiving ECG data, and transmitting the data to a PC through an RS-232 serial connection. Our ADS1298 is configured to receive four channels of ECG data and up to four channels of accelerometer data, which are used to measure the noise due to acceleration that is embedded within the ECG signal.

Investigating Axonal Biology Using Microfluidic Devices

Fenn College of Engineering

Department of Biological, Geological and Environmental Sciences[a]
Department of Chemical and Biomedical Engineering[b]

Student Researchers: James K. Deyling [a] ; Brittany Kastan [b]

Faculty Advisor: Chandrasekhar Kothapalli, Ph.D

Abstract

During nervous system development, various diffusing biomolecules play a critical role in neurite outgrowth and guidance, resulting in the formation of a complex circuitry. However, the precise mechanism by which these molecules are spatio-temporally delivered to the growing tip of the neurites is unclear. To overcome the limitations of conventional *in vitro* cultures, we developed and implemented a sophisticated microfluidic platform to facilitate high-throughput screening, *in situ* imaging, enhanced reproducibility and quantification, and tight spatio-temporal control on biomolecule delivery and sensing. The device consists of a central chamber for cell seeding within 3D gel, flanked by two side (source and sink) channels for gradient generation. Quantification of gradients within the device using immunofluorescence detection of 10 kDa FITC-Dextran diffusion, and computational studies using COMSOL®, demonstrated the establishment of a steep biomolecular gradient across the 3D collagen-1 gel within 180 min, and stable up to 24 h. Cortical neurons derived from rat brain and seeded within 3D collagen gel exhibited excellent survival and neurite outgrowth under controlled gradients within the device, relative to controls. Overall, the results suggest to the utility of this device for studying neurobiology, tissue engineering and cell migration.

The Study of Bone Diffusion in Canine Tibia

Fenn College of Engineering

Department of Chemical and Biomedical Engineering

Student Researcher: Mariela Gonzalez-Nieves

Faculty Advisor: Joanne M. Belovich

Abstract

The provision of nutrients is imperative in order to maintain healthy bone structure. Bones are composed of dense connective tissues that are consistently reforming making it difficult for simple diffusion of large signaling molecules to occur. Fully understanding the rate at which nutrients, minerals, and waste travel throughout bone could lead to solutions to problems such as bone illnesses, breaks, and integration of prosthetics in the human body. Enhanced targeted medication delivery can be established as well.

In this particular case study, experimentation performed by K. Farrell in 2011 yielded an overall average diffusion coefficient of $1.3 \times 10^{-7} \pm 2.0 \times 10^{-8}$ cm²/s while the current experiments yielded average diffusion coefficients of $2.6 \times 10^{-6} \pm 1.5 \times 10^{-7}$ cm²/s. The results are an order of magnitude different. This difference could be attributed to the 2 orders-of-magnitude increase in solute concentration used in this work. Other possible explanations may be the increased age of the bone sample, during which the lipids and proteins may have degraded over time.

Diffusion coefficients differ among the quadrants of each section. This is, in some cases, due to the canaliculi and haversian canals within the sample.

Characterization of Heterogeneous Reaction Systems by Thermal Analysis and Mathematical Modeling

Fenn College of Engineering

Department of Chemical and Biochemical Engineering

Student Researchers: Shreya Adhikari; Chuck Tillie

Faculty Advisor: Jorge E. Gatica, Ph.D.

Abstract

In recent years, aluminum alloys have become a primary option as an alternative to low-carbon steels for uses in the automobile and aerospace industries. Metals are typically coated in a pre-treatment process for the purposes of resistance to corrosion and high-temperature degradation; however, this has been achieved for decades via chromate-based processes, which are now known to have severe environmental consequences. Such processes have been targeted for elimination by the United States Environmental Protection Agency. There is a marked movement to phase these processes out in the near future in favor of alternative, environmentally friendly options. This research focuses on calorimetric analysis and mathematical modeling to develop an alternative process using an aryl phosphate capable of forming films on iron-containing surfaces. This research shows that these ester phosphates can promote organic coatings on aluminum substrates when supplemented by iron additives. The film-forming reaction is monitored using a differential scanning calorimeter, and the kinetic parameters (namely, the pre-exponential factor, order of reaction, and activation energy) are extracted through differential kinetic analysis. It is anticipated that this research will lead to scale-up parameters that can be used to model a laboratory-scale deposition furnace, and guide further experimentation to advance technologies for protective and conversion coatings.

Energy analysis of Bio-ethanol Dehydration Using Pervaporative Processes

Fenn College of Engineering

Department of Chemical and Biochemical Engineering

Student Researcher: Michel E. Kahwaji-Janho

Faculty Advisor: Jorge E. Gatica, Ph.D.

Abstract

Environmental effects and health hazards posed by fossil-fuel based technologies complemented by changes in the global economy have increased the demand for "cleaner" and more efficient technologies. Developments in technologies that rely on renewable or synthetic resources have therefore become more relevant in today's economy and current industrial outlook. An alternative, commonly referred to as bio-fuels, has significantly matured and brought the significance of producing ethanol from renewable resources to the forefront in energy R&D. Moreover, the potential of ethanol to be further converted to hydrogen makes it a very attractive alternative to replace or complement fossil fuels as sources of energy. One of the major hindrances in advancing bio-fuels in general, and ethanol technologies in particular, are the costs involved in one of the critical steps in reaching fuel-grade standards: the dehydration stage. This study focuses on a critical assessment of pervaporation as a dehydration technique in the production of ethanol from sugar-cane. Energy demands of various separation schemes using this technique are evaluated.

Adhesion and proliferation of red fluorescent U87 cells in a mirco-incubator

Fenn College of Engineering

Department of Chemical and Biochemical Engineering

Student Researcher: Rebecca L. Jensen

Faculty Advisors: Surendra N. Tewari; Joanne M. Belovich

Abstract

Availability of bone forming osteoblast cells from genetically modified green fluorescing protein (GFP) expressing mouse opens up the possibility of carrying out live cell imaging of the cells as they adhere, migrate and proliferate on nano-texture modified opaque metallic surfaces. This will lead to improved bone implant materials. A micro-incubator has been designed for this purpose. Adhesion and proliferation of human brain red fluorescent protein U87 cells on a titanium alloy were studied to establish the feasibility of such a research in terms of contamination free live examination of cells over a prolonged period of time. It has been possible to observe and record for seven to eight days the live adhesion and proliferation of U87 cells on titanium surface. Cells inoculated at a density of 200 cells/mm^2 proliferated 131% over a one week period.