CLEVELAND STATE UNIVERSITY
engagedlearning™

2016 UNDERGRADUATE RESEARCH POSTER SESSION

Abstracts

STUDENT CENTER ATRIUM
THURSDAY, SEPTEMBER 1, 2016
10 AM - 2 PM

Sponsored by the Office of the Provost, the Office of Research, and the Office of the Vice Provost for Academic Programs

---

Office of Research

www.csuohio.edu/student-research

2016 Undergraduate Summer Research Award Poster Session

Poster Number	Title of Poster
College of Education and Human Services	
1	Measuring Urban High School Student Outcomes in a Protein Design Course
2	"Say it in Polish!": The Role of Heritage Language in preserving culture among families of Eastern European Origin

College of Liberal Arts and Social Sciences	
3	Voices of Incarcerated Mothers
4	Protest Voices: Using Activist Oral Histories to Teach Historical Thinking

College of Sciences and Health Professions	
5	Synchronization of Cell Growth Makes Capture of G2 Phase Cells Possible
6	Identification of Factors that Mediate Strand Exchange During Early Meiosis at Low Double Strand Break Levels
7	African Clawed Toads' Responses to Visual and Lateral Line Stimuli
8	Biostatistical Analysis on the Effects of the Circadian Clock & Glucose Genes on Different Feeding Regimens
9	Effect of Calorie Restriction on Circadian Rhythms of Glycolytic Enzymes in Mice
10	Expression of Recombinant Proteins in Bacteria for Antibody Production
11	Understanding the expression and trafficking of Plasmodium falciparum Maurer's clefts proteins
12	Bioinformatic Analysis of the Sodium Hydrogen Exchanger Protein in Plasmodium yoelii
13	Sequential and dynamic RNA:RNA base-pairing interactions between U6atac and U12 snRNAs predicted to form Helix 1a and Helix 1b
14	Effect of hypoxic conditions on skeletal myoblasts
15	Effect of p38 kinase and cell cycle position on the expression of the pro-apoptotic Bcl2 family member PUMA in skeletal myoblasts
16	Phosphorus concentrations in the Cuyahoga River watershed linked to anthropogenic inputs
17	The identification of anti-cancer molecular targets of COX-2 inhibitor Nimesulide
18	Synthesis and Characterization of Lectin Mimetics (Neo-Lectins)
19	The Relationship Between Observed and Perceived Measures of Balance Stability
20	The Use of iPad Pros as an Assistive Device in Occupational Therapy
21	The Effects of Superior Laryngeal Nerve lesion on Swallowing Kinematics and Airway Protection
22	Dialects Accents and Intelligence: A Study on Dialectal Perceptions
23	Variation of bone microarchitecture within and among contemporaneous species of fossil horses: Feasibility
24	Defining an Enriched Environment for Pre-Ambulation Training using a Multi-Directional, Over-Ground Harness System for Young Children with Down Syndrome
25	Elimination of Acoustical Noise for STM Examination of Pentacene Crystallization on Si (001)
26	Elimination of Acoustic noise in STM Analysis of Polymer Crystallization on Au (111)
27	Cloud Overlap of Cumuliform Clouds in the Shallow Boundary Layer
28	Which Clouds are Important: Variation of Cloud Size Distribution Functions in Large Eddy Simulations
29	How Big is a Cloud: A Statistical Analysis of Cloud Size Distributions Derived from Large Eddy Simulations

30	How Dry is the Lower Atmosphere: Finding Relations Between Various Moments in the Atmospheric Boundary Layer
31	Optimizing Dynamic Light Scattering for the Analysis of Anisotropic Nanoparticles in Solution
32	Correlating Wet-sample Electron Microscopy with Light Scattering Spectroscopy on the Example of Polymeric Microgels
33	Effects of Flanking Bigrams on Decision Performance in Selective and Divided Attention Tasks
34	Effect of parental communication on adjustment of typically developing children with an atypically developing sibling
35	How does educational opportunities influence decisions for Nigerian girls and the society?

College of Sciences and Health Professions and Washkewicz College of Engineering	
36	Life Behind Glass: Bioreactor studies on the Salt-water adaptation of Scenedesmus dimorphus
37	Glycerolipid Analysis of Adaptation to Saline Changes in the Culture Conditions of Algae, Scenedesmus dimorphus, by GC-MS
38	Design and Fabrication of a Microfluidic Device using a 3D Printer
39	Light Scattering Characterization of Elastin-Like Polypeptide Trimer Micelles
40	Light Scattering Study of Mixed Micelles Made from Elastin-Like Polypeptide Linear Chains and Trimers
41	Scalable Assembly of Nanoparticles onto Templated Substrates
42	Identifying Patterns of Stress Through Biological Markers

Maxine Goodman Levin College of Urban Affairs	
43	The Digitalization of and Research with Real Estate Archival Records: A Longitudinal Study of Changes in Land Use on Miles Avenue

Washkewicz College of Engineering	
44	Design and Development of a Microfluidic Platform to Induce Mechanical Stimuli on Growing Axons
45	High-Throughput Assessment of Developmental Stages of NSCs via Promoter-Reporter Assay System Using Recombinant Lentiviruses
46	Layer-by-Layer Printing of Alginate for Cancer Cell Migration Assays
47	Effect of Salt Concentration on the Composition of Elastin-Like Polypeptides in the Condensed Coacervate Phase
48	Designing Genes that Encode Proteins for Biomedical Applications
49	Design and Characterization of Protein-Based Bioink
50	Explaining Simulator Sickness
51	GPU Assisted High Performance RSA Encryption
52	Privacy-Aware Human Tracking Using Kinect and Android Smart Watches
53	Characterization of Aerospike Nozzle Flows
54	Ground Reaction Force Measurement with a Piezoelectric Insole
55	Bent Knee Adaptor for Experimental Testing of Prostheses
56	Computing Human Arm Stiffness for the Purpose of Robotic Simulation
57	Correcting Reaching Movements Using Force Sensors and Robot Simulation
58	Prediction of Muscle Torque Production for the Control of a Paralyzed Arm
59	Wrist-Mounted Feedback System: Monitoring Force and Torque in Six Degrees of Freedom

Measuring Urban High School Student Outcomes in a Protein Design Course

College of Education and Human Services

Student Researcher: James Gillahan

Faculty Advisor: Robert L. Ferguson

Abstract

STEM (Science Technology Engineering and Mathematics) focused high schools have previously shown promising outcomes in the urban districts, where low income students have lower graduation rates, college acceptance and less access to advanced fields of study as compared to students of wealthier school districts. Modeling a protein design course from a private school, we aim to develop curriculum for a biotechnology course for an urban high school. Biotech is an emerging multidisciplinary field that could have similar outcomes to STEM education. We also aim to measure outcomes including student perspective of resulting STEM and career choice, using ethnographic methods.

"Say it in Polish!" The Role of Heritage Language in preserving culture among families of Eastern European Origin

College of Education and Human Services

Student Researchers: Beth Friedman-Romell, Taylor Darfus, and WanCheng Tsai

Faculty Advisors: Grace Hui-Chen Huang, Diane Kolosionek, and Mary Gove

Abstract

This project is part of a larger qualitative research study exploring the relationship between Eastern European American parenting styles and children's academic achievement. Seven mothers who were either first- or second-generation Eastern European American participated in semi-structured individual interviews. This project focuses on heritage language preservation. It revealed motivations, strategies, and outcomes of parents' desire to transmit their heritage language to the next generation. All participants had at least one child between ages five and eighteen. Based on our findings, four themes have emerged: 1) Motivations for heritage language preservation; 2) Resources and strategies to foster heritage language learning; 3) Family factors affecting heritage language transmission and fluency; and 4) Children's evolving attitudes to heritage language.

Voices of Incarcerated Mothers

College of Liberal Arts and Social Sciences

Student Researchers: Markisha Robinson, Lukas Hamlescher, and Jasmine Conkle

Faculty Advisors: Jill Rudd and Kim Neuendorf

Abstract

This project was two-pronged—it explored the impact of video journaling on functional outcomes for incarcerated mothers, and it created documentary content for understanding methods for changing knowledge and attitudes toward incarcerated mothers in the general population. The project team developed and executed a three-week original, pilot video reflective journaling program for incarcerated mothers at the Ohio Northeast Reintegration Center (NERC). Using the Motivation Enhancement and Therapy perspective, emergent themes for successful re-entry of the women into their families were discovered. And, the team collected a wide array of documentary assets—focus groups and individual interviews of incarcerated and released mothers, the video journaling, person-on-the-street interviews, and B-roll footage--for inclusion in stimulus materials for experiments to test the power of different documentary forms for "changing hearts and minds" with regard to incarcerated mothers.

Protest Voices: Using Activist Oral Histories to Teach Historical Thinking

College of Liberal Arts and Social Sciences

Student Researchers: Amanda Gedeon and Christopher Morris

Faculty Advisors: Shelley Rose and J. Mark Souther

Abstract

The goal of Protest Voices was to create classroom resources using oral history interviews for use in social studies classrooms. Oral histories remain underutilized as primary sources. In an effort to engage students with the historical thinking process, we created clips from oral history interviews of Cleveland-area peace activists and connected those clips to the Ohio Department of Education Social Studies standards. Our work focused on collecting interviews from individuals who were involved in anti-Vietnam protests and members of the Cleveland Latin American Mission team to El Salvador, as well as the InterReligious Task Force. The project created a collection of twelve oral history interviews and numerous clips for classroom use. According to the Oral History Association, oral history interviews "foster intergenerational appreciation and an awareness of the intersection between personal lives and larger historical currents."[1] Our aim was to connect educators, and thus students, with the voices of those who witnessed historical events in order to bring history alive and facilitate the historical thinking process. All of the interviews conducted are archived in the Cleveland Regional Oral History Collection and clips are part of the History Speaks blog.

[1] Debbie Ardemendo and Katie Kuzmar, "Principles and Best Practices for Oral History Education," Oral History Association, 2014. http://www.oralhistory.org/oral-history-classroom-guide/.

Synchronization of Cell Growth Makes Capture of G2 Phase Cells Possible

College of Sciences and Health Professions

Student Researchers: Maryam Assar and Noopur Joshi

Faculty Advisor: G. Valentin Börner

Abstract

During meiosis, homologous chromosomes, one set maternal and the other set paternal, pair with one another. Pairing is a prerequisite for crossing over, where allelic regions on homologs break and recombine with the corresponding homolog. This crossing over results in recombinant chromosomes that in turn increase genetic diversity. What causes the homologs to pair at specific sites is unknown. We are investigating whether specific DNA sequences are involved in pairing. Our first step to identify pairing sites involves mitotic cells of budding yeast in order to isolate pairing regions in sister chromatids. Mitotic cells are used instead of meiotic cells since in haploid vegetative cells pairing can only occur between sister chromatids whereas pairing may occur between sister chromatids and/or homologs in meiotic cells. To isolate pairing regions, it is essential to capture the cells at a stage of the cell cycle when sister chromatids are present in the nucleus. The G2 phase of the cell cycle represents such conditions. Cell cultures were synchronized through initial starvation and then placement in rich growth media. In order to determine whether a sizable portion of the cells were in G2, the culture was analyzed at each time point using microscopy with a fluorescent dye that specifically interacts with DNA (DAPI). A systematic categorization based on cell morphology was used to determine the number of cells in G1, G2, S-phase and mitosis. We found that the optimal time for starving the cells in YPA medium was 17 hours. Following to rich YPD medium, growth for 2.5 hours gave the highest percent of G2 cells. In two vegetative cultures, 28% of cells were at G2 at this point. Given these results, we will be able to enrich for paired homologous sequences utilizing an appropriate molecular assay. Such isolation of paired DNA sequences will assist in decoding the foundations of genetic diversity.

Identification of Factors that Mediate Strand Exchange During Early Meiosis at Low Double Strand Break Levels

College of Sciences and Health Professions

Student Researchers: Isaac Kuragayala and Rima Sandhu

Faculty Advisor: G. Valentin Börner

Abstract

Genetic recombination is essential in order to create diversity amongst all of the genetic information. Crossovers also contribute to segregation of homologous chromosomes to opposite spindle poles during the first meiotic division. Meiotic strand exchange in *Saccharomyces cerevisiae*, budding yeast, aims to diversify genetic information in the resulting gametes which in budding yeast are called spores. While Dmc1 and Rad51 are two proteins that are known to play a role in double strand break (DSB) repair, the exact function of Rad51 is still unclear. It is known that Rad51 is responsible for strand exchange in mitosis, but it is still present in meiosis, even when Dmc1's catalytic strand exchange activity alone is sufficient for repairing DSBs into crossovers. In this project, we carried out a budding yeast strain construction to identify the function of three proteins in strand exchange during early meiosis, when nucleus-wide DSB levels are low. So called Spo11 hypomorphs were used to lower DSB levels during meiosis and thus mimic the conditions of early meiosis. Spo11 hypomorphs express a version of the DSB forming topoisomerase homolog Spo11 that exhibits reduced activity. Three strains (A, B and C) which express a catalytically inactive version of the A gene, or a presumed activator of the A protein, were mated with a Spo11 hypomorph, and haploid spores were derived from diploid precursor cells. Double and triple mutants were identified based on antibiotic marker genes associated with the respective mutations. Southern blot analysis was used to confirm the presence of the relevant mutations in genomic DNA extracted from spore offspring. We hypothesize that during early meiosis at low DSBs, a distinct subset of proteins, including genes A and B, mediate strand exchange during homologous recombination, with protein A functioning as a potential activator of protein B.

African Clawed Toads' Responses to Visual and Lateral Line Stimuli

College of Sciences and Health Professions

Student Researchers: Marko Milosavljevic and Kevin Goth

Faculty Advisor: Jeffrey Dean

Abstract

The African Clawed Toad, *Xenopus laevis*, is an aquatic species commonly found throughout Sub-Saharan Africa. Adults use vision to sense movements and lateral line to sense vibrations in the water. Here, we analyze the effectiveness of the toads' vision and lateral line systems individually and in combination. This study will help us understand how *Xenopus* utilizes sensory information to capture prey. We tested which sensory system elicits greater responses, how stimulus angle and distance affect the probability of a response, and if the toads respond equally to visual and lateral line stimuli.

We found that a combination of both visual and lateral line stimuli elicited the greatest response rate (55%). Compared to this, lateral line stimuli alone elicited almost equal response rates (42%). In contrast, visual stimuli alone were less effective (12%). In addition, toads were more likely to respond to rostral stimuli than to caudal stimuli. When a response was elicited, latencies did not differ according to stimulus type.

Biostatistical Analysis on the Effects of the Circadian Clock & Glucose Genes on Different Feeding Regimens

College of Sciences and Health Professions

Student Researchers: Rana Faraj and Nikkhil Velingkaar

Faculty Advisor: Roman V. Kondratov

Abstract

Circadian clocks are internal biological systems that control many physiological processes. The circadian clock is considered to be the master regulator of metabolism in mammals. The molecular metabolism is not very well known. The circadian clock regulated expression in metabolic enzymes and in turn, diet also regulates circadian clock on a molecular level. To better understand the interaction between circadian clock and metabolism, mice were subjected to different feeding regimens and metabolic tissue, such as liver and skeletal muscles, have been collected across the circadian cycle. Expression of genes have been analyzed in the liver using RT-QPCR. Large set of experimental data on the expression of circadian clock genes and metabolic genes in the liver of mice on different feeding regimens across the circadian cycle has been collected. My task is to analyze using the statistical analysis which treatment has statistically significant effect on rhythms of gene expression. First, I will have to work with three softwares on some data that has been previously analyzed in order to understand how it works and find out the most appropriate one to use. Once that has been done, I will select the software and use future data in this particular software. The complexity of this task is complicated because it comes from multiple parameters, such as several diets and time of day, which might have effect on gene expression.

**Supported by the McNair Scholars Program*

Effect of Calorie Restriction on Circadian Rhythms of Glycolytic Enzymes in Mice

College of Sciences and Health Professions

Student Researchers: Enas A. Muhammad, Artem Astafev, and Kuldeep Makwana

Faculty Advisor: Roman V. Kondratov

Abstract

Multicellular and unicellular organisms have all proven to exhibit circadian rhythms which persist over approximately 24 hours. This internal time keeping system is responsible for regulating the body's biological functions. It has been known that calorie restriction effects circadian rhythms by causing a response in clock gene expression. These clock genes react to food intake and become either upregulated or downregulated accordingly. With glycolysis being a biological pathway that occurs in most organisms, measuring glycolytic gene expression in the liver tissue of young male mice becomes of interest. More specifically, hexokinase, PFK-1, and pyruvate kinase are the enzymes of interest. By analyzing the expression of key regulatory glycolytic genes in the liver tissue of mice, the importance of how diet effects circadian rhythm will be revealed. Results have shown that calorie restriction has some effect on circadian rhythms of glycolytic gene expression. We propose that if calorie restriction effects the circadian rhythms in the expression of glycolytic genes, then a down regulation in the profiles of ad libitum mice will be seen and an upregulation of calorie restricted mice's genes will be shown.

**Supported by the McNair Scholars Program*

Expression of Recombinant Proteins in Bacteria for Antibody Production

College of Sciences and Health Professions

Student Researchers: John Sabljic, Anton Denisyuk, Hallie Schmolz, and Olivera Prica

Faculty Advisor: Bibo Li

Abstract

The protozoan parasite *Trypanosoma brucei* causes fatal African trypanosomiasis in humans and nagana in cattle. Transmitted by the tsetse fly, *T. brucei* proliferates in the bloodstream of its mammalian host and evades the host's immune response by regularly switching its major surface antigen, VSG, which forms a thick coat on its cell membrane. VSGs are exclusively expressed from sub-telomeric regions of the *T. brucei* genome in a strictly monoallelic fashion. Telomeres, DNA-protein complexes located at chromosome ends, help maintain chromosome stability and integrity. We have also found that telomere proteins are important for regulating VSG expression and switching.

We are currently studying functions of telomere proteins in antigenic variation. Antibodies against several proteins including a novel telomere protein, *Tb*1710, the catalytic subunit of telomerase, *Tb*TERT, and a DNA recombination protein involved in DNA damage repair, *Tb*RAD51, are important reagents enabling us to detect these molecules using molecular approaches. We therefore aim to express recombinant proteins in bacteria and raise customized antibodies that specifically recognize these proteins. We have made all expression constructs for these recombinant proteins and are currently purifying these proteins.

Understanding the expression and trafficking of Plasmodium falciparum Maurer's clefts proteins

College of Sciences and Health Professions

Student Researchers: Sophia DeGeorgia, Katharine Komisarz, Ashka Patel, and Raghavendra Yadavalli

Faculty Advisor: Tobili Sam-Yellowe

Abstract

Malaria is a potentially fatal disease caused by parasites in the genus *Plasmodium*. Of the five species that cause human malaria, *P. falciparum* causes an estimated 1 million deaths annually, particularly in young children in sub-Saharan Africa. *Plasmodium falciparum* is most commonly found in tropical and subtropical regions of the world. After invasion into human red blood cells, parasite induced transport structures known as Maurer's clefts, are formed within red cells. In previous studies, two Maurer's clefts proteins were identified; an approximately 130 kDa peripheral membrane protein and a 20-kDa integral membrane protein. Immunofluorescence and confocal microscopy identified both proteins within large cytoplasmic vesicles in the red cell cytoplasm. The 20 kDa protein, known as *P. falciparum* Maurer's cleft two transmembrane protein (PfMC2TM), is encoded by a family of genes identified using proteomic analysis of immune complexes (IC). The gene encoding the 130 kDa protein is unknown. Furthermore, the mechanism of protein trafficking after protein expression is also unknown. Our goal in this study was to prepare IC using schizont extracts for use in proteomic analysis to identify the gene encoding the 130 kDa protein, identify the pathway of protein traffic using Brefeldin A (BFA) in *P. falciparum* cultures and perform bioinformatics analysis of the *PfMC2TM* gene family using the database, PlasmoDB (plasmodb.org). The 110 kDa Rhop-3 rhoptry protein and PfMC2TM were identified using immunoprecipitation and western blotting analysis of parasite extracts prepared with Triton X-100 in stage specific and BFA treated parasites. PfMC2TM proteins encoded by family members in *P. falciparum* strains 3D7 and IT were compared to one another and across species in *P. reichenowi.* Among the proteins encoded by paralogs in *P. falciparum,* there were some differences found. However, there was no reported expression data annotated for *P. reichenowi* within PlasmoDB. Increasing knowledge of the Maurer's clefts proteins is crucial in understanding *P. falciparum* biology and the role of the clefts in malaria vaccine development.

Bioinformatic Analysis of the Sodium Hydrogen Exchanger Protein in Plasmodium yoelii

College of Sciences and Health Professions

Student Researchers: Jamira Virk and Raghavendra Yadavalli

Faculty Advisor: Tobili Sam-Yellowe

Abstract

Since its discovery over 100 years ago, malaria has been the most important parasitic disease in the world. Malaria affects about 300 to 500 million people every year; killing 5 million people every year. The most virulent causative agent in humans is Plasmodium falciparum; it is an important member of the phylum Apicomplexa, which also includes Toxoplasma gondii. These organisms contain specialized, unique structures, including rhoptry organelles. In Plasmodium and Toxoplasma gondii, they assist invasion into the host cell. Analyses have been performed on proteins located in rhoptries in Toxoplasma and Plasmodium. Among the proteins that have been analyzed, the sodium hydrogen exchanger protein has been found in these parasites, but not much is known about its characterization and function in Plasmodium. This protein was found to be localized in the rhoptries in Toxoplasma gondii in an experiment performed by Karasov et. al. The protein homologue in T. gondii, TgNHE2, has become the first intracellular sodium hydrogen exchanger (NHE) characterized in a protozoan parasite. Proteome analysis show that there are four NHE2 in T. gondii, but only two are known in the parasite. Comparative analyses including protein sequence alignments were performed showing the relationship of this protein across several species. This protein is found across several species of Apicomplexa and vary widely in size and weight. The four proteins that were analyzed were two strains in P. falciparum (PFIT_1302700 and PF3D7_1303500), P. yoelii (PY02931), and T. gondii (TGME49_105180). The analysis shows regions of similarity in the location of the transmembrane domains amongst PFIT, PF3D7, and PY02931. These species also contain regions of asparagine-, aspartic acid-, and lysine-rich regions that overlap. This protein is also present in mammals, in the mitochondria. It is primarily characterized as an intracellular protein in mammals although it is found in the plasma membrane of certain cells. The characterization of this protein in T. gondii will provide a groundwork in better understanding its function in Plasmodium, specifically P. falciparum.

**Supported by the McNair Scholars Program*

Sequential and dynamic RNA:RNA base-pairing interactions between U6atac and U12 snRNAs predicted to form Helix 1a and Helix 1b

College of Sciences and Health Professions

Student Researchers: Maitri Patel and Jagjit Singh

Faculty Advisor: Girish C. Shukla

Abstract

In eukaryotes, pre-mRNA splicing is important step for gene expression. Splicing is a two-step process which is carried out by a multi-megadalton molecular weight ribonucleoprotein (RNP) machinery called spliceosome. Spliceosome converts pre-mRNA to mRNA by removing non-coding sequence (introns) and splice together coding sequence (exons). Mammalian pre-mRNA are spliced by two different class of spliceosomes which are known as U2- and U12- dependent spliceosomes. U12 dependent spliceosome is composed of five small nuclear RNAs (snRNA). As compared to U2-dependent spliceosome, there is very less known about the catalytic process of U12-dependent splicing. U6atac and U12 snRNA are central to U12-dependent splicing. Therefore, to understand importance of U6atac and U12 snRNA interaction during splicing we have created a series of 2nd site nucleotide mutations in both U6atac and U12 snRNA to test for their functionality in in vivo splicing assays. Our work will help to better understand the catalytic process of minor class spliceosome and involvement of these snRNA in mammalian gene expression and genetic disorders.

Effect of hypoxic conditions on skeletal myoblasts

College of Sciences and Health Professions

Student Researchers: Abdo Boumitri and Shuai Zhao

Faculty Advisor: Crystal M. Weyman

Abstract

Ischemic injury in skeletal muscle caused by hypoxic (low oxygen) conditions occurs in response to vascular and musculoskeletal traumas, diseases and following reconstructive surgeries. Thus, a thorough understanding of the effect of hypoxia on skeletal myoblasts is warranted to identify potential therapeutic targets. We have determined that treatment with cobalt chloride (to mimic hypoxic conditions) leads to decreased numbers of viable (attached) skeletal myoblast over time and an increase in the percentage of detached myoblasts. To determine the contribution of apoptosis (cell death) to this increase in detached myoblasts, we assessed PARP cleavage, a well-accepted marker for apoptosis. Consistent with cell death via the apoptotic process, PARP cleavage was detected following cobalt chloride treatment. We next assessed the effect of cobalt chloride on the expression of the pro-apoptotic Bcl2 family member PUMA. We determined that after three hours, cobalt chloride treated myoblasts possessed PUMA mRNA levels six times greater than untreated myoblasts. Further, this increase in PUMA mRNA resulted in a three-fold increase in PUMA protein. Future experiments will focus on determining the mechanism whereby cobalt chloride treatment results in increased PUMA levels.

**Partially Supported by the McNair Scholars Program*

Effect of p38 kinase and cell cycle position on the expression of the pro-apoptotic Bcl2 family member PUMA in skeletal myoblasts

College of Sciences and Health Professions

Student Researchers: Victoria Bensimon and Briana Boslett

Faculty Advisor: Crystal M. Weyman

Abstract

Skeletal muscle regeneration relies on myoblast stem cell differentiation and is a crucial response to muscle injury caused by trauma and numerous diseases. In skeletal myoblasts, cell death and differentiation are mutually exclusive biological endpoints that are both induced by culture in differentiation media. MyoD, the master muscle-specific transcription factor, is well-known to regulate the expression of muscle specific genes such as myogenin and the ensuing differentiation. However, we have previously reported that MyoD also plays a critical role in the expression of PUMA and apoptosis, rather than myogenin and differentiation, in a subset of myoblasts, thus diminishing the regeneration. It is, therefore, critical to understand the molecular events that distinguish between this coordinate regulation of differentiation and apoptosis by MyoD. p38 kinase is known to be required for the expression of myogenin. Herein, we report that pharmacological inhibition of p38, while diminishing the expression of myogenin, actually enhances the expression of PUMA. Since myoblast cell cultures are asynchronous, we hypothesized that cell cycle position may contribute to this molecular distinction. To investigate this possibility, we have successfully synchronized cultures and experiments are underway to determine the effect of cell cycle position on PUMA expression versus differentiation specific gene expression.

Phosphorus concentrations in the Cuyahoga River watershed linked to anthropogenic inputs

College of Sciences and Health Professions

Student Researcher: Christopher Kasden

Faculty Advisor: Fasong Yuan

Abstract

Twenty-four water samples were taken from twelve sites throughout the Cuyahoga watershed from upstream to downstream within two separate occasions. Twelve samples were taken on May 25th, 2016 with no prior precipitation and the conditions were calm, and twelve samples were taken on July14, 2016 when high precipitation had occurred and water conditions were much more diverse. Using the Automated Discrete Analyzer, the concentrations of phosphorus could be analyzed and differentiated between Total Phosphorus and Soluble Reactive Phosphorus. In comparison to the Environmental Protection Agency whose target concentrations for rivers is .05ppm, in both cases of the experiment the hypothesis has been conclusive with maximum concentrations of .14ppm on May 25th and .20ppm in July14. Although phosphorus levels were lower in May than July, the results were conclusive and consistent with an increase of phosphorus from source points to downstream. SRP is more of an interest because of the properties in which allows the utilization by Cyanobacteria and other types of algae. Excessive growth can lead to issues such as increased dead zones, raising levels of biological oxygen demand and diminishing water quality overall.

The identification of anti-cancer molecular targets of COX-2 inhibitor Nimesulide

College of Sciences and Health Professions

Student Researchers: Yuridia Olivera Ortiz and Nethrie D. Idippily

Faculty Advisor: Bin Su

Abstract

Non-steroidal anti inflammatory drugs which were primarily used for the treatment inflammation and pain have also shown anti-cancer activity in many studies. The mechanism of action of NSAIDs in cancer may involve cyclooxygenase (COX) dependent or independent pathways. According to studies, COX-2 is overexpressed in several cancers such as prostate, breast, nonsmall-cell lung, colon, and pancreas. Nimesulide is an NSAID with COX-2 inhibitory activity and investigations show that it could induce apoptosis in cancer. Previously, a library of compounds was synthesized using Nimesulide as a lead compound. However, they displayed different molecular targets: tubulin and heat shock protein 27 (HSP27). Since Nimesulide does not interfere with any of these proteins, the targets of it in cancer remain unclear. Therefore, it is necessary to identify the original anti-cancer targets of Nimesulide in order to understand the structure activity relationship that lead to target switching in the Nimesulide derivatives. For this purpose, a six carbon linker and biotin conjugated Nimesulide probe was designed and synthesized. A human prostate cancer cell line, LnCap, was used to perform protein pull-down assay in order to analyze the proteins that bind to the Nimesulide probe. This study provides insight into the structural interactions that are important for the anti-cancer activity which can be used to synthesize more potent analogs with the original target of Nimesulide.

**Partially Supported by the McNair Scholars Program*

Synthesis and Characterization of Lectin Mimetics (Neo-Lectins)

College of Sciences and Health Professions

Student Researchers: Czharena Kay Rama and Joshua Whited

Faculty Advisor: Xue-Long Sun

Abstract

The cell surface expresses a variety of carbohydrates such as glycoproteins, proteoglycans and glycolipids. They play critical roles in pathological and physiological processes, including cell signaling, immune responses, pathogen-host interactions, tumor metastasis, and other cellular events. Due to its function and uses in cell communication, it is a curious subject of observation for scientific research. The molecular mechanism of carbohydrate recognition is still undetermined, and lectins, sugar binding proteins, are used to analyze the particular structures expressed on the cell surface. Lectins are normally found in plants and animals, and the isolation process of lectins is laborious, toxic, immunogenic and because of this it is considered a major drawback. Therefore, the exploration of lectin mimetics provide an alternative to natural lectins with multiple advantages. Bovine serum albumin conjugated with boronic acid (BA) was used in this experiment to mimic the function of lectins. Boronic acids (BA) have unique properties for carbohydrates, they form cyclic esters with diols of sugars in aqueous solution. BA conjugates are used as artificial carbohydrates receptors, drug delivery agents, and can be used to visualize the carbohydrates on the cell surface. Lectin mimetics, alternatively known as neo-lectins, preferably interact with terminal sialic acid residues at physiological pH. The research goal is to utilize BSA-BA as synthetic lectins for glycomic applications and immunotherapy.

The Relationship between Observed and Perceived Measures of Balance Stability

College of Sciences and Health Professions

Student Researchers: Lorenzo Bianco, John DeMarco, and Sarah Gualtier

Faculty Advisors: Debbie Espy and Ann Reinthal

Abstract

Introduction Injurious falls have risen significantly in the past decade, raising concerns about the efficacy of fall prevention programs. The purpose of this study was to analyze the correlation between perceived and observed balance measures used in a falls prevention program.

Methods Subjects (S) were 70 (F), 59 (F), and 73(M). They were taught the Rate of Perceived Stability (RPS), a perceived measure of balance intensity and completed the Berg Balance Test (Berg), Timed up and Go (TUG), and Activities Specific Balance Confidence Scale (ABC). The Berg and TUG are observed measures and the ABC is a perceived measure. Last, subjects underwent Limits of Stability Testing (LOS), an observed measure allowing calculation of base of support (BOS) and center of mass (COM).

Results The Berg predicted fall risk for S2 and 3 (2:51/56, 3:43/56). TUG results were well below age norms for S 1 and 3 (1: 12.1s, 3: 12.7s). S1 and 3 reported fear of falling; S 2 and 3 reported frequent falls. LOS testing showed S1 and 3 with minimal COM movement.

Discussion S1, with a fear of falling, history of falls, and no fall risk, moved slowly and with minimal COM displacement. S2, with a fall risk and history of falls, moved with more COM excursion. S3, with a fall risk and history of falls, moved slowly with little COM excursion. Perceived versus observed clinical balance measures correlated well. LOS analysis was more complex, however, perceived RPS scores mirrored observed measures. This study provides initial feasibility data on this assessment protocol.

Conclusion Perceived balance scores matched actual balance measures when overall excursion and movement speed were taken into account in this preliminary descriptive study.

The Use of iPad Pros as an Assistive Device in Occupational Therapy

College of Sciences and Health Professions

Student Researcher: Lana Osorio

Faculty Advisor: Glenn Goodman

Abstract

RESEARCH QUESTION: How can IPADS be used as an assistive devices for children and adults with disabilities?

A literature review was conducted using the keywords, in order to find articles about using iPads as a therapeutic device. As a result it was concluded that iPads due to its versatility and popularity has made great progress as a therapeutic tool. Apps recommended as having a therapeutic purpose were also purchased and installed. The iPads will be used as a learning device amongst the Health Science Programs at Cleveland State University.

KEYWORDS: iPad, assistive technology, occupational therapy, tablet, allied health, assistive therapeutic devices.

Supported by the McNair Scholars Program

The Effects of Superior Laryngeal Nerve lesion on Swallowing Kinematics and Airway Protection

College of Sciences and Health Professions

Student Researcher: Saja Abid and Rebecca Z. German

Faculty Advisor: Andrew Lammers

Abstract

The superior laryngeal nerve (SLN) carries sensory information from the mucosal tissues of the pharynx superior to the vocal folds, and carries motor signals to the cricothyroid muscles. It also provides partial innervation to the thyroarytenoid and posterior cricoarytenoid muscles. Finally, the SLN initiates the swallow. When a food or liquid bolus is swallowed, the epiglottis and the false and true vocal folds work together to seal off the airway and allow the bolus to pass through the esophagus. If the SLN is damaged, it usually leads to dysphasia in which food or liquid enters the airway. We hypothesized that a lesion in the SLN would (1) cause an increase in liquid bolus entering the airway, and (2) the coordination between the soft palate, hyoid bone, thyroid cartilage, and epiglottis would be decreased. We surgically transected the right SLN in four 2- 3 week old infant pigs. Under anesthesia, radio-opaque markers were injected into the soft palate, or sutured into the tissues superficial to the hyoid bone and thyroid cartilage. A metal clip was placed onto the tip of the epiglottis to facilitate visualization. Videofluoroscopy was used to assess the airway protection. We digitized the markers to assess movement of the pharynx and larynx during swallows. We found that the unilateral lesion of the SLN did not significantly affect the airway safety. However, it appears that sensory deficits have a considerable impact on neuromuscular coordination. Without the sensory information, the brainstem sends poor, uncoordinated instructions to the muscles controlling the soft tissues of the pharynx.

Supported by the McNair Scholars Program

Dialects Accents and Intelligence: A Study on Dialectal Perceptions

College of Sciences and Health Professions

Student Researcher: Taylor Moore

Faculty Advisor: Myrita S. Wilhite

Abstract

Speech language pathologists are given the tools to help clients with a wide range of pathologies. Issues relating to speech, hearing, swallowing, etc can all benefit from a Speech language pathologist's insight. One area that can be difficult is dialect. People across America speak with many different dialects and speech language pathologists are taught to recognize these differences but not correct them. Dialect showcases culture but does not define intelligence. Dialects like African American Venacular English are rule governed systems of communication (Carter, 2012). The research done on AAVE is seemingly endless (Baugh, 1983; Pearson,2013; Robinson,2011; Carter 2010; Bronstein,1970……) and many of them compare AAVE to Standard American English(SAE). Very few studies, however, look at other dialects and even fewer compare these dialects to something other than SAE. This study compares African American Vernacular English, Standard American English, and Arabic Accented(AAccented) English in the areas of perceived likability and intelligence. 30 adults listened to three different voice samples. Each sample featured a speaker of one of the tested dialects/accents. They then completed a survey rating each speaker's likeability and intelligence. I hypothesized three things: (1) The speaker of AAVE will be perceived as less intelligent and less likeable than other dialectal speakers, (2) The speakers of SAE will be perceived as more likable and more intelligent than the dialectal speakers, and (3)The speaker of AAccented speech will be perceived as more intelligent and more likeable than AAV, but less intelligent and likeable than speakers of SAE. These findings may be useful in changing the way SLP's think about dialects and accents.

Supported by the McNair Scholars Program

Variation of bone microarchitecture within and among contemporaneous species of fossil horses: Feasibility

College of Sciences and Health Professions

Student Researcher: Emily A. Edwards

Faculty Advisor: Anne Su

Abstract

Mesohippus, Miohippus, and Merychippus are extinct horse species that date back fifteen to thirty million years ago, which spanned over three time periods in North America. Each of the horses habituated different terrains from wet to dry. The third metacarpal became the prominent one-toe of horse evolution and is the specimen of this study. The aim is to determine if reorientation, segmentation, correcting size differences, and isolation are feasible. Horse fossils are extensive, documented, and are used as an analogous fossil lineage to humans for this study. Imaging of the third metacarpal was accomplished by micro-CT scanning with a focus on the distal end. Each specimen was standardized using methodical steps to show feasibility. Reorientation was used to align the same bone landmarks of each fossil. Segmentation was performed and separated bone from non-bone. Fossils were corrected for size differences for relative comparison. Isolating bone was accomplished by using arithmetic for the distal end. Evolution of the equine foot is important for equine health, sports, foot paleontology, and can analogously be converted to human orthopedics. As a feasible study for future bone microarchitecture, this analysis serves to present an enhanced understanding of standardizing the third metacarpal of horse fossil bones.

Defining an Enriched Environment for Pre-Ambulation Training using a Multi-Directional, Over-Ground Harness System for Young Children with Down Syndrome

College of Sciences and Health Professions

Student Researchers: Lauren Schuck and Lisa Haecker

Faculty Advisors: Andrina Sabet and Madalynn Wendland

Abstract

This theoretical literature review aims to define the components of an enriched environment (EE) while using a multi-directional, over-ground harness system (MOH), for pre-ambulatory children with Down syndrome (DS). While using an EE has not been clearly defined within humans, children with DS may benefit from this combination of interventions to optimize developmental outcomes. Of the 15 articles critiqued, 6 were found to be most relevant to help define an EE with specific activities when using a MOH for pre-ambulation training. As a part of defining an EE within a MOH, activities will be suggested that stimulate the four components of an EE: social, sensory, cognitive and motor skill acquisition. This description will include specific parameters such as the motor action to be elicited, the position of child within the harness, how the environmental should be set up, specifics regarding task implementation and examples of toys to utilize to enhance the emergence of motor skills, including independent walking. Although ensuring the presence of all components of an EE can be challenging, the optimization of outcomes from using an MOH in an EE in young children with DS may allow for improved function and quality of life long-term.

Elimination of Acoustical Noise for STM Examination of Pentacene Crystallization on Si (001)

College of Sciences and Health Professions

Student Researchers: William Myers and Mark Bowling

Faculty Advisor: Jessica E. Bickel

Abstract

Organic electronics are used in traditional solar cells and also in flexible electronics. Unfortunately, the conductivities of organic semiconductors are significantly lower than their inorganic counterparts. This project examines crystallization by directed self-assembly of the organic molecules via a surface reconstruction as a method to increase conductivity. The crystallization is characterized by Scanning Tunneling Microscopy (STM). In order to achieve optimal STM images, this work examined: (1) noise isolation, (2) etching sharp STM tips and (3) achieving reconstructed Si surface. The STM is housed in a glovebox to keep the surface reconstructions and organic molecules from degrading. However, acoustical noise of the glovebox circulation pump makes achieving atomic resolution impossible. Introducing a foam-lined acoustical shell around the microscope significantly reduced acoustic noise and atomic resolution is achieved. We also determined optimal PtIr tip etching procedures, demonstrating that an alternating current of 40V in a 1M $CaCl_2$ solution results in a tip with an ~ 13μm radius of curvature, comparable to other PtIr tips found in literature. Finally, we demonstrated a Si(001) surface with 20nm terrace widths and two atomic height steps achieved by cleaving inside the N_2 environment.

Elimination of Acoustic noise in STM Analysis of Polymer Crystallization on Au (111)

College of Sciences and Health Professions

Student Researchers: Mark Bowling and William Myers

Faculty Advisor: Jessica E. Bickel

Abstract

Organic molecules offer a potentially cheap and environmentally friendly alternative to traditional silicon based electronics. The main limitation is that they are not as conductive as their inorganic counter parts. By crystalizing organic molecules, it is possible to increase the conductivity so that they can be more competitive with silicon electronics. This project examines the crystallization of polymers through self-assembly on the Au(111) surface reconstruction. The success of the crystallization is characterized with scanning tunneling microscopy (STM). In order to achieve high resolution STM images, we examined acoustic isolation by enclosing the microscope within a rubber-coated box, which was not effective, and a cylindrical shell lined with open cell foam. This was determined by examining both the images and the tunneling current data both with and without the acoustic isolation. We were further able to demonstrate that acoustic noise, while it destroys the ability to take high resolution images, does not appear in the tunneling current, which has not been previously reported. Finally, we report on the ability to create flat terraces of the Au(111) surface.

Cloud Overlap of Cumuliform Clouds in the Shallow Boundary Layer

College of Sciences and Health Professions

Student Researcher: William Calabrase

Faculty Advisor: Thijs Heus

Abstract

Cloud albedo, or the proportion of sunlight reflected by a cloud, has a significant impact on the Earth's radiation budget and is strongly influenced by cloud shape. It is a major source of uncertainty in climate modeling. To characterize the shape of shallow cumulus clouds we study the behavior of the cloud overlap ratio, the ratio between the average cloud fraction and projected cloud cover. In this study, we use a high resolution computer model (LES) to 1) determine how the cloud overlap ratio of a cloud *field* is related to the overlap of individual clouds, and 2) to study how the cloud overlap behaves under different atmospheric circumstances. We find that the overlap ratio does not vary much between different cases or cloud heights, but it is sensitive to cloud layer depth and that the smallest clouds in a field contribute a negligible amount to the albedo.

Which Clouds are Important: Variation of Cloud Size Distribution Functions in Large Eddy Simulations

College of Sciences and Health Professions

Student Researchers: Dorothy Pharis and Nicholas Barron

Faculty Advisor: Thijs Heus

Abstract

Accurately measuring and modeling clouds is an important factor in improving weather and climate prediction. One way of measuring the most important cloud size in a cloud field is a cloud size distribution (CSD) function, or the number of clouds per cloud size within the field. The information from a cloud size distribution can then be used to determine which cloud sizes contribute the most to cloud cover. This research focuses on creating and comparing cloud size distributions for a variety of cumulus cloud fields generated by Large Eddy Simulations (LES), a high resolution computer model. Our work found that the majority of the cloud fields followed the same functional form of a power law with a scale break, or change in exponent at larger cloud sizes. However, considerable variation was found in the value of the exponents and scale break location between different cloud fields, while some fields had no scale break at all. This is in contrast with previous studies that showed the scale break was the only changing element. We suggest that this discrepancy is caused by small domain sizes in previous studies limiting large cloud formation.

How Big is a Cloud: A Statistical Analysis of Cloud Size Distributions Derived from Large Eddy Simulations

College of Sciences and Health Professions

Student Researchers: Nicholas Barron and Dorothy Pharis

Faculty Advisor: Thijs Heus

Abstract

To accurately represent cumulous clouds in climate and weather models, it is important to understand how large clouds, in certain cloud fields, are. These fields can be described by a cloud size distribution (CSD), the number of clouds of a certain defined size. This study utilized data from a Large Eddy Simulation (LES), a high resolution numerical model describing the atmosphere, to explore what defines the cloud size distribution. First, we have developed a toolkit to illustrate the cloud size distribution by using the slope and deriving an estimate for the scale break. Second, we performed a statistical analysis of cloud size distributions for several cases and measurement methods. Based on this analysis, we found that cloud size distributions do not compare well from case to case; but are comparable, regardless of time, within cases. Large eddy simulations of smaller domain sizes result in cloud fields that underestimate the number of clouds. Lastly, analyzing the cloud size distribution methods showed that, although similar, not all measurement methods obtain identical results. In particular, CSDs from linear transects through the cloud layer ("fly-through") deviate significantly from other methods.

How Dry is the Lower Atmosphere: Finding Relations Between Various Moments in the Atmospheric Boundary Layer

College of Sciences and Health Professions

Student Researcher: Vladimir Sworski

Faculty Advisor: Thijs Heus

Abstract

The Atmospheric Boundary Layer (ABL), consisting of the bottom few kilometers of the troposphere, is a highly turbulent region with strong mixing of moisture and winds. This region's activity is driven by thermals, which rise to the top of the boundary layer and thicken it through entrainment of warm air from above. To better predict the behavior of the ABL, a good understanding of the distribution of heat, moisture and momentum is important. In this study, we use a high resolution computer model (LES) to determine those distributions. We were able to reproduce observations when using a temporal averaging that is close to the algorithm used in the observations. However, we found significant discrepancies between temporal and spatial averaging of the same model results. For example, skewness and kurtosis have a strong relationship that helps describe the shape of the distribution. It showed that there is significantly fewer points with both positive skewness and kurtosis. This is related to a strong change that is also present between the temporal and spatial third moments. A study of these differences was also conducted.

Optimizing Dynamic Light Scattering for the Analysis of Anisotropic Nanoparticles in Solution

College of Sciences and Health Professions

Student Researcher: Tony Dobrila

Faculty Advisor: Kiril A. Streletzky

Abstract

To further understanding of light scattering on solution of anisotropic hard-to-image soft particles such as elastin-like polypeptide micelles the light scattering characterization of anisotropic easy-to-image inorganic gold nanoparticles was undertaken. We used Depolarized Dynamic Light Scattering (DDLS) and Scanning Electron Microscopy (SEM) to study commercial gold nanoparticles: nanospheres, nanorods with aspect-ratio=3, and nanorods with aspect ratio=7. According to SEM particles appeared to be larger than manufacturer specs, namely 2R=18.9±1.3nm, (26.1±4.1)x(65.5±9.5)nm, and (16.3±2.2)x(103.6±16.7)nm, respectively. DDLS on nanospheres showed no rotational diffusion (VH) signal, q dependence of decay rate consistent with that of spherical particles, no concentration dependence of translational diffusion coef- ficient (DVV), no absorption change under incident laser light, and a hydrodynamic radius Rh=12.2±0.4nm, largely consistent with SEM-measured size. The aspect-ratio=3 rods also revealed no VH signal, sphere- like q-dependence of decay rate, no concentration dependence of DVV, and apparent Rh=20.9±0.5nm. These samples also revealed unexpected change of absorption and color under incident laser light. However, the absorption change didn't affect particle diffusion. In other words, DDLS on 26x66nm nanorods yielded apparent diffusion properties of 41.8nm diameter spherical particles! DDLS on aspect-ratio=7 rods revealed noticeable VH signal and significant change in absorption altering diffusion properties under the laser light. The absorption change might have been caused by plasmon resonance, which greatly alters the particles' absorption. It was also found that, after certain "exposure" to the laser beam 16x104nm particles became stable and showed diffusion properties consistent with diffusion of cylinders.

Correlating Wet-sample Electron Microscopy with Light Scattering Spectroscopy on the Example of Polymeric Microgels

College of Sciences and Health Professions

Student Researcher: Christian Gunder

Faculty Advisors: Kiril A. Streletzky and Petru Fodor

Abstract

Amphiphilic cellulose-based microgels with a reversible volume-phase transition at around 40.5°C—the low critical solution temperature (LCST)—have been synthesized, characterized, and optimized. After carefully planned synthesis and filtering the samples with a 0.22μm filter microgels were characterized with dynamic light scattering (DLS), yielding reproducible results for the radii of particles around 100-120 nm below the LCST and 60-70 nm above it. Through the use of scanning electron microscopy (SEM), air dried samples and wet samples were also analyzed. Air dried samples were dried for 24 hours until all water was evaporated, ensuring the collapse of microgels as if they were expelling water above the transition. It was discovered that air dried microgels at room temperature had radii of 60-70 nm identical to radii determined from DLS above the LCST. Wet samples were imaged in home- made wet cells that contained in a silicon nitride window and sealed with epoxy glue to examine microgels in natural state of droplets in solution. The wet samples at room temperature revealed microgel radii larger than radii observed via DLS, indicating a need to look further into the SEM wet sample method both below and above the transition.

Effects of Flanking Bigrams on Decision Performance in Selective and Divided Attention Tasks

College of Sciences and Health Professions

Student Researchers: Nicole Russo and Jamie Rodman

Faculty Advisor: Albert F. Smith

Abstract

In previous research, lexical decision performance for word targets flanked by pairs of letters was better when flankers consisted of letters in the target (e.g., BI BIRD RD; RD BIRD BI; IB BIRD DR; DR BIRD IB) than of non-target letters (e.g., CE BIRD NT). Also, performance was better when flankers contained letters ordered as in the target (e.g., BI BIRD RD; RD BIRD BI) than switched (e.g., IB BIRD DR; DR BIRD IB), but flanker order relative to the target did not affect performance. That flankers affect lexical decision performance indicates that participants do not attend selectively to the target. We sought to replicate and extend these findings and also examined performance in a comparison experiment that required attention to the flankers: Participants indicated whether the flanker letters were the same as (e.g., BI BIRD RD; NE BUNE BU) or different from (e.g., CE BIRD NT; CA BUNE RF) those in the target. We found no systematic effects of flankers on "word" responses in the lexical decision experiment. In the comparison experiment, for "same" responses, we found performance differences among flanker conditions. Further, although lexicality was irrelevant, we found directionally different effects of lexicality on "same" and "different" responses.

Effect of parental communication on adjustment of typically developing children with an atypically developing sibling

College of Sciences and Health Professions

Student Researchers: Christina Adkins and Meghan Murray

Faculty Advisor: Ilya Yaroslavsky

Abstract

Disorders comprised of intellectual and developmental disabilities (IDD) as a group are comprised of autism spectrum disorders, Down syndrome, and various genetic conditions that stunt the intellectual and functional development of an individual. These disorders affect roughly 14% of families in the US (Boyle et al., 2011), which approximates to seven million households in the US. The presence of IDD in a child is often associated with increased stress for the parents, given that IDD is often accompanied by behavioral problems in the affected child. Surprisingly, relatively little work has been done on the effects of IDD on typically developing children (TD) of the affected siblings. The few studies that examine these effects show mixed results, with some noting worse adjustment, in the form of greater internalizing problems (e.g., depression & anxiety) and externalizing behaviors (e.g., oppositional defiant behaviors) in the TD child that continues through adulthood, and others noting positive interpersonal outcomes (Kersh, 2007; Hodapp, Urbano, & Burke, 2010). One potential explanation for these mixed findings may lie with the communication between parents and their TD offspring. Specifically, discussing the IDD sibling's condition with the TD child may reduce the resentment these youths often feel by the high parental demands required by their IDD sibling. Further, it may reduce the TD child's worries about developing the IDD child's condition. This study aimed to examine the role of parental communication in the TD children's worries about their IDD sibling and their internalizing and externalizing symptoms.

**Supported by the McNair Scholars Program*

How does educational opportunities influence decisions for Nigerian girls and the society?

College of Sciences and Health Professions

Student Researcher: Shalonda Swanson

Faculty Advisor: William Morgan

Abstract

This paper raises questions about educational opportunities for Nigerian girls to understand if traditional Islamic or Western education influence the girls on various factors; including, their religious connections, optimism for their future, and the value in Islamic education compared to Western education. To discuss the current status of the country the paper discusses the historical underlying factors that influenced Nigeria's policies for educational opportunities for girls. Nigeria has struggled with gender disparities that disproportionately provided educational opportunities for boys at an increased rate compared to girls. This research reports the traditional values that restricted girls' access to education and the structural changes that permitted the enrollments of girls in education aside from traditional Islamic education. In addition, the paper illustrates Nigerian's economic changes that implemented different structures within society which influenced the educational opportunities for Nigerian girls.

**Supported by the McNair Scholars Program*

Life Behind Glass: Bioreactor studies on the Salt-water adaptation of Scenedesmus dimorphus

College of Sciences and Health Professions and Washkewicz College of Engineering

Student Researchers: Joshua Hartranft, Alex Fedai, and Sahar Ataya

Faculty Advisors: Joanne Belovich and Yan Xu

Abstract

Algae has considerable promise as source for liquid biofuel because of high productivity and because algae farms do not compete with food crops for arable land. Freshwater algae is preferred over saltwater algae because of the higher lipid content in the former. Unfortunately, freshwater algae "farms" would require a vast amount of fresh water, and given the scarcity of fresh water, this is not a viable long-term solution. Therefore, the adaption of a fresh-water species of algae to a salt-water environment is a potential solution. In this study, it was shown that the growth rate of the freshwater algae *S. dimorphus* increased over 3-fold in a salt-supplemented growth medium (16.6% of the salinity of pure ocean water) compared to that in standard growth media. Additional research will be needed to determine the level of salinity that can be tolerated by this species.

Glycerolipid Analysis of Adaptation to Saline Changes in the Culture Conditions of Algae, Scenedesmus dimorphus, by GC-MS

College of Sciences and Health Professions and Washkewicz College of Engineering

Student Researchers: Tyler Fitzgerald, Satya Girish Chandra Avula, and Chandana Mannem

Faculty Advisors: Joanne Belovich and Yan Xu

Abstract

Since fossil fuels are decreasing over time an alternative energy source will be soon required. The algae, *Scenedesmus dimorphus*, grows in freshwater and is known for its fast growth of glycerolipid content which is used for biodiesel production. After the algae is grown in optimal conditions, the released fatty acids and glycerolipids are transformed into fatty acid methyl esters (FAMEs) which are used as biodiesel.

The FAMEs were quantitatively determined by gas chromatography mass spectrometry (GC-MS) to determine the total glycerolipid content in the different algae samples. The samples that were analyzed include freshwater controls and saline adapted samples. Analysis also included using a calibration curve with calibrators ranging from 0.500 to 1,000 µM. In the calibration curve and algae samples, a heavy isotope internal standard of C16:0-d-2 was used to determine the accuracy of the results. Results: total percent glycerolipid content in each sample ranged from 2.95-8.5%. The lower range of results could be due to the control 2-L bottle which had no CO_2since it did not have optimal growth conditions, and the bioreactor control was low possibly due to low light intensity. However, the 1.005 TSG for the 2-L bottle was similar to the controls which proves that adaptation is successful. Also, the bioreactor control was lower than the 1.005 TSG saline sample in the bioreactor which shows that increasing the salt concentration and controlling the environment is useful for saline adaptation.

Design and Fabrication of a Microfluidic Device using a 3D Printer

College of Sciences and Health Professions and Washkewicz College of Engineering

Student Researcher: Aaron Smith

Faculty Advisors: Petru Fodor, Tushar Borkar, and Chandra Kothapalli

Abstract

The goal of this work was to design and implement a microfluidic mixer-based chemical reactor using a 3-D printer. Microfluidic devices are very useful for processes that use expensive reactants or require a high level of control, and we hypothesize that the ability to develop a prototype using a 3-D printer would lower their costs and help overcome some of the limitations of soft-lithography based devices. One-level and two-level designs were made using SolidWorks® software, and various stages of the model were printed on Objet® and FDM® printers. The Objet printer offers the advantage of printing a prototype using a transparent polymer. However, initial trials did not result in the printing of a functional prototype, and preliminary simulations suggest that changing the design features results in less efficient mixing. The FDM printer is capable of printing a functional prototype, but the polymer used is opaque. This hinders the live-imaging capabilities of the experimental analysis of the mixing in the device. The design features and selection of polymeric materials are currently being evaluated and optimized, and future research will experimentally evaluate mixing of fluids in these devices.

Light Scattering Characterization of Elastin-Like Polypeptide Trimer Micelles

College of Sciences and Health Professions and Washkewicz College of Engineering

Student Researchers: Ilona Tsuper, Daniel Terrano, and Adam Maraschky

Faculty Advisors: Nolan Holland and Kiril A Streletzky

Abstract

Elastin-Like Polypeptides (ELP) can be used to form thermo-reversible vehicles for drug delivery systems. The ELP nanoparticles are composed of three-armed star polypeptides. Each of the three arms extending from the negatively charged foldon domain includes 20 repeats of the (GVGVP) amino acid sequence. The ELP polymer chains are soluble at room temperature and become insoluble at the transition temperature (close to 50 oC), forming micelles. The size and shape of the micelle is dependent on the temperature and the pH of solution, along with the concentration of the Phosphate Buffered Saline (PBS) solvent. The technique of Depolarized Dynamic Light Scattering (DDLS) was employed to study the structure and dynamics of micelles at 62 oC; the solution was maintained at an approximate pH level of 7.3 - 7.5, while varying the concentration of the solvent (PBS). At low salt concentrations (< 15 mM), the micellar size is not very reproducible due to unstable pH levels, arising from low buffer concentration. At intermediate salt concentrations (15 – 60 mM), the system formed spherically-shaped micelles exhibiting a steady growth in the hydrodynamic radius (Rh) from 10 to 21 nm, with increasing PBS concentration. Interestingly, higher salt concentrations (> 60 mM) displayed an apparent elongation of the micelles evident by a significant VH signal, along with a surge in the apparent Rh. A model of micelle growth (and potentially elongation) with increase in salt concentration is considered.

Light Scattering Study of Mixed Micelles Made from Elastin-Like Polypeptide Linear Chains and Trimers

College of Sciences and Health Professions and Washkewicz College of Engineering

Student Researchers: Daniel Terrano, Ilona Tsuper, and Adam Maraschky

Faculty Advisors: Nolan Holland and Kiril Streletzky

Abstract

Temperature sensitive nanoparticles (E20F) were generated from a construct of three chains of Elastin- Like Polypeptides (ELP) linked to a negatively charged foldon domain. This ELP system was mixed at different ratios with a single linear chain of ELP (H40L) which was deprived of the foldon domain. The mixed system is soluble at room temperature and at a transition temperature will form swollen micelles with the hydrophobic linear chains hidden inside. This system was studied using Depolarized Dynamic Light Scattering (DDLS) and Static Light Scattering (SLS) to model the size, shape, and internal structure of the mixed micelles. The mixed micelle in equal parts of E20F and H40L show a constant apparent hydrodynamic radius of 40-45 nm at the concentration window from 25:25 to 60:60 µM (1:1 ratio). At a fixed 50 µM concentration of the E20F with varying H40L concentrations from 5 to 80 µM, a linear growth in the hydrodynamic radius is seen from about 11 to about 62 nm, along with a 1000-fold increase in VH signal. A possible simple model explaining the growth of the mixed micelles is considered. Lastly, the VH signal can indicate elongation in the geometry of the particle or could possibly be a result from anisotropic properties from the core of the micelle. Static Light Scattering was used to study the molecular weight, and the radius of gyration of the micelle to help identify the structure and morphology of mixed micelles and the tangible cause of the VH signal.

Scalable Assembly of Nanoparticles onto Templated Substrates

College of Sciences and Health Professions and Washkewicz College of Engineering

Student Researcher: John Juchnowski

Faculty Advisors: Christopher L. Wirth and Jessica E. Bickel

Abstract

Anisotropic nanoparticles, such as carbon nanotubes and noble metal nanorods, have excellent electrical, mechanical, and thermal properties. This work examined techniques for the nanopatterning of silicon substrates for the subsequent deposition of anisotropic nanoparticles in order to exploit their properties in macroscopic applications. Argon-ion-sputter induced rippling of Si (100) as well as a microparticle mask were examined as methods for templating a silicon substrate. For the ion-sputter technique, the angle of incidence of the ion beam was 67° from the surface normal, with beam energies between 1 and 5 keV, and ion beam fluxes between 1700 and 5000 μA/cm^2. Rippled structures were not observed under these conditions. As an alternative, we used a single layer of microspheres which had been arranged into a close-packed structure as a template. This surface will then be irradiated at normal incidence with argon ions. By doing so, a network of channels is expected to be formed in-between the microspheres. Future work will examine the influence of beam flux on the formation of rippled structures, as well as exploring the effect of variations in particle size and concentration on the formation of large monolayer template areas.

Identifying Patterns of Stress Through Biological Markers

College of Sciences and Health Professions and Washkewicz College of Engineering

Student Researcher: Kristyn Oravec

Faculty Advisors: Ilya Yaroslavsky and Wenbing Zhao

Abstract

The integration of biologic and behavioral processes has received increased attention as a means to identify biomarkers of functional and disease outcomes in the areas of human performance, medicine, and mental health. Stress is one candidate process associated with multiple adverse health and functional outcomes, including myocardial infarctions, depression, and lost work productivity. Indeed, interventions that target stress show incremental improvements in patients' health and mental functioning relative to treatment as usual. However, the effectiveness of intervention efforts are largely constrained by the ability of an individual to detect the onset of stress, which is often not recognized at a time when stress reduction strategies may be most effective. One obstacle to the detection of stress is the over-reliance on the individual's subjective experience, which requires self-knowledge that is commonly limited. One promising means of overcoming such limitations is the detection of physiologic and behavioral patterns that presage the stress state. The present study builds on the extant theoretical and empirical literature on autonomic nervous system and behavioral responses to stress to detect when individuals transition from a resting to a stress state. Findings will be presented and framed in the context of the clinical literature.

The Digitalization of and Research with Real Estate Archival Records: A Longitudinal Study of Changes in Land Use on Miles Avenue

Maxine Goodman Levin College of Urban Affairs

Student Researchers: Rasheedah Najieb and Amelia Caldwell

Faculty Advisor: Mark J. Salling

Abstract

The purpose of this pilot study is to research what the long-term impacts of commercial and industrial land use are on residential property values in areas around Miles Avenue in Cleveland, Ohio. The study analyzes data from 1945 and 2015. This research stems from a larger study being conducted by a PhD candidate in Levin College of Urban Affairs that analyzes to what degree spatially targeted public and private investment policy decisions have impacted wealth disparities for different ethnic and social class concentrations over time within Cuyahoga County.

The design of my study is based on data available from the Cuyahoga County Auditor's *Residential Appraisal Cards* from the 1940's and 1950's. This primary archival data source is supplemented by current data from the Cuyahoga County property records' database as well as the Western Reserve Land Conservancy's Thriving Communities Institute's (TCI) *Cleveland Property Survey*.

The variables used in my analysis include real property data (building, land, and total value), date built, square footage, the 1940 Home Owners' Loan Corporation's (HOLC) *Residential Security Map*'s ratings, the 2015 TCI quality and condition *Cleveland Property Survey's* ratings, land-use designation, and proximity to industrial and/or commercial property. The data was analyzed using visual mapping, graphs, and statistical analysis. My research hypothesis is that industrial and commercial development in an area does not positively correlate with an increase in residential property values.

Design and Development of a Microfluidic Platform to Induce Mechanical Stimuli on Growing Axons

Washkewicz College of Engineering

Student Researchers: Edward Jira and Erin Tesny

Faculty Advisors: Jason Halloran and Chandra Kothapalli

Abstract

In cases of injury and degenerative diseases, stresses can be placed on individual nerve cells in the human body that greatly, and often permanently, impact the function of the human nervous system. In order to treat these it is imperative to better understand the effects these stresses can have on the development and function of individual neurons. Because of the logistical difficulties of studying cells in-vitro, it has become increasingly popular to study neuronal cells in vivo using microfluidic devices. Current studies focus mainly on the impact of chemical signals on neurons. The focus of this study however, is to develop a versatile system for testing a variety of mechanical stimuli and its effect on axonal outgrowth and signaling in neurons. In this study a microfluidic device was designed and produced in which neurons could be cultured. The device design encourages unidirectional axon outgrowth in the cells so that once the cells are grown, stresses applied to the device itself will impact each cell in a similar manner. With the mold created, a high number of identical device can produced and cultured in parallel to study different mechanical stimuli such as tension and compressive forces placed on the axons.

High-Throughput Assessment of Developmental Stages of NSCs via Promoter-Reporter Assay System Using Recombinant Lentiviruses

Washkewicz College of Engineering

Student Researchers: Emily Serbinowski, Pranav Joshi, Kyeong Nam Yu, and Yana Sichkar

Faculty Advisors: Chandra S. Kothapalli and Moo-Yeal Lee

Abstract

Many drugs and chemicals currently available have not been fully evaluated for their toxic effects on the developing brain. Expensive and low-throughput *in vivo* studies are still being used to evaluate developmental neurotoxicity (DNT). Thus, there is a need to develop an *in vitro assay* system which is economically feasible and high-throughput. Among various cellular models used for *in vitro* assay, human neural stem cells (NSCs) are highly desired due to their ability to self-renew and differentiate into neurons, astrocytes and oligodendrocytes. *In vitro* assessment of developmental stages (proliferation and differentiation) of human NSC is highly important to predict the *in vivo* effect of various chemicals on developing brain. However, conventional *in vitro* assay uses immunofluorescence staining to monitor changes in cell morphology and neural cell-specific biomarkers which can either be inaccurate or cumbersome. Therefore, we have developed an *in vitro* promoter-reporter assay system to monitor the proliferation and differentiation of NSCs using recombinant lentiviruses. Four NSC-specific biomarkers can be monitored by infecting NSCs with recombinant lentiviruses such as synapsin1 for neuron differentiation, glial fibrillary acidic protein (GFAP) for astrocyte differentiation, myelin basic protein (MBP) for oligodendrocyte differentiation, and SOX2 for self-renewal.

Layer-by-Layer Printing of Alginate for Cancer Cell Migration Assays

Washkewicz College of Engineering

Student Researchers: Yana Sichkar, Alexander Roth, Emily Serbinowski, and Kyeong Nam Yu

Faculty Advisor: Moo-Yeal Lee

Abstract

Rapid assessment of the invasion potential of various cancers in three-dimensional (3D) cell culture via layer-by-layer printing of cells encapsulated in hydrogels has been studied. Microarray bioprinting technology on microwell chips has been explored to create 3D cancer-like tissue structures and study cancer cell migration. Alginate, a negatively charged biopolymer, forms hydrogels via ionic crosslinking.

Oxy-methacrylated alginate (OMA) is polymerized via near-ultraviolet light in the presence of photoinitiators. Our goal is to demonstrate rapid creation of cancer tissue-like structures via microarray 3D-bioprinting and develop a high-throughput, 3D cancer cell migration assay. To achieve this goal, layer-by-layer cell culture conditions were optimized in OMA by varying exposure time, photoinitiator concentration, alginate concentration, and cell seeding density. 3D cancer cell migration was demonstrated by printing two layers of hydrogels into the microwells: the bottom layer with a mixture of alginate and matrigel, and the top layer with Hep3B cells in alginate. Printed cells were cultured for fourteen days to investigate cell migration in 3D. As a result, it was found that migration of liver cancer cells needs to be extended for longer times. Also, bidirectional migration potential and leaching of additives (e.g., Matrigel) over time from alginate matrices will be investigated.

Effect of Salt Concentration on the Composition of Elastin-Like Polypeptides in the Condensed Coacervate Phase

Washkewicz College of Engineering

Student Researchers: Louise L. Beckstrom, Adam Maraschy, and Daniel P. Miller

Faculty Advisor: Nolan B. Holland

Abstract

Elastin-Like Polypeptides (ELPs) are thermo-responsive polymers which could potentially be used as vehicles for drug delivery. The nanoparticle vehicles are called micelles and the basic structure is made of ELP-foldon. This ELP-foldon has a head group (foldon) that is hydrophilic and three tails (ELP) that are hydrophobic. Above a certain temperature, the transition temperature (T_t), the hydrophobic tails aggregate together to form spheres with the hydrophilic headgroups on the outside. Inside the micelles, linear ELP and drugs can be captured. Although micelles can form without linear ELP, they are bigger when it is present. At lower temperatures the ELPs are fully soluble and exist as one solution phase, but at higher temperatures there exists two liquid phases. Even though they are both liquids, one is more viscous than the other. The less viscous phase is mostly water and the more viscous one is a condensed phase called a coacervate. Coacervate consists of a high concentration of protein, but still contains a significant amount of water. It appears as glue-like substance with a slight yellow tinge. The concentration of linear ELP may depend on the concentration of salt in solution and since the body naturally contains salt, knowing this relationship would be useful in designing micelles for drug delivery. We varied the concentration of salt in linear ELP to see its effect on the volume of the condensed coacervate at different temperatures.

Designing Genes that Encode Proteins for Biomedical Applications

Washkewicz College of Engineering

Student Researcher: Isaiah Traben

Faculty Advisor: Nolan B. Holland

Abstract

DNA is a crucial component of all known life. It encodes in genes the structure of the proteins necessary to perform many of the functions in a cell. Proteins are biological polymers consisting of a chain of amino acids. The specific sequence of the amino acids determines the structure and therefore function of the protein. The sequence of the amino acids of a protein is coded in DNA via triplets of the nucleotide bases known as codons, which each can represent only one amino acid. However, an amino acid can be represented by more than one codon, so there are many combinations of DNA that can code for any given protein. The efficiency of expressing a protein from a gene can be affected by the DNA sequence, so to optimize protein production, we want an optimal sequence of DNA. Particularly, we would like to be able to design *ab* initio, optimized genes that code for protein-based materials for biological applications. We are working to develop a computer program to generate DNA code from an amino acid sequence. The ultimate goal is to optimize the sequence by using codons in an efficient way and removing unwanted patterns in the gene.

Design and Characterization of Protein-Based Bioink

Washkewicz College of Engineering

Student Researchers: Ryan Martin and James Deyling

Faculty Advisors: Nolan B. Holland and Moo-Yeal Lee

Abstract

Elastin-like polypeptide (ELP) based, temperature responsive triblocks are an attractive alternative to current cell encapsulation hydrogels (bioinks) used in bioprinting, due to their natural physiological properties and their potential for higher cell viability. Many cell encapsulating hydrogels in current use, require UV light to initiate crosslinking which can be damaging to the encapsulated cells. Other materials irreversibly gel with a change in temperature potentially clogging the bioprinting instruments. ELP based hydrogels utilize temperature dependent gelation, but gel reversibly. Elastin is a natural material in human tissue which many protein scaffolds are made of. We are studying an ELP triblock consisting of a long hydrophilic center ELP segment with a short, temperature responsive ELP segment at each end. When a solution of these ELP triblocks is brought to a transition temperature, the end segments become hydrophobic and phase separate. This results in a crosslinked hydrogel network of hydrophobic ELP nodes connected by hydrophilic ELP segments. The ELP hydrogel's properties are dependent on concentration, temperature, pH and salt concentration of the solution. We have characterized the gelation behavior through temperature dependent and time dependent complex modulus profiles of the ELP hydrogel measured using a rheometer with cone and plate geometry. This study is an important step in designing a temperature responsive solution that gels between room and physiological temperature.

Explaining Simulator Sickness

Washkewicz College of Engineering

Student Researcher: Jonathan Cohen

Faculty Advisor: Jacqueline Jenkins

Abstract

Subjects who participate in driving simulation experiments often experience symptoms similar to motion sickness, called "simulator sickness." However, the exact cause of these symptoms is unknown, which makes it difficult to predict whether a subject will experience them, or to warn them of the likelihood of experiencing those symptoms. A possible relationship between motion sickness and simulator sickness has been conjectured, based on the similarity of the symptoms, but not proven. In this study, we examined whether subjects in CSU simulator experiments who reported a history of motion sickness were more likely to experience the symptoms of simulator sickness. We performed a meta-study of 6 CSU driving simulation experiments and compared subjects' reports of past experiences with motion sickness to their symptoms of simulator sickness before and after the tests. We found that the subjects who reported having experienced motion sickness in the past were more likely to experience an increase in simulator sickness symptoms during the test, and to report these symptoms to a greater degree after it was over, particularly if they reported having experienced motion sickness while being a passenger in a car or small boat, or while riding a bus. This knowledge will allow researchers to more accurately predict whether a subject is likely to experience simulator sickness during this type of experiment, and to forewarn subjects about their personal risk of experiencing those symptoms.

GPU Assisted High Performance RSA Encryption

Washkewicz College of Engineering

Student Researchers: Zhe Zhao and Alec McGrady

Faculty Advisors: Haodong Wang and Janche Sang

Abstract

GPU has become highly popular due to its parallel computing ability. It accelerates operations in large scale. Many applications associate with intensive computations. RSA cryptosystem is one of them that can benefit from its utility. The purpose of this research is to implement RSA encryption and decryption by utilizing GPU to enhance the performance of the process. Since RSA public key and private key operations actually consist of large integer multiplications in a finite field, this research explores the efficient algorithms and implementations of the high performance GPU large integer multiplications.

Our work has been implemented on the following three different GPU platforms: (1) Ohio Super Computing's Ruby machine; (2) NVidia Quadro K620 graphic card on HP Z230 workstation; (3) NVidia Shield 8" Tablet. In particular, we develop and implement the row-wise and column-wise multiplication schemes that sufficiently take the advantage of GPU computing parallelism. Our experiments show that the GPU-assisted large integer multiplication accelerates the process by up to 200 times. The performance enhancement of RSA operations is also observed on the platforms of Ohio Super Computing Center and HP workstation. Due to the time constraint, we only test the 1024-bit RSA operations. In our future work, we expect to have much more performance enhancement on the RSA cryptosystem operations with larger key sizes.

Privacy-Aware Human Tracking Using Kinect and Android Smart Watches

Washkewicz College of Engineering

Student Researcher: Mudenda Martin Bbela

Faculty Advisor: Wenbing Zhao

Abstract

Using the Microsoft Kinect® in conjunction with an Android Wear device, this project aims to design a Privacy Aware 3D motion tracking application with haptic feedback functionality used to reduce prevalence of Back Injuries in Caregivers. The System will use a registration method to ensure the caregiver is both uniquely tracked and abstract from most of the information used by the application.

Characterization of Aerospike Nozzle Flows

Washkewicz College of Engineering

Student Researchers: Donald Grimes, Maggie Kolovich, Justin Flaherty, Umesh Balar, and Hitarthsinh Chudasama

Faculty Advisors: Mounir Ibrahim, Dr. George Williams (OAI), and Wei Zhang

Abstract

Aerospike nozzles possess many qualities that make them more desirable and efficient than conventional bell-shaped rocket nozzles. Aerospike nozzles have been studied since the 1960s, but problems and limitations with experimentation often led to abandoning further efforts on aerospike nozzles and implementing much more familiar bell-shaped nozzles. In fact, aerospike nozzles have yet to be used in flight—they have only undergone ground testing. The goal of our research is to develop multiple additively manufactured aerospike nozzles and characterize the flow experimentally, numerically, and computationally. Schlieren photography and Particle Image Velocimetry (PIV) are used to experimentally characterize the flow, ANSYS CFD software and SolidWorks Flow Simulation are used to computationally analyze the nozzle flows, and hand calculations with the assistance of Matlab and Microsoft Excel are performed to analyze the nozzle flows numerically. Using these methods, we will study and compare the flows present in aerospike nozzles with a singular annular entrance as well as multiple orifice entries. To date, we have developed an experimental setup and procedure to study the nozzles we produce. Furthermore, using this setup we've successfully designed, manufactured, and analyzed a converging-diverging nozzle for our setup that produces supersonic flow—a necessary property of flow to accurately characterize nozzles use for aerospace applications. We hope that our research helps to develop a better understanding of aerospike nozzles and their many advantages over the bell nozzle, and motivates further research and eventually the implementation of aerospike nozzles in both aircraft and spacecraft.

Ground Reaction Force Measurement with a Piezoelectric Insole

Washkewicz College of Engineering

Student Researcher: Mohamad Khattab

Faculty Advisor: Hanz Richter

Abstract

The objectives of this research project are to design and build an instrumented shoe to measure the vertical ground reaction force (GRF) associated with a person walking or running. Sensor outputs are calibrated to actual GRF with an artificial neural network.

Currently, GRF measurements require special equipment such as force plates or scientific treadmills. A force plate measures GRF over a limited area. A shoe insole fitted with sensors was identified as a good solution that allows free-range walking over arbitrary surfaces.

Piezoelectric film sensors were chosen due to their low cost, flexibility and for being self-powered. Eight sensors were bonded to a conventional insole and wires attached. A data acquisition interface was prepared using a dSPACE MicroLabBox system, which contained digital filters for noise removal.

Training and validation data were collected using a force-sensing treadmill available at the Parker-Hannifin Human Motion and Control Lab at CSU. A 3-layer feedforward network was successfully trained to approximate the training data. A separate data set was used to validate the trained network. A normalized root mean square error associated with training was 1.01, while the error in validation was 2.78.

Bent Knee Adaptor for Experimental Testing of Prostheses

Washkewicz College of Engineering

Student Researcher: Santino Bianco

Faculty Advisor: Hanz Richter

Abstract

Novel prosthetic devices must undergo testing as part of their development. Testing with amputees is problematic at the development stage due to safety and administrative burdens. A bent-knee adaptor allows able-bodied individuals to wear a prosthesis and facilitate prototype testing.

An existing bent-knee adaptor was used as a basis to design an improved device. The existing adaptor did not preserve alignment between thigh and prosthesis, resulting in unnatural walking. 3D scanning and printing technologies were used to design the new adaptor.

Solid modeling was used to verify that the new design would withstand the loads associated with walking. The device was 3D-printed and attached to a prosthesis, and a preliminary walking test was conducted. Improvements will be required in terms of a better fit between the user's thigh and the adaptor. A systematic procedure will be followed to tune the prosthesis control system. For this, the subject will wear a safety harness and walk over a treadmill. The user will undergo a natural learning process to improve walking.

Computing Human Arm Stiffness for the Purpose of Robotic Simulation

Washkewicz College of Engineering

Student Researchers: Nicholas Gehler and Philip Sesco

Faculty Advisor: Eric Schearer

Abstract

To replace a human during experiments, we've calculated the endpoint stiffness of a human arm to be simulated on a robot. The model used to calculate arm stiffness includes gravitational, short-range muscle, and muscle force-moment arm stiffnesses. The parameters of this model were estimated using data from the open source musculoskeletal MATLAB model, Dynamic Arm Simulator. The model will be used by a Barrett Proficio robot to simulate the stiffness of a human arm. The purpose of this human arm simulation is for experimentation during the development of a force sensing feedback system for functional electrical stimulation (FES). A robot that moves and produces similar stiffness to a human arm will be used in place of a human during experiments, for reproducibility and convenience. This requires the stiffness an arm produces under FES control to be computed and then replicated on the robot. Having an accurate representation of the stiffness an arm produces will create a better lab environment for the promotion of FES research.

**Partially Supported by the McNair Scholars Program*

Correcting Reaching Movements Using Force Sensors and Robot Simulation

Washkewicz College of Engineering

Student Researcher: Megan Carrick

Faculty Advisor: Eric Schearer

Abstract

People who have suffered high spinal cord injuries are unable to move their limbs. Functional electrical stimulation (FES) activates paralyzed muscles by electrical current and is a way to restore some function to a paralyzed arm. This research was conducted to develop a way for a caregiver to correct reaching movements to a person with paralyzed arms. We asked participants to take part in this study to help obtain data to test the learning feedback system. We represented a paralyzed arm with a Barrett Medical Proficio robot. The robot is programmed to reach out and purposely miss a target. The participant then moves the robot arm during a second reach to correct the reaching movement in order to hit the intended target. While moving the robot's arm, we record the forces required to move the arm to reach its intended target. With the data collected by the force sensor, we were able to calculate new joint torques from the applied forces and program the robot arm to move to the correct position using those joint torques. These results show promise for developing an adaptive feedback system to correct reaching movements for use with FES systems for people with paralyzed arms.

Prediction of Muscle Torque Production for the Control of a Paralyzed Arm

Washkewicz College of Engineering

Student Researchers: Andrew Aylward and Kyra Rudy

Faculty Advisor: Eric Schearer

Abstract

Functional electrical stimulation (FES) is a method of restoring function to muscles using electrical pulses delivered through an implanted controller. FES has shown potential for enabling people with high spinal cord injuries to perform basic reaching motions essential to everyday tasks. In order to determine the necessary muscle activations an FES neuroprosthesis must produce to cause a desired arm motion, we must first be able to predict the amount of torque that muscles can produce at each joint. The torque production varies depending on the state of the system. Gaussian Process Regression models were trained with data gathered using a dynamic arm simulator in MATLAB that includes models of joint and muscle groups within the shoulder and arm. The Gaussian Process Regression models are able to predict, with acceptable accuracy, the torque at a given joint due to the activation of a certain muscle group. These predictions can be used to develop a method to calculate the muscle activations that will produce the torques necessary to move the arm along a specified trajectory.

Wrist-Mounted Feedback System: Monitoring Force and Torque in Six Degrees of Freedom

Washkewicz College of Engineering

Student Researcher: Christopher Schroeck

Faculty Advisor: Eric Schearer

Abstract

This project developed a wrist-mountable, six Degrees of Freedom (DoF) feedback system that monitors force and torque. This system is designed to be used by nontechnical operators to correct movements of a paralyzed arm under the control of a functional electrical stimulation (FES) neuroprosthesis. The resulting corrections are recorded and processed by additional programs so as to improve the accuracy of future movements controlled by the FES system. The feedback system was tested on a robotic arm that is programmed to simulate a paralyzed human's arm. These tests checked the sensor for accuracy, reliability, durability, ease of use, and stability.

After production and testing, the feedback system was found to be durable enough to repeatedly withstand the forces of moving the robotically simulated paralyzed arm. The system was considered easy preform corrections with by testers after having minimal to no prior instruction and can readily record forces and torques input during the correction process, accurate within ±1N.