4-29-2022

19th Annual Symposium of the School of Science, Engineering and Health

Messiah University

Welcome

Message from the Dean

We in the School of Science, Engineering and Health welcome you to this 19th Annual Symposium, and we are pleased to invite you to join us physically on campus in the Frey, Kline, and Jordan buildings or to join sessions virtually. Each year our students, faculty and staff present the fruits of their basic and applied research in science and health fields. The outcomes of scientific research expand intellectual understanding and have tremendous impact on quality of life, environmental health, and human flourishing. We warmly welcome you as guests for the day.

Angela Hare
Dean School of Science, Engineering and Health, Messiah University

Presentation Abstracts

Biology, Cellular & Molecular

Analysis of Pancreatic Tumor Growth in Response to Targeted Immunotherapy

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Sarah Bath, Daniel L Guevin, John F Harms†, & Lawrence M Mylin†

Pancreatic cancer is currently the 4th leading cause of cancer deaths, with a survival rate of only 10%. The tumors grow deep inside the body and do not produce clearly defined symptoms until later stages. Pancreatic cancer is very aggressive due to genetic makeup and local tissue alterations (e.g. fibrosis) that block access by traditional chemotherapeutic agents. One strategy to combat tumor growth has been to activate [or relieve repression of pre-existing] host immunity so that host tumor-specific lymphocytes, specifically T lymphocytes, are empowered to detect and destroy tumor cells. CD8+ or CD4+ T lymphocytes, respectively, may combat tumors upon recognition of altered peptides presented on MHC molecules expressed by the tumor cells, or on phagocytes that have ingested tumor materials. CD8+ T cells may directly kill tumor cells, while cytokines secreted by CD4+ T cells empower tumoricidal functions of other cellular effectors. Host immunity can be augmented by vaccination using altered tumor-associated targets. We have designed a system in which a unique tumor target has been incorporated into a highly immunogenic viral oncoprotein, the SV40 T antigen. Immortal cells expressing this recombinant protein given as a vaccine are readily destroyed by the host immune system as tumor-specific T cells are generated. We have tested the efficacy of this vaccine by implanting vaccinated mice with murine pancreatic cancer cells engineered to express the human

target protein. In a preliminary study, vaccination did reduce tumor growth. Tumor samples will be analyzed for the presence of infiltrating T cells in a future extension of this study.

IACUC Approval: 2015-08R-2024 Date: November 22, 2021

Presentation and Question & Answer Session: 4:00 to 4:20 pm in Jordan 159

Development and Testing of a Tumor Cell-Based Vaccine for Pancreatic Cancer

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Daniel L Guevin, Sarah Bath, John F Harms†, & Lawrence M Mylin†

Pancreatic cancer is an aggressive and deadly cancer. An altered form of the cholecystokinin receptor (CCK2i4svR) that includes 69 extra amino acids in a third intracellular loop is expressed by many aggressive pancreatic tumors. We aim to develop a vaccine that will "train" host adaptive immunity to recognize this novel target. We have engineered a tumor cell-based vaccine in which immortalized syngeneic cells express a derivative of the Simian virus 40 Large Tumor antigen protein (SV40 T ag) that contains a 20 amino acid insert corresponding to a portion of the 69 amino acid sequence found in the CCK2i4svR receptor variant. Immunization of mice with a synthetic peptide corresponding to the 20mer insert induced peptide-specific CD4+ T cells in previous studies. C57Bl/6 mice were injected with the tumor vaccine cells (4A-1) or control cells (B6/WT-19) that expressed unaltered SV40 T ag to elicit T cell responses against SV40 T ag epitopes only and the CCK2i4svR sequence. An ELISPOT assay was employed to detect epitope-specific T cells using three target peptides: a known CD4+ epitope from SV40 T ag; the 20mer from CCK2i4svR; a control HBV epitope. CCK2i4svR-specific responses were detected, but frequencies were inconsistent. We tested whether immunity elicited by the vaccine cells could control the growth of orthotopically implanted murine pancreatic cancer Panco2 cells engineered to co-express the human CCK2i4svR variant. Groups of mice were immunized twice with either 4A-1 or B6/WT-19 cells before implantation and proglumide therapy. Tumor progression/burden and immune status (ELISPOT) were monitored at 4 weeks. Tumor presence and mass were reduced in the mice of the experimental group relative to controls. Leukocyte infiltration will be assessed by future immunohistochemistry and staining.

IACUC Approval: 2015-08R-2024 Date: November 22, 2021

Presentation and Question & Answer Session: 1:00 to 1:20 pm in Kline 120

Developing a Protocol for Accurately Quantifying Low Levels of CCK2R Expression in Downregulated Pancreatic Cancer Cells

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Joshua B Harding & John F Harms†

Pancreatic ductal adenocarcinoma (PDAC) is responsible for over 90% of pancreatic cancer diagnoses and has an average 5-year survival rate of under 10%. Recent research has pointed to the involvement of gastrin/CCK signaling in pancreatic tumor fibrosis as an antagonist of gastrin/CCK receptors (e.g., CCK2R) has been shown to decrease fibrosis. To identify downstream pathways, our lab has set out to determine the effect of CCK2R downregulation on tumor fibrosis and the expression of various stromal/immune mediators. Because many PDAC lines endogenously express low levels of CCK2R mRNA, it is imperative that quantification in down-regulated clones by RT-PCR is as sensitive as possible. To achieve this, our lab sought to determine the most reproducible and sensitive primer-probe set among three commercially available sets. It is essential that the assay will not present false positives due to contaminating genomic DNA prompting the lab to test two different DNase protocols. We found that commercial set #3 is the most reproducible and sensitive primer-probe set compared to sets #1 and #2. Commercial set #3 also proved to be the best set for biasing against genomic DNA contamination, with only 24.1% of negative control (DNase treated, reverse transcriptase negative) samples showing low-level amplification within 50 cycles, compared to 37.9% for set #2 and 66.7% for set #1. To address this persistent contamination, we treated our samples with a high efficiency DNase enzyme, and it showed no significant improvement in reducing gDNA in preliminary trials.

Presentation and Question & Answer Session: 1:40 to 2:00 pm in Kline 120

Establishing Developmental Hypoxia Models in *Danio rerio* and Cultured Oligodendrocytes

51

Madeline Johnston & Jennifer K Ness-Myers Ph.D.†

Oligodendrocytes produce and maintain myelin in the central nervous system (CNS), enabling neurons to transmit axonal signals rapidly via saltatory conduction. During development, oligodendrocyte precursor cells (OPCs) respond to multiple environmental signals and intrinsic timing to initiate myelination. In the event of tissue injury, the myelination program is disrupted and results in a ‘maturation arrest’ and consequent defects in CNS myelin. Oxygen deprivation (hypoxia) during prenatal development is a common cause of white matter injury, which leads to cognitive and functional impairment. It is the purpose of this study to establish new developmental hypoxia models for zebrafish embryos and cultured oligodendrocytes. Chemical hypoxia using sodium sulfite was tested as a developmental zebrafish hypoxia model. The parameters of sodium sulfite solutions were evaluated for pH and dissolved oxygen (DO) stability over time, and the effects on myelin gene expression in zebrafish larvae subjected to hypoxia were analyzed by qPCR. A new method for cell culture hypoxia was also tested on purified cultures of immature oligodendrocytes. This model utilized an oxygen absorber and vacuum-sealed bags to produce a hypoxic environment for cells grown in a 6-well dish.

IACUC Approval: 2018-16R-F2024 and 2018-13R-S2024 Date: January 13, 2022

Presentation and Question & Answer Session: 1:40 to 2:00 pm in Jordan 159

Optimization of a Novel QRT-PCR Assay for Relative Quantification of CCK2R Splice Variants in Pancreatic Cancer

42

Natalie M Johnston & John F Harms†

Pancreatic ductal adenocarcinoma (PDAC) is a particularly aggressive cancer and its behavior is driven in part by the hormone, gastrin, via its preferential receptor, CCK2R. A splice variant of CCK2R, called $CCK2_{i4sv}R$, encodes a hyperactive receptor associated with elevated tumor growth, and arises from failure to splice the 4th intron. To test the hypothesis that the relative abundance of CCK2R and $CCK2_{i4sv}R$ expression will present prognostic value, we developed a novel SYBR Green qRT-PCR assay capable of differentiating the variant transcripts. Employed against RNA isolated from patient samples representing both PDAC and normal pancreas, primer-dimer and occasional non-specific amplification were observed in samples with low or no receptor expression. We hypothesized primer modifications and annealing/extension temperature optimization would eliminate these artifacts in no-template conditions. Analyses demonstrate that primer-dimer artifacts were heterodimeric. Artifact frequency was significantly reduced by slight modifications to each of three reverse primers while redesign of the shared forward primer significantly compromised selectivity against contaminating genomic DNA. Having validated the new primer combinations using no-template and plasmid-based qPCR, qRT-PCR analysis of a panel of control RNAs and low-expression samples is ongoing.

Presentation and Question & Answer Session: 1:20 to 1:40 pm in Kline 120

Developing an Immunocompetent Murine Model for the Investigation of Fibrosis in Metastases of Pancreatic Ductal Adenocarcinoma

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Sean Lapp & John F Harms†

Of major cancer types, pancreatic cancer has the worst 5-year rate of survival at only 10%. Its prognosis is especially devastating when diagnosed in the metastatic stage, with only 3% of these patients surviving 5 years. The lethality of pancreatic cancer can be attributed in part to resistance to chemotherapy, the delivery of which is difficult due to the complex tumor microenvironment, characterized by a dense matrix of fibrosis. It is hypothesized that reducing this fibrosis would increase infiltration of therapies into the tumor and therefore improve their efficacy. Proglumide, a CCK receptor antagonist, has been shown to reduce fibrosis in primary tumors of pancreatic cancer. However, the effects of this drug on metastases are still unknown. To test the effect of proglumide on disseminated disease, a reliably metastatic animal model is essential. We tested the metastatic potential and primary tumor growth of a newly acquired murine pancreatic cancer cell line, MCB/1, by injecting the cells into mice using four different injection routes: orthotopic, intrasplenic, intravenous, and subcutaneous. The orthotopic and intrasplenic models showed primary tumor growth in the pancreas and spleen, respectively. These models also showed signs of metastases in the liver, peritoneal cavity, and lungs, while the

intravenous model metastasized exclusively to the lungs. In future studies, we plan to characterize the fibrosis of the metastases compared to the primary tumors. We also aim to utilize this line to investigate the effects of proglumide on metastatic pancreatic cancer.

IACUC Approval: 2017-11R-S2023 Date: September 23, 2020

Presentation and Question & Answer Session: 10:20 to 10:40 am in Frey 349

Generation of Neutralizing Monoclonal Antibodies Against Bacteriophage T4

52

Lily X Velazco, Hunter Zondory, & Lawrence M Mylin†

Antibodies protect by various mechanisms, but induction of antibodies that block infection by binding to pathogen surface structures is a goal of current vaccines. Past Messiah University Microbiology courses included experiences wherein students blocked infection of *Escherichia coli* B by bacteriophage T4 using polyclonal T4-specific goat antiserum. Unfortunately, the polyclonal serum is no longer available. We have undertaken to generate mouse monoclonal antibodies that neutralize phage T4 to use in the same laboratory experiences. Our strategy was to immunize Balb/c mice with concentrated T4 suspensions from which endotoxin (lipopolysaccharide) had been depleted by gentle organic extraction. Mice were injected twice over two weeks with ~ 1.6 – 3.5 x 10^{10} pfu of T4r+ phage. Serum was prepared from blood collected by cheek vein puncture and assessed for T4-neutralizing activity in a 96-well plate scale-screening assay. Briefly, small amounts of *E. coli* B and T4 were combined in each well. Ongoing infection by T4 limited the density of bacterial growth in a well when measured at 6 – 8 hours. The presence of neutralizing antibodies prevented infection and instead allowed the bacteria to grow to near-saturation. The use of serially diluted serum samples allowed relative neutralizing titers to be determined. This presentation will describe the development of the 96 well plate-scale screening assay and how it was further adapted to tolerate the presence of antibiotics that will be in supernatants of hybridoma cultures (Gentamicin, or the mixture of Penicillin and Streptomycin). Exponentially growing *E. coli* B cells were transformed with plasmids encoding ampicillin and either gentamicin or streptomycin resistance. Infection by T4 was confirmed in the presence of the relevant antibiotic, as well as the ability of each transformant to proliferate if T4 was neutralized by goat antisera under similar conditions. Production and screening of hybridomas are in progress.

IACUC Approval: 218-15R-F2024 Date: November 22, 2021

Presentation and Question & Answer Session: 2:00 to 2:20 pm in Jordan 159

Generating Neutralizing Monoclonal Antibodies Against Bacteriophage T4: Designing a Screening Assay

53

Hunter Zondory, Lily X Velazco, & Lawrence M Mylin†

Antibodies protect by various mechanisms, but induction of antibodies that block infection by binding to pathogen surface structures is a goal of current vaccines. Past Messiah University Microbiology courses included experiences wherein students blocked infection of *Escherichia coli* B by bacteriophage T4 using polyclonal T4-specific goat antiserum. Unfortunately, the polyclonal serum is no longer available. We have undertaken to generate mouse monoclonal antibodies that neutralize phage T4 to use in the same laboratory experiences. Our strategy was to immunize Balb/c mice with concentrated T4 suspensions from which endotoxin (lipopolysaccharide) had been depleted by gentle organic extraction. Mice were injected twice over two weeks with ~ 1.6 – 3.5 x 1010 pfu of T4r+ phage. Serum was prepared from blood collected by cheek vein puncture and assessed for T4-neutralizing activity in a 96-well plate scale-screening assay. Briefly, small amounts of *E. coli* B and T4 were combined in each well. Ongoing infection by T4 limited the density of bacterial growth in a well when measured at 6 – 8 hours. The presence of neutralizing antibodies prevented infection and instead allowed the bacteria to grow to near-saturation. The use of serially diluted serum samples allowed relative neutralizing titers to be determined. This presentation will describe the development of the 96 well plate-scale screening assay and how it was further adapted to tolerate the presence of antibiotics that will be in supernatants of hybridoma cultures (Gentamicin, or the mixture of Penicillin and Streptomycin). Exponentially growing *E. coli* B cells were transformed with plasmids encoding ampicillin and either gentamicin or streptomycin resistance. Infection by T4 was confirmed in the presence of the relevant antibiotic, as well as the ability of each transformant to proliferate if T4 was neutralized by goat antisera under similar conditions. Production and screening of hybridomas are in progress.

IACUC Approval: 2018-15R-F2024 Date: November 22, 2021

Presentation and Question & Answer Session: 2:20 to 2:40 pm in Jordan 159

Biology, Organismal & Ecological

Hybridization and Evaluation of Spring Varieties of Flax (*Linum usitatissimum*) in South Central PA

49

Katelyn M Boyce & Glafera Janet B Matanguihan†

Heart disease and cancer are currently the top two causes of death in the United States. With doctors increasingly recommending changes in diet and lifestyle, the demand for accessible and nutritious food is rapidly growing. Within the past several years, “superfoods” have surged in popularity, and more evidence is coming out in support of their potential health benefits. One of these is flaxseed oil, which contains high levels of fatty acids that show potential for decreasing the risk of heart disease, lowering cholesterol, preventing cancer, and managing diabetes. The

majority of oilseed flax cultivation in North America occurs in North Dakota and Canada, but the growing superfood market is making its agricultural expansion into new regions more likely. Flaxseed (*Linum usitatissimum* L.) shows great potential for its introduction to south-central Pennsylvania. The overall goal of this research is to explore the sustainable cultivation of flax in the area. Initially, two projects will focus on 1) collecting preliminary data on the performance of spring flax cultivars under Pennsylvania field conditions and 2) establishing hybridization protocols in the greenhouse as the foundation to investigating the genetics of flaxseed oil production. Data collected will form the basis of flaxseed growing guidelines for the area, which are not well-established, so that local farmers will be more inclined to include it in their crop rotations.

Presentation and Question & Answer Session: 1:00 to 1:20 pm in Jordan 159

Breaking Down Barriers: Understanding the Impacts of Small Dam Construction on Biodiversity of Aquatic Macroinvertebrates

50

Kayla M Herr & Jeff S Erikson†

Freshwater ecosystems are a valuable resource for human life as they provide economic, cultural, aesthetic, scientific, and educational resources that other ecosystems cannot. Freshwater environments are critical in preserving biodiversity as they sustain a wide range of both aquatic and terrestrial life. Although these freshwater habitats are essential for human and animal life alike, humans continue to alter these fragile environments by means of overexploitation, water pollution, and flow modification through dam construction. Aquatic macroinvertebrates are a key part of aquatic life and can be collected to assess the health of freshwater habitats that have been modified by humans. The main objective of this study is to investigate the effect of small dams on the biology of streams in the Yellow Breeches Watershed in Mechanicsburg, PA through aquatic macroinvertebrate sampling and analysis. Research was performed by collecting multiple water and macroinvertebrate samples from two Yellow Breeches Creek tributaries, both above and below the small dams, and analyzing the samples in the lab. Expected results include an increase in the abundance and biomass of macroinvertebrates but a decrease in richness and biodiversity downstream from dam sites. Additional predictions include an increase in tolerant macroinvertebrate species and a decrease in intolerant species downstream from dam construction.

Presentation and Question & Answer Session: 1:20 to 1:40 pm in Jordan 159

Dietary Analysis of the Long-tailed Salamander, *Eurycea longicauda*

45

Joshua C McCoy & Randy W Cassell†

This study examines the diet of the Long-tailed Salamander, *Eurycea longicauda*, in south-central Pennsylvania and attempts to determine whether its diet varies seasonally. Little is currently published on the diet of the Long-tailed Salamander, which mainly inhabits leaf litter and rocky crevices on the forest floor. Because of the Long-tailed Salamander's habitat, it was hypothesized that its diet consists largely of leaf litter-dwelling and crevice-dwelling invertebrates belonging to the following taxa: *Gastropoda, Acari*, *Isopoda, Diplopoda, Collembola*, *Coleoptera, Hymenoptera*, and *Diptera*. It was also hypothesized that non-hexapod species would make up a greater portion of the diet during portions of the year when hexapods are in diapause. To test these hypotheses analysis of the gut contents of wild-caught Long-tailed Salamanders was conducted. Long-tailed Salamanders were caught using a visual encounter search. After capture, sex and snout-vent length (SVL) were recorded, and gut contents were removed using a non-lethal gut-flushing technique. Following stomach evacuation, salamanders were returned to the site of capture. Samples were collected throughout the year and compared to identify seasonal patterns in prey species variation. It was found that three specimens collected in September fed almost exclusively on Isopods, with Collembolans and Diplopodans also present in one individual. Additional data will be collected throughout the spring, summer, and fall of 2022.

Presentation and Question & Answer Session: 2:20 to 2:40 pm in Kline 120

Aquaponic Growth of Ginseng and Potatoes

44

Jessie T Wynne & David K Foster†

American ginseng (*Panax quinquefolium*) is a highly coveted medicinal herb native to forested regions of the eastern United States. This study is to determine if growing American ginseng in an aquaponic system has the ability to increase medicinal ginsenosides present in the plant. Seeds and live roots were cold stratified (6 months at 4°C) to break thermal dormancy resulting only in emerging hypocotyls. The aquaponic system was monitored for dissolved oxygen (DO), nitrate (NO^{-}_{3}), phosphate (P), temperature, and pH. Nitrate had an upward trend from 124.89mg/L to 213.90mg/L. while other parameters remained relatively constant. Potatoes were grown to test the system and were planted at water level (0cm), 5.08cm, and 10.16cm above water level, the most productive growth occurring with tubers planted at water level. All Ginseng roots were transferred from the cold stratification on 03/22 and then planted in the aquaponic system at water level. All Ginseng seeds were transferred from the cold stratification to the greenhouse on 03/22 and were planted in potting soil. They were monitored daily and kept moist. Ginseng seeds began to germinate on 4/3/22.

Funding for this work provided by The Gary and Sylvia Emberger Research Scholarship .

Presentation and Question & Answer Session: 2:00 to 2:20 pm in Kline 120

Biochemistry

Generating Expression Vectors for an *in vitro* Heme Attachment Assay

46

Spencer P Clements & Jesse Kleingardner†

Metal-based redox catalysts that efficiently convert energy to or from stored fuel are a key part of the transition to sustainable global energy. Metal-substituted heme proteins have been shown to perform rapid oxygen or proton reduction, demonstrating their potential for redox catalysis, but their initial exploration has largely been through synthetic modification of heme proteins. The biosynthetic generation of a substituted holocytochrome c would be a first step towards the efficient generation of proteins with these metal-substituted hemes. Holocytochrome c is a protein that has a covalently attached heme group at a CXXCH amino acid motif and performs electron transfer in bacteria as well as in the mitochondrial electron transport chain. A truncated form of cobalt-substituted holocytochrome c, unlike its naturally occurring iron-heme-containing counterpart, can catalyze the reduction of water into diatomic hydrogen. To synthesize a large quantity of the desired coenzyme, the cobalt substitution has previously been performed synthetically after recombinant expression of the iron-heme protein in E. coli. Cytochrome c production in E. coli requires co-expression of a cytochrome c heme lyase, the naturally existing enzyme is responsible for heme attachment to form holocytochrome c. In this project expression vectors for cytochrome c and its heme lyase have been modified to express axial ligand mutants of cytochrome c as well as mutants of heme lyase with decreased substrate -specificity for the heme attachment motif. The cytochrome c and heme lyase mutants, upon purification, will be quantitatively analyzed to find the tolerance of the mutated heme lyase towards heme attachment motifs within cytochrome c and metal-ion substitution within the heme substrate. Success would represent a step towards the goal of providing a method to cost-effectively generate a biocatalyst that could aid in efficient production of fuels from sustainable energy sources utilizing a modification to the heme protein biosynthesis pathway

Funding for this work provided by Steinbrecher Undergraduate Summer Research Program.

Presentation and Question & Answer Session: 4:00 to 4:20 pm in Kline 120

Incorporation of a Red Fluorescent Protein, MScarlet, into an HIV-binding Fusion Protein

63

Abigail Colon & Jesse Kleingardner†

Continuing Dr. Farrar's eGFP-mD1.22 double-ended protein probe project and last semester's successful creation of the pET-His6-PAP-mD1.22-GFP plasmid, this semester's research focused on designing primers for the pET-His6-PAP-mD1.22 backbone vector and the mScarlet gene and producing clean and concentrated PCR fragments for SLiCE cloning. Using the sequence of the pET-His6-PAP-mD1.22-GFP plasmid, the sequences of mScarlet and the pET-His6-PAP-mD1.22 backbone vector and the sequences of mScarlet and eGFP were aligned using

Clustal Omega. The backbone vector primers were constructed to amplify the entire backbone vector excluding the eGFP gene. The mScarlet primers were fashioned to amplify the mScarlet gene. Then, PCR reactions were run with the pET-His6-PAP-mD1.22 backbone and the mScarlet forward and reverse primers. The initial PCR products, analyzed by DNA gel electrophoresis, were impure and showed no product. This was attributed to an annealing temperature that was too high for the mScarlet PCR reaction and too low for the pET-His6-PAP-mD1.22 backbone PCR reaction. Successive pET-His6-PAP-mD1.22 primer PCR reactions were run with variations of the original PCR recipe and annealing temperatures. The mScarlet PCR reaction was run again at a lower temperature. The lower annealing temperature produced a promising mScarlet fragment at 0.7 kbs which was then purified. The pET-His6-PAP-mD1.22 PCR products were still unsuccessful which indicated an incorrect elongation time. After running at an increased elongation time, the correct PCR product (around 5.7 kbs) was obtained using GC buffer and a combination of GC buffer and DMSO. The two PCR products were combined and purified. The concentrations of the purified PCR products were measured using the nanodrop instrument. The mScarlet PCR product was measured to be 28.2 ng/µL and the pET-His6-PAP-mD1.22 PCR product was measured to be 52.7 ng/µL. SLiCE cloning will be used to fuse the DNA fragments together.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presentation and Question & Answer Session: 1:20 to 1:40 pm in Kline 113

Expression Trials of an Engineered Heme Protein with Novel Heme C Stacking 64

Michael A Florio & Jesse Kleingardner†

Hemoproteins in the class of metalloproteins have been shown to be incredibly efficient catalysts of oxygen reduction reactions. These have also shown promise in engineering synthetic metalloproteins which could serve as more efficient catalysts than the commonly used inefficient expensive platinum fuel cells. A porphyrin structure with the ability to rapidly transfer four electrons to dioxygen-producing water has been shown to possibly be the replacement of platinum fuel cells. CHIP is a protein homodimer that has presented the ability to bind with the heme *c* attachment and is able to orient so more hemes can attach. Given that this CHIP heme is synthetic, finding vectors that could successfully produce this CHIP heme could prove helpful for fuel cell research. This study attempted to express this protein in different E. coli genomes, *BL21, pLysY*, and with the addition of other genes such as *pEC86,* and *HemH.* Also, a *NrfA, PelB,* and *OmpA* signal sequence with the CHIP-gene. Most transformations were able to grow in the small-scale cultures but did not produce detectable levels of heme.

Presentation and Question & Answer Session: 1:40 to 2:00 pm in Kline 113

Evaluating the Fluorescence of Twitch-2B Calcium Binding Proteins *in vivo*

47

Sarah R Mateer & Jesse Kleingardner†

Detecting improper metal ion accumulations is key in diagnosing diseases, but few protein-based metal ion detectors have been developed. Using Twitch-2B calcium binding proteins, a standard method of fluorescence is being developed to better aid in the detection of calcium ions that can then be applied to other metal ions for diagnostic purposes.

When Twitch-2B binds to calcium ions, the protein conformation is changed, bringing two fluorescent peptides closer together and initiating energy transfer from the donor peptide to the acceptor peptide. This transfer of energy can be measured using fluorescent spectrometry. The measurement technique allows the fluorescent ratio from the acceptor protein to the donor protein to be calculated (FRET), which correlates to the concentration of calcium ions in the cell. By measuring the FRET response when EDTA or free calcium is added, the maximum and minimum concentrations of calcium that can be measured with Twitch-2B can be calculated.

By evaluating the effect of cell lysis, different spectroscopy techniques, buffer solutions, and growth method, a stardardized method of maximizing fluorescence at even low natural levels can be developed for Twitch-2B proteins. The current research indicates that this technique can be used to measure low calcium levels, demonstrated by a consistent lowest ratio of 0.6. It has also been determined that conducting lysis is the most effective way of measuring fluorescence. Ongoing experiments seek to measure the range of natural calcium in the cells as well as the maximum calcium concentration that can be detected using Twitch-2B.

Presentation and Question & Answer Session: 4:20 to 4:40 pm in Kline 120

Metal Cofactor Substitutions in Heme C

48

Sean J Schreckengast & Jesse Kleingardner†

This project will focus on the substitution of different metals into a molecule called heme *c*. Heme *c* attaches to many proteins in the body and is essential to their functions. In this experiment, heme *c* will be attached to a protein called cytochrome *c* which performs many important biological functions such as moving oxygen throughout the body and speeding up certain biological processes. Heme *c* has an iron molecule in it which is essential to its function, but we hypothesize that changing this iron to a different metal such as nickel or copper could change the properties of cytochrome *c* once heme *c* attaches to it. In addition, an enzyme attaches heme *c* to cytochrome *c*, and slightly changing the enzyme can affect how quickly heme *c* attaches to cytochrome *c*. In this experiment, we will attempt to substitute nickel and see how six different versions of the enzyme affect the attachment of heme *c* for each metal. This will be accomplished by exposing *E. coli* cells that naturally produce cytochrome *c* to high concentrations of the desired metal. The cytochrome *c* will then be extracted from the *E. coli* cells and analyzed to determine if the metal substitution was successful.

Presentation and Question & Answer Session: 4:40 to 5:00 pm in Kline 120

In vivo Synthesis of Metal-substituted Horse Cytochrome C in *E. coli* Via Metal-supplemented Autoinducing Media

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Courtney P Smith & Jesse Kleingardner†

Horse cytochrome *c* (hCc) is a heme protein that operates in essential metabolic processes, including the electron transport chain for energy generation. Metal-substitution of heme proteins with metals such as copper or cobalt has been shown to perform oxygen or proton reduction, demonstrating their potential for redox catalysis. A metal-substituted heme can be attached to hCc by four systems of heme attachment, notably the horse cytochrome *c* synthase (HCCS) attachment system that attaches the heme with HCCS and the cytochrome *c* maturation system (Ccm) that uses an assembly of proteins to attach the heme. Substitution of hCc's heme with zinc can create Zn-hCc, a useful tool for studying protein folding and hCc's cellular activity due to zinc's intrinsic fluorescence. However, the metal-substitution has only been performed synthetically in an inefficient process with low scalability. Copper substitution could also beneficially alter hCc's catalytic activity. This study attempted an *in vivo* method that induces *E. coli* BL21 cells to synthesize Zn-hCc or Cu-hCc naturally, eliminating the complications of a semisynthetic process. The cells were grown in autoinducing minimal media supplemented with minimal iron and excess metal (zinc or copper) to induce foreign metal-take up in the heme. Mutant HCCS enzymes were developed to attach the heme, including N107A, N134A, P100A, and E138A. When analyzed via UV/Vis spectrophotometry, the hCc expressed with each mutant HCCS showed signs of possible zinc or copper incorporation, particularly with 5 μM Fe/100 μM zinc or copper, or 10 μM Fe/400 μM cobalt. Future work will attempt the metal substitution with the less specific Ccm system. Once purified, the protein will be analyzed with SDS-PAGE, UV/Vis spectrophotometry, fluorescence spectroscopy, and electrochemistry to determine the success of the synthesis and the protein's catalytic potential.

Funding for this work provided by Steinbrecher Undergraduate Summer Research Program.

Presentation and Question & Answer Session: 1:00 to 1:20 pm in Kline 113

Designing Anti-diabetic Therapies Inspired by the Medicines of Nature

61

Noah D Smith, **Sydney A White**, **Seth Kabonick**, & Anne M Reeve†

Protein phosphatases are considered a target for drug-based therapy because of their involvement in cell signaling pathways linked to type II diabetes, obesity, and some cancers. Protein tyrosine phosphatase 1B (PTP1B) functions as a negative regulator of the insulin pathway, and as such, is considered a target for anti-diabetic therapy. A gene knockout study in mice showed that the absence of this enzyme caused an increase in insulin sensitivity. High conservation across the

active site of non-receptor class I subfamily of phosphatases has made finding specific inhibitors difficult; competitive inhibitors have been unsuccessful in clinical trials due to undesirable interactions with other phosphatases. Chalcone, (*E*)-stilbene, and flavonoid substructures all showed promise in preliminary computational modeling and bioactive natural products from each class are known to interact with PTP1B. Therefore, we have synthesized an array of derivatives to observe the effects of hydrogen bonding patterns and electronic characteristics on inhibition. Several of the synthetic compounds decreased the activity of PTP1B, with the most potent of the synthetic stilbene and chalcone compounds exhibiting low-micromolar mixed type inhibition and inhibitory constants lower or comparable to the selected natural products. Through consideration of further computational modeling alongside trends in the potency of inhibition, we have identified key structural motifs for inhibition that will enable the design of stronger, more specific antagonists of PTP1B.

Funding for this work provided by Steinbrecher Undergraduate Summer Research Program.

Presentation and Question & Answer Session: 4:00 to 4:20 pm in Jordan 161

Chemistry

Ionic Liquids as Both Solvent and Reagent in Electrophilic Addition Reactions

65

Hannah E Artz & Roseann K Sachs†

Ionic Liquids (ILs) are an environmentally friendly alternative to organic and aqueous reaction solvents. ILs do not emit hazardous gasses, are readily recycled and reused, and often do not require an excess volume of harmful reagents and purification solvents. The IL anion's capacity to participate in a reaction as the nucleophile source is a much less understood area of this research, and it may advance the use of ILs in organic synthesis, particularly for addition and substitution reactions. Markovnikov hydrohalogenation of alkenes is one addition reaction that is generally taught as an introduction to organic chemical reactions; however, this reaction is difficult to successfully complete in the laboratory. ILs overcome the challenges posed in those traditional methods and can be used as both a reaction solvent and halogen source to successfully complete the Markovnikov addition of H-X across a double bond. The hydrohalogenation reaction was completed over 100 times using a variety of ionic liquids including imidazolium, pyridinium, pyrrolidinium, and piperidinium cations. Products were isolated using organic extraction and analyzed with NMR and GC-MS. Bromide anion ILs were consistently successful with all substrates, iodide was most efficient under nitrogen, and chloride was successful with additional heat. Hydrohalogenation of styrene was successful in all ILs used and most successful in the imidazolium-based bromide ILs. Reactions with cyclic aliphatic substrates were less successful with lower yields. Finally, hydrohalogenation of styrene derivatives was recently investigated with moderate success after modification of reaction conditions.

Funding for this work provided by Ray Crist Undergraduate Summer Research Program.

Presentation and Question & Answer Session: 2:00 to 2:20 pm in Kline 113

Methylimidazolium Bromide as a Recyclable Ionic Liquid for Electrophilic Addition Reactions

66

Caleb D McClymont & Roseann K Sachs†

Ionic liquids (ILs) have unique properties which present them as superior environmentally friendly solvents that can limit the quantity of waste that is produced when performing a chemical reaction. Unlike common traditional solvents, ILs do not release harmful vapors into the environment. ILs can be efficiently recycled and reused, limiting the waste being produced. Also, ILs can function as both a catalyst and reagent, greatly reducing the need for additional hazardous reagents. One area of research that warrants further investigation is the IL's ability to function as a solvent in electrophilic addition reactions where the halide of the IL acts as the nucleophile. This is the focus of our research. Methylimidazolium bromide is our IL of interest due to its ability to also act as an acid. This removes the need to add sulfuric acid to the reaction. After the product is isolated the IL can be regenerated simply by adding one equivalence of hydrobromic acid. This gives this IL greater potential as a recyclable solvent in which to carry out these reactions.

Presentation and Question & Answer Session: 2:20 to 2:40 pm in Kline 113

The Reduction of Oxygen Using Screen Printed Electrodes with a Nafion® Barrier

55

Erik D Olson & Richard W Schaeffer†

Hydrogen fuel cells provide environmentally friendly energy production, specifically in cars. The issue with this is that it uses a platinum catalyst, which is expensive. Cheaper alternatives are in the works, such as nitrogen-doped graphite. Because of its two-dimensional hexagonal structure, the material flakes easily from surfaces. Therefore, this research will focus on Nafion®, a potential protecting barrier for nitrogen-doped graphite. Nafion® was selected as it is cheaply and readily available and has been shown to work as a cation-permeable barrier. In this work, standard gold and platinum screen-printed electrodes were used to measure the oxidation and reduction of hexacyanoferrate via cyclic voltammetry with and without Nafion® coatings to determine a model system. This work also attempted to see if the reduction reaction of oxygen would still occur on a screen-printed electrode coated in Nafion® via cyclic voltammetry. It was observed that the reduction and oxidation potentials of hexacyanoferrate decreased in the presence of a Nafion® barrier. Once the impact of Nafion was measured on the electrodes compared to the model system, redox potentials of both O_2 and N_2 were measured using the platinum electrode with and without a Nafion®. At this time, no reproducible results have been found, therefore no conclusions can be drawn about this part of the project.

Presentation and Question & Answer Session: 4:20 to 4:40 pm in Jordan 159

Computer & Information Science

The Loop

38

Alec C Chappell, Caden N Robertson, Robbie C Dorsey, Joseph M Tonnies, & Timothy Diana

Over the past two years, we have felt an abundance of isolation in our lives, so we decided to create an app to bring people together. Our application is a group communication platform where people with similar passions can collaborate together in defined spaces. The hope of these groups is for people to create and find events that they would like to attend. We have created nine core categories of interests for people called “Loops”. These Loops were strategically created to allow people to get meaningful content delivered to them while not oversaturating their feed. Our app is about community, leading people back together through events, and letting them express themselves through their profiles. Visit our GitHub repository to check out our code, https://github.com/alecclyde/TheLoop.

Presentation and Question & Answer Session: 1:20 to 1:40 pm in Frey 349

Emotive

37

Josiah A McCracken, **Micah C Johnson**, Kyle B Luce, Annika R Kowalski, & Wesley Peng Hym Cheah

Self-care is something often overlooked yet highly marketed in our world today. The digital market is oversaturated with hyper-specific and artificial checklists that promise personal growth. An app will never be as good at caring for someone as the people in their lives. We built emotive in an attempt to connect people’s journeys and enhance the support structures that already exist in people’s lives. By externalizing emotions, we enable our users to treat themselves like they would treat a close friend. We provide straightforward goal creation, following the SMART framework, and encourage vulnerable sharing for accountability. Instead of flooding a user with artificial encouragement, we leverage our notifications to encourage those that are close to the user to reach out in love to a user who isn’t doing well. We have hopes that emotive will be a tool that helps strengthen a healthy support network for everyone who uses it. You can join us at https://www.emotiv.app

Presentation and Question & Answer Session: 1:00 to 1:20 pm in Frey 349

Intelligent Water Dashboard

39

Hallie A Nicholas, Adam D Hungerford, & Isaac Parada

The Collaboratory's Intelligent Water project has installed 17 water pumps around the world in water-disadvantaged places. Although data from these pumps is currently transmitted to a database, its use and visibility are limited. The data could play an instrumental role in response times from mechanics, feedback from donors, and public interest. Our application builds on the vision of the Intelligent Water Project team and uses a dashboard to create visual representations of this data. This makes it easily accessible to users and allows for broken or faulty pumps to be handled as soon as possible, giving more people steady access to clean drinking water. Read more at http://iwp.cs.messiah.edu/

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presentation and Question & Answer Session: 1:40 to 2:00 pm in Frey 349

Multicultural Council App

40

Felix A Zarate, Roman P Searle, Joe Vera, & Emily J Lopez

We built an application for Messiah students so they can stay updated with the diverse Multicultural Program on campus. The various multicultural clubs add vibrancy to campus life and we could do a better job of sharing and organizing those opportunities with students.

Our application provides a platform for multicultural clubs to post announcements, promote events, and advertise their merchandise. Our application also facilitates member feedback to the leadership of each club so that member experience can continue to be enriched and improved.

We seek to improve the multicultural program and to push the student experience at Messiah. To learn more about us, you can find our project on Github (https://github.com/felixzrte/Multicultural-App-Frontend)!

Presentation and Question & Answer Session: 2:00 to 2:20 pm in Frey 349

Engineering

Designing a Locally Manufacturable Wheelchair for Nepal

1

Ethan M Barnes, **Levi D Hauger**, Pauline Deutcheu Tchouako, Joshua J Holley Mr., Jacob Petrovich, & Timothy J Van Dyke†

Persons with disabilities in developing countries often lack the basic equipment needed to assist them in their daily lives. International Nepal Fellowship (INF) is a Christian medical organization located in Nepal that provides medical care and assistance to people with disabilities and other conditions. Because importing wheelchairs is expensive and involves a prolonged and unpredictable border process, INF has reached out to the Collaboratory to ask them to design a wheelchair that can be manufactured in Nepal from locally available materials and that will withstand the challenges of operating in Nepal's rugged terrain. The Nepal Wheelchair team has developed a design and an initial prototype of it was constructed. This year, testing was done on this initial wheelchair prototype to evaluate the strength and durability of the design. Design changes based on information gleaned from testing and the manufacturing process were implemented on a second prototype. Additionally, an improved seat design was created and a process for creating push rims using a roller bender was developed. Moving forward the team is preparing for a trip to Nepal to assist INF in beginning to set up for manufacturing our current design.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presentation and Question & Answer Session: 9:00 to 9:20 am in Frey 110

A Low-Cost Microprocessor-Controlled Stance-Control Knee Orthosis for Pediatric Mobility Impairments

14

Jacob M Barton, **Ethan R Cornwell**, Levi M Fertig, Jordan M Witt, Ryan J Farris P.E., & Ph.D.†

Knee-ankle-foot orthoses (KAFOs) are commonly prescribed for individuals with knee instability or quadriceps weakness resulting from a variety of conditions such as spinal cord injury, stroke, spina bifida, and cerebral palsy. A locking KAFO fixes the leg fully straight and is the most prescribed orthotic intervention for these conditions. However, the functional benefits of lower extremity orthoses are maximally realized in stance-controlled knee-ankle-foot orthoses (SC-KAFOs) which allow free knee motion during swing but lock during stance. Existing SC-KAFO options are generally unreliable or expensive, and thus an unmet need exists for a reliable, versatile orthosis which can be manufactured at relatively low cost. The SC-KO team is working to meet this need by developing an intelligent stance-controlled knee orthotic with an any-angle locking mechanism controlled by a microprocessor based on information received from onboard inertial gait-phase sensing. The resulting device will allow for reliable knee locking for support during the stance phase, easy unlocking even under load for the free swing phase, and predictable, safe behavior on stairs and uneven terrain. The system is being developed

as a knee-only orthosis but can be adapted for a full knee-ankle-foot orthosis, with ankle support being prescribed as needed. The first system developed will be configured for pediatric use to address mobility impairments arising from cerebral palsy and spina bifida with CURE Ethiopia serving as the clinical partner for the development and testing.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presentation and Question & Answer Session: 3:00 to 3:20 pm in Frey 110

Rapid Orthotics for CURE Kenya 3D-Printed Transtibial Socket Design and Safety Testing

8

Rachel E Bruns, **Joey D Andrews**, **Ryan G Class**, Rachel Huang, Lauren N Seubert, & Jamie R Williams Ph.D.†

The ROCK (Rapid Orthotics for CURE Kenya) team has partnered with CURE International's hospital in Kijabe, Kenya, to implement a 3D printing system into their orthopedic workshop to help patients decrease ostracization and integrate into society with custom prosthetics and orthotics. Workshop technicians see a heavy patient load and have asked the Collaboratory to establish an automated 3D printing system to produce transtibial sockets for below-the-knee amputees. The team has successfully developed a transtibial socket prototype through a process which scans the residual limb and converts that to a printable file type; however, before allowing the sockets to be distributed to the community, rigorous safety testing must be carried out to ensure that the sockets are durable, functional, and do not present a risk to the user. The team has established a step-by-step procedure to conduct maximum-load testing according to ISO 10328, an international standard for lower-limb prosthetics. Over the past two years, the team has successfully developed MTS Testing Adaptors, equipment that will interface the sockets with the MTS machine at Messiah University to accommodate the complex geometry laid out by the standard, as well as completed 3D printing optimization and testing for the PLA socket prototype which resulted in a passing model. The team will be looking to these results to guide future design changes and has been developing objectives for the upcoming site team trip in the summer of 2022 to further the release of the sockets into the community in Kijabe, Kenya.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presentation and Question & Answer Session: 1:00 to 1:20 pm in Frey 110

A Sustainable Mobility Solution for Persons Living with Disability in Burkina Faso

3

Katie Bunch, **Rachel Rashford**, Timothy M Glavin Mr., Joey Sinsel, John Meyer†, & David T Vader†

The Sustainable Mobility project of the Collaboratory empowers people living with a disability in rural West Africa to pursue educational and work opportunities and more fully participate in family and community life. Our electric, 3-wheeled, off-road wheelchair has transformed the lives of clients through partnerships with the Center for the Advancement of the Handicapped in Mahadaga, Burkina Faso, and the Center of Hope in Fada, Burkina Faso. Now, to reach more people in new locations and with more partners, Sustainable Mobility is working to reduce manufacturing time and cost by authoring image-driven fabrication guides to enable local fabricators to build trikes. We seek to put local fabricators to work building tricycles wherever they are needed.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presentation and Question & Answer Session: 9:40 to 10:00 am in Frey 110

Better Pumps: Promoting Reliable Water Infrastructure for Everyone

4

Josh Card, **Joshua L Maxson**, Benjamin J Brandt, Andrea Hunsberger, Reese N Johnston, Jonathan G Wyrick, Tony Beers†‡, Matthew Schwiebert†‡, & David T Vader†

Approximately 90 million people in Africa lack access to safe drinking water, despite having water infrastructure installed in their community. The India Mark II and the Afridev handpumps are among the most widely used handpumps in the world. Sadly, studies show that approximately 30% of these handpumps are non-operational due to failures of the bearings, seals, head flange, and other common components. The Better Pumps team of the Collaboratory provides engineering support for partners who are working to improve handpump sustainability. We have partnered with Tony Beers and AlignedWorks to validate a bearing test methodology for the India Mark II handpump. By modifying the loading conditions in our handpump test machine, we were able to replicate failures observed by AlignedWorks in a field trial of their bearing design. However, these modifications caused our test machine tabletop to noticeably deflect, so we made modifications to stiffen the tabletop. We partnered with Matt Schwiebert and Living Water International to test new seal designs for the India Mark II and Afridev handpumps. Seal performance data collected by the team was used to validate a new

design in advance of field trials by Living Water International. We developed and performed clear cylinder testing on the seals to visualize the leak paths. A new Afridev testing apparatus is being designed to test the longevity of the Afridev bearings and seals. Test methodologies and results are reported.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presentation and Question & Answer Session: 10:00 to 10:20 am in Frey 110

Kenbrook Bridge Project

26

Luke T Fetterman, **Jordan T Barner**, Logan J Horst, Noah W Thrush, & Brian D Swartz†

The Kenbrook Bridge Team seeks to address Kenbrook Bible Camp's need for maintenance and emergency access across a small stream on the property that separates their main office location from cabins on the northwestern portion of the campus. Kenbrook Bible Camp's mission is to facilitate a closer connection to God, self, others, and nature for all guests. The bridge site was selected by the Kenbrook staff based on the greatest need for accessibility. An existing footbridge in this location cannot support passage of heavy equipment used for camp maintenance or the ATV used for emergency response. After thorough decision-making and a detailed design process, the team proposes a 16-foot-long by 8-foot-wide concrete culvert for the site. The culvert has been designed in compliance with AASHTO structural requirements and all elements of the structure are detailed in a complete drawings sheet set, serving as a reference for on-site construction in May.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presentation and Question & Answer Session: 2:40 to 3:00 pm in Frey 150

Sustainable Agriculture

25

Madalyn A Heckman , **Jacob T Dean**, **Gabriel J Tiday**, Cassie P Gehenio, Miggy Matanguihan, Josh R Rosengrant, Jacob Wong, Aleesa Wu, & Michelle L Lockwood†

The Sustainable Agriculture team is addressing malnutrition through aquaponics. Aquaponics is a soil-free farming method that reduces growing periods and water consumption by 90% compared to traditional methods. The Sustainable Agriculture team works alongside its clients, Youth with a Mission and Trans World Radio, to develop and implement universal and scalable aquaponics prototypes. The team worked to determine the best set of variables for aquaponic growth, as well as, explored two alternative airlift pumps.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presentation and Question & Answer Session: 2:20 to 2:40 pm in Frey 150

Wear Testing of a Mechanized Percussion Well Drilling System for Water Access in West Africa

6

Matthew R Higgs, **Robert H Donley**, Matthew D Merlo, Matthew J Siegrist, Jacob S Wildasin, & J Scott Heisey †

The Mechanized Percussion Well Drilling (MPWD) Collaboratory project is assisting in the development of a mechanized well drilling system for drilling shallow water wells in West Africa. Our client, Mr. Joseph Longenecker with Open Door Development (ODD), desires to make water wells accessible to all in this region, but has encountered difficulty drilling through hard soil layers. To overcome this problem, the MPWD team has worked closely with Mr. Longenecker to develop a mechanized percussion well drilling rig using a rubber friction wheel drive system that is capable of drilling through these harder layers.

Currently, the MPWD team is working to provide recommendations to improve the useful service life of our client's new, mechanized rig design. The MPWD team's most recent work includes the design and fabrication of a testing rig to simulate the operation of our client's full-size rig. The testing rig will allow our team to conduct fatigue testing on a model of the driveline system to analyze the wear patterns on the rubber friction wheel and to estimate its expected service life. The team has also performed a series of finite element analyses on the mast design of our client's rig to evaluate working stresses under static loading and buckling, along with fatigue analysis, to confirm safe operation of the rig and to identify any elements that might require upgrades.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presentation and Question & Answer Session: 10:40 to 11:00 am in Frey 110

Prosthetic Knee for CURE Kenya: Mechanical Design and Manufacturing of a Prosthesis for Disarticulation Amputees

9

Sarah N Kelchner, **Isaiah D Bryner**, **Carter D Urich**, Nathan E Jaloszynski, Josiah D Moyer, Josh D Mundis, & Jamie R Williams Ph.D.†

The Prosthetic Knee team is partnered with CURE International's orthopedic hospital in Kijabe, Kenya. Medical professionals at CURE treat many patients with lower-extremity amputations; however, the only prosthetic knee available to through-knee amputees is extremely expensive and is rarely financially accessible to those who need it. Therefore, the Prosthetic Knee team seeks to enable everyone to have access to the reliable, high-quality medical devices they need to function on a daily basis regardless of their financial status. Our team has designed a lightweight, fully functional, and aesthetically pleasing through-knee prosthesis costing less than $100 that will be tested and provided to CURE International in May of 2023. The talk will explore the fundamentals of the knee design as well as the locking and damping mechanisms integrated into the knee to promote easy use and a natural gait cycle.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presentation and Question & Answer Session: 1:20 to 1:40 pm in Frey 110

A Modular Functional Electrical Stimulation (FES) System for Gait Assistance in Pediatric Cerebral Palsy

13

Timothy Lee, **Nick Hamann**, Wyatt P Bingaman, Andrew T Clancy, Callan W Heise, Ryan J Farris P.E., & Ph.D.†

Foot drop, the inability to lift the forefoot during gait, is a common symptom of disorders such as diabetes, stroke, spina bifida, and cerebral palsy. This condition makes walking difficult and unsafe, often resulting in stumbles and falls due to lack of ground clearance. The current standard of care is orthotic bracing, which presents donning and doffing challenges, restricts ankle motion, and contributes to social stigma in many parts of the world. Functional electrical stimulation (FES) is an alternative approach that uses small amounts of electrical current delivered through skin-surface electrodes to stimulate peripheral nerves, thus generating muscle

contraction and ultimately functional movement of a human limb. When packaged in a wearable device with onboard sensors capable of detecting gait phase, stimulation current can be applied to the lower leg to cause the foot to lift during the swing phase of gait. While several FES foot-drop systems are commercially available, they cost upward of $13,000 and provide a level of adjustability and complexity not needed for many conditions. The Messiah FES team is working to develop a low-cost, portable, easy-to-use, and durable electrical stimulation device to restore legged ambulation to children with mobility impairments resulting from cerebral palsy, spina bifida, and other conditions with similar effects. Our clinical partner is CURE Ethiopia, with our primary contacts being Dr. Tim Nunn and Dr. Laurence Wicks at the CURE Ethiopia Children's Hospital in Addis Ababa, Ethiopia.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presentation and Question & Answer Session: 2:40 to 3:00 pm in Frey 110

Fluency Assistance Device (FAD): Masker Upgrades

22

Chad M Long, **Jake T Finkbeiner**, Timothy Fair, Jon R Sweeton, Elijah Wood, & Harold R Underwood†

There are around seventy million people internationally who have a stutter, a form of fluency disorder. Some fluency assistance devices are available to the public, but most are highly expensive or unreliable. The Fluency Assistive Device (FAD) team seeks to assist a niche community of these individuals for whom therapy has not worked, and who currently rely on a device known as the Edinburgh Masker. To best reach this community, FAD is partnering with Dave Germeyer, who has invaluable experience repairing these masker devices for his clientele. FAD is redesigning the masker to increase its portability, functionality, and cost-effectiveness by developing an improved analog and new digital version. The Analog Masker v1.3 focuses on updated components and consolidated circuitry to eliminate troublesome wiring of the original. The Digital Masker v1.0 employs a Bluetooth-enabled microcontroller to achieve masker functionality, offering the flexibility of alternative fluency assistance algorithms to assist a broader group of users. An updated prototype of the Analog Masker v1.3 was fabricated and tested for power consumption and overall functional output characteristics versus the original Edinburgh version. The Analog Masker v1.3 has also been fully packaged and enclosed to produce a client testable unit. Bluetooth audio output for the Digital Masker has almost been completed, and two of the alternative algorithms have been coded for the masking output. One of these algorithms, Delayed Altered Feedback (DAF), now produces the expected output in response to an audio test input. Clarity and integrity of the DAF signal output have also been improved. The Masking Altered Feedback (MAF) algorithm that emulates the behavior of the Edinburgh original on the Digital Masker v1.0 is under development.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presentation and Question & Answer Session: 1:20 to 1:40 pm in Frey 150

Improving Access to Clean Water Through Autonomous Monitoring of Hand Pump Operation

23

Josiah J McCarthy, **Lydia Reber**, Matt J Caldwell, Jared M Groff, & Randall K Fish†

Millions of people in developing countries rely on hand pumps for access to clean water. Proper maintenance of these pumps is impossible without timely reporting on the pump's operation and state of repair. The Intelligent Water System, which improves access to clean water by autonomously monitoring and reporting on the health of hand pumps, has been under development for several years. Recent work has been addressing the accuracy of leak rate calculations and volume pumped. For the system to report this data, it must be equipped to communicate using cellular communication technologies. Recently, it was decided that the system's method of communicating over 2G frequency bands was no longer practical, and the need for technology that could be used to communicate over 3G and 4G bands arose. In response to this need, a 3G cellular board was designed and manufactured, and it is scheduled to be tested this summer in Zimbabwe. Additionally, a 4G cellular board has been designed and will be manufactured and tested the following academic year. This presentation will go over recent developments and will give a brief overview of their functionality and importance for the system.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presentation and Question & Answer Session: 1:40 to 2:00 pm in Frey 150

A Low Cost, Portable Fluorescence Correlation Spectrometer for Disease Diagnosis

11

Al W Mokris, **Jessica E Paulus**, Michael A Geyer, Brittany Shirk, Jon Sison, & Randall K Fish†

People being treated for HIV need to periodically test to determine if their antiviral medication is effectively keeping their viral loads at a safe level. Individuals living in rural areas of developing

countries are more likely to get these viral load tests if an instrument existed that reduced costs and was small and rugged enough to be brought to the client rather than require the client to travel for hours to a clinic. The Diagnostics for Viral Disease team is developing such a device in cooperation with Dr. Edgar Simulundu and the Macha Research Trust in Zambia.

Our method is based on fluorescence correlation spectroscopy, which deduces particle sizes from their diffusion rates, and includes an engineered fluorescent protein probe, confocal optics, low-level light detection, and integrated electronics capable of digital signal processing analysis and providing a graphical user interface.

This talk will present work done on an alternate diagnostic method that correlates activity in a light-scattering channel in addition to the fluorescence channel to view the viral activity as individual events rather than using autocorrelation. We will also present our work which allows the results of the signal processing performed within a Field Programmable Gate Array to be successfully transferred to a Raspberry Pi used as a user interface to display the HIV load results. Our current project status has us on track to complete full system integration resulting in a functional exploded prototype in Fall 2022.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presentation and Question & Answer Session: 2:00 to 2:20 pm in Frey 110

Energy Independence with Solar for Tree 4 Hope

7

Noah A Rood, **Jonas E Kolb**, **Christian Pilawski**, **Garrison Shields-Seelig**, Josh Ginck, Riley Harro, Michael Stefanchik V, & Harold R Underwood†

The Solar Photovoltaics (PV) team designs and installs solar electricity systems in developing countries where power is less reliable or non-existent. Starting in 2020, the Solar PV team began collaborating with Tree 4 Hope—a nonprofit organization that partners with an orphanage near Guatemala City, Guatemala. Over the past year, the team has designed a solar system to be installed at the orphanage which will provide them with a cleaner and cheaper source of electricity. Thus far, the overall 5 kW solar panel system design including lead-acid batteries has been completed. Key components of the system consisting of the system controller, two charge controllers and the inverter have been programmed and tested, by plugging them into existing elements of the solar lab system, in preparation for installation in Guatemala. This talk details the progress accomplished this year in the design, including system sizing, configuration, and anticipated mounting strategies for the solar panels and associated equipment, in preparation for installation at the orphanage during May of this year.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presentation and Question & Answer Session: 11:00 to 11:20 am in Frey 110

Muscle Activated 3D Printed Prosthetic Arm

12

Meghan L Sampson, **Lindsay L Haseltine**, **Jaymie R Monday**, Paige M Campbell, Antonio P Santelli, Caleb J Wright, & Tim Howell †

Due to the rapid growth of children and the cost of myoelectric technology, children are not given the same opportunities to use myoelectric prosthetics as adults. The Muscle Activated Prosthesis (MAP) team is developing an affordable, trans-radial, myoelectric prosthesis for a fourteen-year-old girl. The MAP team has completed the design and prototype of a myoelectric prosthesis with a materials cost of under $1,000 as opposed to the $10,000-$20,000 cost of commercial myoelectric prosthetic upper limbs. Electromyography (EMG) electrodes are used to detect muscle flexion and relay a signal to a microprocessor controlling a set of internal motors that will close the handgrip of the 3D printed prosthetic arm. Repeating the muscle flexion will send another signal to return the hand's grip to its open position. The team successfully tested the EMG response with an adaptive electrode sleeve for full limbs. After visiting the client and gathering feedback on their latest prototype in February 2022, the team is focusing on polishing the final prototype to conclude work with the current client and exploring options for future project directions and clients, including CURE International.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presentation and Question & Answer Session: 2:20 to 2:40 pm in Frey 110

Force Characterization and Manufacturing of a Dynamic Unilateral Clubfoot Brace

10

Leigha R Southall, **Jacob R Cornwell**, **Michelle Lo**, **Clint M Meekins Jr**, Brittney D Fouse, Sam J Rasinske, Stevie R Snodgrass, & Tim Howell †

Clubfoot is a musculoskeletal birth defect characterized by an inward twisting of an infant's feet. Currently, a series of casts are used to correct clubfoot and the Steenbeek brace is used to

maintain the correction. However, this method has issues with compliance, comfort, and social stigma. Mr. Jerald Cunningham, CPO, designed and is utilizing a unilateral clubfoot maintenance brace called the Cunningham Clubfoot Brace. He expects his brace to reduce treatment time, lessen social stigma, and increase child mobility. Hope Walks, in Kijabe, Kenya, is interested in implementing this new maintenance brace at their clinics. However, there is not enough published research on its biomechanics and patient success rates to confirm Mr. Cunningham's findings.

The Cunningham Clubfoot Brace Collaboratory project seeks to validate the effectiveness of this design through biomedical testing and increase brace accessibility through sustainable manufacturing. The team is measuring the biomechanical forces applied by the brace with multiple force sensors on the Cunningham and Steenbeek braces. Mr. Cunningham plans to use injection molding to increase brace production. The team is completing Finite Element Analysis to determine how the brace's properties change with injection molding. The team is also completing fatigue analysis with the Cunningham Brace to quantify its reusability. Furthermore, the clinical study in Kenya and Dr. Emily Farrar's retrospective research paper will contribute to the published research on the Cunningham Brace. The collaborative efforts of the team will increase further understanding of the Cunningham Brace and its acceptance as an alternative clubfoot maintenance brace.

IRB Approval: 2019-001 Date: September 15, 2021

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presentation and Question & Answer Session: 1:40 to 2:00 pm in Frey 110

Village Water Ozonation System

24

Sam B Stone, **Benjamin R Gates**, Olivia R Allbee, Nate Binko, Caleb L Bruner, Ruth C Galyen, Seth M Kline, Ray Knepper†‡, & Michelle L Lockwood†

The Village Water Ozonation System (VWOS) team's core mission is to provide economically sustainable drinking water solutions for communities, empower them with the ability to properly maintain their drinking water supply, and to transform peoples' lives by decreasing the occurrence of waterborne diseases. Currently, the VWOS team is partnering with Friends in Action to implement two drinking water treatment systems this summer for the community living on Rama Cay, an island in Nicaragua. The wells on the island have a high salt content and are contaminated with bacteria which makes the water unsafe to drink; therefore, the system design consists of a Reverse Osmosis unit, a UV light, and other filters to ensure potable water.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presentation and Question & Answer Session: 2:00 to 2:20 pm in Frey 150

Stormwater Management for Greenwood Hills Bible Camp

27

Daniel O Thomas, **Warner C Hockenberry**, **Caleb R Light**, Abby Bartels, Caleb J Hilton, & Thomas S Soerens†

The stormwater team addresses flooding and erosion issues. In the spring of 2022, the team analyzed erosion problems for Greenwood Hills Bible Camp near Chambersburg PA and designed a system to capture and divert the runoff that is causing erosion. The design includes collection of the runoff with French drains and rock channels and conveyance of the water through a culvert with discharge down-gradient of affected houses. The system should lessen the erosion affecting the camp road and fix nuisance flooding and erosion at the residences. In the fall of 2021, the team partnered with the City of Harrisburg and Capital Region Water to address flooding in the Allison Hill neighborhood of Harrisburg Pennsylvania and designed a plan to mitigate this problem for neighborhood residents.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presentation and Question & Answer Session: 3:00 to 3:20 pm in Frey 150

Cracking the Code to Locally Sourced, Low-Cost and High-Quality Egg Incubators for Zambian Churches

5

Claudia M Tolley, **Aaron Bashore**, **Matt D Eells**, Shekinah Ellis, Brandon Koehnke, Lane Magness, Joshua R Mah Mr., Cooper Willoughby, Cadee A Wood, Josiah T Zehr, Dan Elliott†‡, & Philip M Tan Ph.D.†

Partnering with the Brethren in Christ Church in Zambia, the Egg Incubator Team is seeking to provide a source of income for the growing churches in Choma, Zambia. We will accomplish this by designing a high-quality, low-cost egg incubator fabricated from local parts as well as affordable internationally available parts. The final designs will be used by the Nahumba Mission in Choma and will provide the means for the Mission to hatch and sell chickens, providing both food security and a sustainable supplemental income. After conducting temperature and humidity tests on our initial incubator prototype last year, we found that the

initial model has significant heat losses and temperature fluctuations around the set point. To fix these problems, we designed a heating/humidity PID control system and a new incubator frame design that reduced extra air space in the unit and optimized the airflow. The system uses locally sourced stove coils for a heat source and an atomizer as a means of producing and controlling humidity. In addition, we also created a SolidWorks model for the complete design of the incubator which includes heating, humidity, ventilation, and electronic components. To conclude this semester, we are conducting a 21-day test on the incubator using fertilized eggs. This test will not only allow us to evaluate the success of the design, but it will also highlight any areas of the project that must be improved before the site team trip in late May 2022.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presentation and Question & Answer Session: 10:20 to 10:40 am in Frey 110

Redesign and Fabrication of an Adjustable Prone Trolley for People Suffering from Spinal Cords Injuries in Nepal

2

Connor Welch, **Jared T Pavlovich**, Katie Anthony, Blake N Clemmer, Ryan J Friend, Abby Miller, Lukas Sonon, & Timothy J Van Dyke†

For people who suffer from spinal cord injuries in Nepal, rehabilitation and care are often difficult to receive, especially for those for whom fewer resources are available. Thankfully, International Nepal Fellowship (INF), a non-profit serving Nepal for nearly 70 years, aids patients with spinal cord injuries at Green Pastures Hospital and Rehabilitation Centre in Pokhara, Nepal. A crucial part of any rehabilitation is adequate exercise to improve circulation and prevent sores and muscular atrophy. Yet, due to the nature of the injury, using a traditional wheelchair is not an option to fulfill this need for those with spinal cord injuries. Therefore, Green Pastures uses prone trolleys so that these patients can exercise. A prone trolley is a horizontal cushioned board where the patient lies flat on their stomach and is able to move themselves using the wheels attached to the cushioned board. Despite the importance of the prone trolley, the trolleys at Green Pastures Hospital have a few critical issues. The major issue is that the prone trolleys are internationally imported, which not only means that delivery can take months, but also that the trolleys are also difficult to repair when damaged. Both these factors severely hamper Green Pastures Hospital's ability to provide spinal cord injured patients with the care they need. The Nepal Prone Trolley team, a part of Messiah University Collaboratory, seeks to develop and design a fundamentally better prone trolley for INF. The goal of our project is to design a prone trolley that can be fabricated by the INF staff with locally sourced materials. The advantage of this new design is that it will be easier to obtain and can easily be repaired when needed. After creating a design that satisfies our goal and fulfills the criteria of a functional prone trolley as defined by INF, we were able to fabricate a prototype of the prone trolley using resources and techniques available in Pokhara. Moving forward, we will

conduct testing and redesign the trolley so that our finalized prone trolley design will be able to transform how Green Pastures Hospital aids their spinal cord injury patients.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presentation and Question & Answer Session: 9:20 to 9:40 am in Frey 110

EMMS: Increasing Hope and Transforming Lives Through Improved Access to Electrical Power

21

Seth Wilcox, **Bennett A Andrews**, Adam Dressler, Zach L Gillen, Samuel N Goertzen, Kyle Green, Caitlin Ross, & Tom Austin†

Developing countries often face a challenge involving energy conservation. Energy Monitoring and Management Systems (EMMS) was tasked to make an energy meter in order to provide a practical way of controlling energy consumption and create a tool for teaching energy conservation. This meter should be able to measure energy usage over a period of time and prevent further energy usage after a specified amount has been consumed. In this presentation, the team will explain what they have been doing in recent semesters to work towards improving the meter, making it more robust and ready for implementation in Zimbabwe this summer, as well as how they have been improving the user experience through website implementation.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presentation and Question & Answer Session: 1:00 to 1:20 pm in Frey 150

Mathematics

COMAP Modeling Competition: Automated Trading Strategies

29

Noah D Andrews, **Matthew R Fisher**, & **Jaron Wenger**

This talk describes a model used to determine a portfolio's optimal bitcoin, gold, and cash allocation based only on past price data. To do this, the Sharpe ratio is utilized as a metric of an

asset's risk vs reward. For each trading day, this ratio is maximized based on historical price and volatility data. Additionally, appropriate changes in cash holdings are modeled using two common technical analysis indicators: RSI and Bollinger bands. The Sharpe ratio combined with technical indicators identify proportions of bitcoin and gold which result in maximum expected portfolio efficiency. We apply this model to bitcoin and gold price data from 2016-2021, starting with a portfolio cash balance of $1,000. In this setting, our model results in a final portfolio balance of $1,130, for an annualized return of 2.5%. While not as successful as a simple buy-and-hold strategy for bitcoin, our model provides greater downside protection and variance limitation than buy-and-hold. An overview of the COMAP modeling competition is provided, as well as the other problems available to competitors. A brief discussion of the modeling process and limitations of the model ensues.

Presentation and Question & Answer Session: 9:20 to 9:40 am in Frey 349

Development and Applications of Brownian Motion

28

Noah D Andrews

The background of random walks is established as a foundation for Brownian motion. Simple examples of real-world random walks are provided. Random walk properties are then used to derive properties of Brownian motion. Drift terms are introduced, as well as the concept of geometric Brownian motion. Some applications of geometric Brownian motion are briefly discussed in the context of financial settings.

Presentation and Question & Answer Session: 9:00 to 9:20 am in Frey 349

An Introduction to Sabermetrics

30

Kasey B Caras

This presentation will focus on sabermetrics, which is an applied mathematical field where mathematical and statistical analysis can be used to increase the probability of a baseball team winning the game. The history of sabermetrics will be examined to see how and why this field of study gained significance in the public eye. Common sabermetric and traditional baseball statistics will be examined to see how mathematics has been utilized in baseball. Hitter and pitcher match-ups will be examined to determine hit probability. Launch angle and exit velocity will be examined to see how they impact the probability of a hit. Additionally, infield shifts will be examined to see if they are beneficial for a defense. The final focus of the study will address the impact sabermetrics has had on baseball, including both the benefits and the detriments to the game.

Presentation and Question & Answer Session: 9:40 to 10:00 am in Frey 349

Linear Programming and Its Algorithms

31

Matthew R Fisher

This talk is focused on Linear Programming, a method of optimization with a wide array of applications in the real world ranging from optimizing delivery routes to routing data networks. it achieves this by using mathematical models that are represented by linear relationships. These models give us feasible regions for a finite set of constraints, which we can then use an algorithm to find the optimal point in this region. The algorithms used to solve linear programming problems have been improving and adapting for over 70 years now, and have led to Linear Programming being an incredibly strong tool in modern-day mathematical problem solving.

Presentation and Question & Answer Session: 10:00 to 10:20 am in Frey 349

Nonparametric Curve Fitting: Techniques and Applications

34

Sarah E Hartman, **Ryan McAllister**, **Griffin McVay**, & Samuel P Wilcock†

Regression is a common tool for analyzing relationships between two variables which requires assumptions about form and variability. We will provide an introduction to nonparametric curve fitting, which attempts to remove the need for these assumptions. Three basic approaches of nonparametric curve fitting will be discussed and demonstrated using simulated and real-world examples, including COVID case data and data gathered from our own campus.

Presentation and Question & Answer Session: 11:00 to 11:20 am in Frey 349

An Exploration of Nondimensional Parameters and Applications in Fluid Dynamics

33

Sarah N Kelchner

Data collection can be a time-consuming and expensive endeavor, particularly when many combinations of experimental conditions need to be tested. However, the use of dimensionless parameters can dramatically reduce the cost and time required to obtain data and test prototypes. Dimensionless parameters are generated by strategically combining variables relevant to the application using the method of repeating variables. This talk explores the topic of dimensionless parameters and their usefulness in concisely modeling real-world phenomena. Specific focus will be placed on the applications of dimensionless parameters in the field of fluid mechanics, as

dimensionless parameters provide the theoretical foundation for why precise flow analysis and small-scale prototype testing are possible!

Presentation and Question & Answer Session: 10:40 to 11:00 am in Frey 349

Probability Distributions and Settlers of Catan

35

Griffin McVay

Most board games operate around basic probability, but how can you form a winning strategy around this information? We will unpack an applicable approach to utilizing probability distributions and how we can rule over our family game night. The most common distributions that relate to dice probability are the discrete Binomial and Negative Binomial distributions, along with the "Expected Values" for each. We will cover how to use this knowledge to build a strategy in "The Settlers of Catan". Finally, we will look at some simulations and analyze the results from games played for us by AI. A basic understanding of probability distributions can help to build a strong strategy in any game of Settlers of Catan.

Presentation and Question & Answer Session: 11:20 to 11:40 am in Frey 349

An Alternative Approach to Center of Mass Problems in Introductory Calculus and Its Implications for Teaching

36

Jacob T Whipple

Utilizing integrals to solve real world problems in a classroom setting is often a rushed process that leaves students wondering why certain elements are or are not included in an integral. Center of mass calculations for two dimensional lamina are frequently misunderstood. This paper introduces a new approach to calculating the center of mass of a two dimensional lamina. Furthermore, the method introduced has the potential to more successfully teach the traditional material. The proposed method utilizes a more intuitive approach to solving center of mass problems which would potentially be better comprehended within the classroom.

Presentation and Question & Answer Session: 11:40 to 12:00 pm in Frey 349

Nutrition & Dietetics

Perceived Stress Does Not Have an Impact on Dietary Behavior in Messiah University Students Enrolled in a Wellness Course

56

Kaitlyn DeStefano, **Heidi Nolt**, **Sabrina Garman**, & Amy B. Porto†

Dietary behaviors can be influenced by various factors, including stress. Exposure to stress over a long period of time can result in negative health consequences. The aim of this study was to examine the relationship between perceived stress and eating habits in university students using the Perceived Stress Scale (PSS) and the Healthy Eating Assessment (HEA). Undergraduate students at Messiah University enrolled in a wellness course for the 2022 Spring semester were invited to participate. The PSS and HEA were administered electronically to interested students three times throughout the spring semester: at the beginning of the semester; three weeks into the semester; and eight weeks into the semester: four weeks into the semester; eight weeks into the semester; and eleven weeks into the semester. Of the 250 students enrolled in a wellness course, 18% completed the first round of data collection, 14% completed the second round, and 6% completed the third data collection. Data were analyzed in Microsoft Excel using linear regression models. R^2 values from the 1st, 2nd, and 3rd data collections were 0.10, 0.11, and 0.02, indicating a weak relationship between perceived stress scores and changes in dietary behavior. More research is needed to assess the changes in perceived stress and eating habits over time.

IRB Approval: 2021-033 Date: January 4, 2022

Presentation and Question & Answer Session: 1:00 to 1:20 pm in Jordan 161

Short-term Ashwagandha Supplementation Produced Inconclusive Acute Stress and Anxiety Data in College Students

58

Jordan M Lepley, **McKenna J Brown**, **Cameron K Carter**, & Amy B. Porto†

Context: Stress remains a primary public concern across all demographics and age groups. College students in particular suffer from outsized stress loads throughout their academic careers. Adaptogens, such as Ashwagandha (ASW) root, may represent a possible supplementation methodology to decrease both objective and subjective measures of acute stress.

Aims: The aim of this study was to evaluate the efficacy of a short-term high-concentration full-spectrum extract of ASW in reducing stress and anxiety in college-age students.

Design: Prospective, parallel, double-blind, randomized, placebo-controlled trial.

Materials and Methods: A total of 17 college-age subjects (mean age = 20.82, SD = 1.79, 5 female, 12 male) were enrolled in the study after inclusion and exclusion criteria were met. They were randomized to either the treatment group or the placebo control group and asked to take one capsule per day for a period of 30 days. In the treatment group, each capsule contained 600 mg of high-concentration full-spectrum ASW extract. Two in-person lab sessions were conducted to

measure subjective and objective stress response to an acute stress stimulus before and after the supplementation period.

Statistical Analysis: Paired *t*-tests were used for both subjective and objective measures.

Results: No significant reductions in stress measurements were observed. Additionally, the chosen acute stress protocol did not elicit an acute stress reaction in approximately half of the participants. As a result of this discrepancy, the remaining statistical analyses were viewed with skepticism.

Conclusion: The findings of this study do not provide significant evidence either in support of or against the research hypothesis. Additional research examining the efficacy and reliability of acute stress protocols in college-age participants is warranted.

IRB Approval: 2021-031 Date: February 2, 2022

Presentation and Question & Answer Session: 1:40 to 2:00 pm in Jordan 161

Preprandial Caffeine Administration Has No Effect on Blood Glucose Response in Messiah University Students

57

Alyssa R Meisel, **Brittany A Myers**, **Tyler J Kuykendall**, & Amy B. Porto†

Blood glucose control is important to avoid serious health complications. Caffeine is one of many factors that can potentially affect blood glucose levels. The purpose of this study was to determine the effect of caffeine on blood glucose response. Twelve Messiah University students (n=4 males and n=8 females) between the ages of 18-25 participated in this randomized single blind crossover study. Participants were recruited via word of mouth and classroom announcements. A baseline blood glucose measurement was obtained via finger stick following an overnight fast. Subjects immediately consumed 14 oz of coffee [caffeinated (315mg) or decaffeinated]. They then received a meal consisting of 75g of carbohydrates, after which their blood glucose level was measured three additional times in one-hour intervals. Participants returned the following week to repeat the procedure with the opposite treatment. The area under the curve between the caffeinated and decaffeinated treatments showed no statistical significance ($p>0.1$). Results of this study suggest the presence of preprandial caffeine does not have an effect on blood glucose response.

IRB Approval: 2021-034 Date: January 24, 2022

Presentation and Question & Answer Session: 1:20 to 1:40 pm in Jordan 161

Habitual Breakfast Skipping Contributes to Lower GPA but Not Caffeine Intake in Messiah University Students

59

Sophie Stambaugh, **Joy E Galbraith**, **Kirsten Howland**, **Cera H Connolly**, & Amy B. Porto†

Background: Breakfast has been labeled as the most important meal of the day. However, it is also the most frequently skipped. Regular consumption of a high quality breakfast has been associated with a healthy lifestyle and dietary habits, which are related to improved academic performance. Additionally, increased caffeine intake may be linked to breakfast skipping due to its impact on the quality and quantity of sleep.

Objective: To determine whether regular versus irregular breakfast consumption affects academic performance and caffeine intake.

Methods: Researchers created an online survey containing questions concerning breakfast habits, caffeine intake, and academic performance. The survey was administered via the Messiah University course management platform and on-site recruitment. Four hundred and thirty-four Messiah students between the ages of 18 and 23 responded. Data were analyzed using a two sample t-test.

Results: The GPA of breakfast eaters was 3.67 ± 0.02 compared to breakfast skippers 3.47 ± 0.48 ($p<0.0001$). No significant difference ($p=0.20$) was found for the frequency of caffeine intake of breakfast eaters (3.31 ± 2.66 days) compared to breakfast skippers (3.53 ± 2.45 days).
Conclusions: While caffeine intake appears to have no effect on breakfast habits, consuming breakfast regularly may contribute to a higher GPA.

IRB Approval: 2021-030 Date: January 22, 2022

Presentation and Question & Answer Session: 2:00 to 2:20 pm in Jordan 161

Eating Attitudes Assessment of Children Enrolled in the Salvation Army's After School Program

60

Sarah L Taylor, **Rachel H Marcroft**, **Heather E Mayo**, & Amy B. Porto†

The prevalence of disordered eating symptoms is increasing in adolescents and eating disturbances are being reported at young ages. Disordered eating has serious health and physiological consequences, thus it's imperative to have a reliable survey instrument for young children for early identification and prevention. The aim of this descriptive study was to assess the food preoccupation, dietary patterns, and eating attitudes in elementary-aged students by using the Children's Eating Attitudes Test (ChEAT). Survey items are categorized into four subscales: (1) concerns about weight, (2) limiting food intake, (3) pressure to eat, and (4) concerns about food. Students enrolled in The Salvation Army's Roller Enrichment Academy were invited to participate in the study. Of 26 enrolled, 15% provided parent permission and child assent. The ChEAT was orally administered over 2 sessions to participants (n=4), aged 7-

10. Results indicated subscales 1 and 4 had the highest scores (4 ± 5.48 and 4 ± 2.45, respectively). Item 25 (I enjoy trying new rich foods), contributed 56% to the total score of subscale 4. The participant with the highest total score (23 out of 78) appeared to be the most comfortable during survey administration. The participant who appeared to be the least comfortable during survey administration had the lowest total score (1 out of 78). These results suggest comfort level may be associated with participant willingness to answer survey items. However, more research is needed to explore eating attitudes in young children, so that disordered eating patterns can be better understood in this population.

IRB Approval: 2021-029 Date: February 21, 2022

Presentation and Question & Answer Session: 2:20 to 2:40 pm in Jordan 161

Physics

Calorimeter Reconstruction Tools for AI-Driven Optimization on the Electron Ion Collider

17

Nathan Branson & Abaz Kryemadhi†

The new Electron Ion Collider (EIC) will be a novel machine in the nuclear physics sector and is at the forefront of current technology. With new technology, detector research and development (R and D) becomes ever more important to ensure the machinery is reporting the best results. With artificial intelligence (AI) becoming widespread in many professional fields, AI detector optimization is a logical step for nuclear physics. This project focuses on event reconstruction of the electromagnetic calorimeter located in the electron endcap.
This calorimeter has an especially important role to detect scattered electrons that collide with a proton and report the energy, position, and incident angle of the electron. With this data, events are graphically and visually reconstructed. Calorimeter reconstruction methods need to be finished before optimization is started in order to verify the optimized results. The calorimeter in the EIC will be a hybrid calorimeter that has two different materials. Methods need to be developed to analyze the area between the materials. The reconstruction tools were built using JANA2, G4E (Geant4 EIC), and CERN ROOT.

Presentation and Question & Answer Session: 9:40 to 10:00 am in Frey 150

Laser Tomography

20

Dalton J Daugherty & Abaz Kryemadhi†

Lasers play an important role in imaging techniques in areas such as medicine.

This is a proof of concept work to see how one can use a laser to create an image of an object embedded in an acrylic block in order to demonstrate the feasibility of laser tomography.

Presentation and Question & Answer Session: 10:40 to 11:00 am in Frey 150

Dark Photon Dark Matter Detector II

16

Samantha Neal, Abaz Kryemadhi†, & Niklas Hellgren†

About 85% of the matter in the Universe is in a form known as Dark Matter which interacts with regular matter mostly via gravity. The faster than expected speeds of stars around the galaxy indicate its' presence. Regular matter is made of protons, neutrons, and electrons, while we do not know what dark matter is made of. A promising candidate is a dark photon motivated by scalar quantum field additions to the standard model of particle physics. The dark photon can spontaneously convert to an ultraviolet photon which can be measured. Designing experiments with dark chambers (to shield from other light sources) and in vacuum (so ultra-violet light is not absorbed) would be a way to search for dark photons. This work extends past the previous work done, where the next phase of dark photon searches would involve a larger vacuum chamber and different photo-detectors. The focus of my work was to understand the response of two photo-detectors to different levels of light in order to assess their ability for usage in the next phase of dark photon searches

Presentation and Question & Answer Session: 9:20 to 9:40 am in Frey 150

Damping Effects on Sound Waves

18

Hanna M Pavill & Niklas Hellgren†

Sound quality is greatly affected by any object that interferes with a sound wave that was created. These objects could be walls, carpets, or blankets, and are known as damping conditions. The primary aim of this research is to discover how damping conditions affect sound waves produced at different frequencies. A series of experiments were conducted with two separate systems, one that was damped and one that was not. Sound waves were produced at multiple frequencies and data was collected in each of the above scenarios. Amplitudes and phase shifts of the waves were compared to see what difference the damping conditions had on the wave. The fast Fourier transform was also utilized using MATLAB which allowed for a difference to be seen between the frequency produced and the one that was measured.

Presentation and Question & Answer Session: 10:00 to 10:20 am in Frey 150

Development of a Detector System for Dark Photon Dark Matter

15

Ryan J Thurber, Abaz Kryemadhi†, & Niklas Hellgren†

Dark Matter is assumed to exist because of the gravitational effects on stars as they move around galaxies. Efforts have been made to discover its properties in ways such as studying possible inelastic collisions in particles, but they have not yielded conclusive results. Dark photons have been motivated from theory as dark matter candidates. They can convert to regular photons at a small rate. Therefore, my study will strive to discover the regular photons emitted by the dark photons. This can be done by setting up an experimental area shielded from all light sources where the existence of a dark photon would be manifested by the appearance of regular photons in a completely dark area. To increase the chance of detection, a spherical mirror will be used to reflect the photons towards our detector, which increases our effective surface area. So far, I have worked with the photodetector and the data acquisition system in order to understand detector performance in a vacuum, which allows for photons of a shorter wavelength to last longer before they are absorbed, and how to determine the background noise from actual signals.

Presentation and Question & Answer Session: 9:00 to 9:20 am in Frey 150

Protecting Coastal Communities: Impact of Partial Wave Data on Oceanographic Modeling

19

Eli S Whitehead-Zimmers & Niklas Hellgren†

Before a storm hits the coast of the United States, scientists deploy sensors on beaches that measure water levels. From the water level data, statistics about the waves are obtained and are used to verify models created for that storm and create models for future storms. From tidal variations, a sensor often captures the top of the wave, but the trough of the wave falls below the sensor and does not get recorded. This project explores how partial wave data affects the wave height and period by chopping full data sets spatially and temporally. Percent errors were then calculated for a given percent incompleteness of a wave. It was found that both spatially and temporally incomplete data sets impacted the accuracy of the wave height and period.

Presentation and Question & Answer Session: 10:20 to 10:40 am in Frey 150

Poster Abstracts

Biology, Cellular & Molecular

Analysis of Contamination in Fetal Bovine Serum (FBS) for Pancreatic Cancer Research

67

Rebekah D Cordell & John F Harms†

Cancer accounts for many deaths in the United States, and pancreatic cancer is one of the deadliest varieties. Pancreatic cancer tumors make an abundance of collagen, a protein that makes the tumor extracellular matrix dense and reduces normal blood and lymphatic flow. This restricts access for chemotherapy, oxygen necessary for radiation efficacy, and immunotherapy targeting the tumor. Proglumide is a drug that has been proven to reduce collagen levels in mouse models of pancreatic cancer, but this collagen reduction has not been reproduced in cell cultures. Our lab plans to use cocultures to determine if the overproduction of collagen is caused by signaling crosstalk between cell types. Recently, these efforts have been complicated by the presence of an unknown contaminant in the media for the cell culture. The contaminant is a motile, slow-growing bacteria that grows in fetal bovine serum (FBS), a crucial media supplement. Several experiments were performed to determine its antibiotic sensitivity and the serum concentration required for bacteria growth. Penicillin-streptomycin was the only tested antibiotic that could delay cell growth, albeit only slightly. The bacteria do not require high percentages of FBS, growing in media down to 10% FBS. It appears human cells may inhibit bacterial cell growth as no growth was observed in RLT-PSC cultures until after cell death. Ongoing experiments will attempt to identify the bacteria and explore ways to eliminate its growth.

Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

Development and Testing of a Tumor Cell-Based Vaccine for Pancreatic Cancer

41

Daniel L Guevin, Sarah Bath, John F Harms†, & Lawrence M Mylin†

Pancreatic cancer is an aggressive and deadly cancer. An altered form of the cholecystokinin receptor (CCK2i4svR) that includes 69 extra amino acids in a third intracellular loop is expressed by many aggressive pancreatic tumors. We aim to develop a vaccine that will "train" host adaptive immunity to recognize this novel target. We have engineered a tumor cell-based vaccine in which immortalized syngeneic cells express a derivative of the Simian virus 40 Large Tumor antigen protein (SV40 T ag) that contains a 20 amino acid insert corresponding to a portion of the 69 amino acid sequence found in the CCK2i4svR receptor variant. Immunization of mice with a synthetic peptide corresponding to the 20mer insert induced peptide-specific CD4+ T cells in previous studies. C57Bl/6 mice were injected with the tumor vaccine cells (4A-1) or control cells (B6/WT-19) that expressed unaltered SV40 T ag to elicit T cell responses

against SV40 T ag epitopes only and the CCK2i4svR sequence. An ELISPOT assay was employed to detect epitope-specific T cells using three target peptides: a known CD4+ epitope from SV40 T ag; the 20mer from CCK2i4svR; a control HBV epitope. CCK2i4svR-specific responses were detected, but frequencies were inconsistent. We tested whether immunity elicited by the vaccine cells could control the growth of orthotopically implanted murine pancreatic cancer Panco2 cells engineered to co-express the human CCK2i4svR variant. Groups of mice were immunized twice with either 4A-1 or B6/WT-19 cells before implantation and proglumide therapy. Tumor progression/burden and immune status (ELISPOT) were monitored at 4 weeks. Tumor presence and mass were reduced in the mice of the experimental group relative to controls. Leukocyte infiltration will be assessed by future immunohistochemistry and staining.

IACUC Approval: 2015-08R-2024 Date: November 22, 2021

Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

Developing a Protocol for Accurately Quantifying Low Levels of CCK2R Expression in Downregulated Pancreatic Cancer Cells

43

Joshua B Harding & John F Harms†

Pancreatic ductal adenocarcinoma (PDAC) is responsible for over 90% of pancreatic cancer diagnoses and has an average 5-year survival rate of under 10%. Recent research has pointed to the involvement of gastrin/CCK signaling in pancreatic tumor fibrosis as an antagonist of gastrin/CCK receptors (e.g., CCK2R) has been shown to decrease fibrosis. To identify downstream pathways, our lab has set out to determine the effect of CCK2R downregulation on tumor fibrosis and the expression of various stromal/immune mediators. Because many PDAC lines endogenously express low levels of CCK2R mRNA, it is imperative that quantification in down-regulated clones by RT-PCR is as sensitive as possible. To achieve this, our lab sought to determine the most reproducible and sensitive primer-probe set among three commercially available sets. It is essential that the assay will not present false positives due to contaminating genomic DNA prompting the lab to test two different DNase protocols. We found that commercial set #3 is the most reproducible and sensitive primer-probe set compared to sets #1 and #2. Commercial set #3 also proved to be the best set for biasing against genomic DNA contamination, with only 24.1% of negative control (DNase treated, reverse transcriptase negative) samples showing low-level amplification within 50 cycles, compared to 37.9% for set #2 and 66.7% for set #1. To address this persistent contamination, we treated our samples with a high efficiency DNase enzyme, and it showed no significant improvement in reducing gDNA in preliminary trials.

Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

Establishing Developmental Hypoxia Models in *Danio rerio* and Cultured Oligodendrocytes

51

Madeline Johnston & Jennifer K Ness-Myers Ph.D.†

Oligodendrocytes produce and maintain myelin in the central nervous system (CNS), enabling neurons to transmit axonal signals rapidly via saltatory conduction. During development, oligodendrocyte precursor cells (OPCs) respond to multiple environmental signals and intrinsic timing to initiate myelination. In the event of tissue injury, the myelination program is disrupted and results in a 'maturation arrest' and consequent defects in CNS myelin. Oxygen deprivation (hypoxia) during prenatal development is a common cause of white matter injury, which leads to cognitive and functional impairment. It is the purpose of this study to establish new developmental hypoxia models for zebrafish embryos and cultured oligodendrocytes. Chemical hypoxia using sodium sulfite was tested as a developmental zebrafish hypoxia model. The parameters of sodium sulfite solutions were evaluated for pH and dissolved oxygen (DO) stability over time, and the effects on myelin gene expression in zebrafish larvae subjected to hypoxia were analyzed by qPCR. A new method for cell culture hypoxia was also tested on purified cultures of immature oligodendrocytes. This model utilized an oxygen absorber and vacuum-sealed bags to produce a hypoxic environment for cells grown in a 6-well dish.

IACUC Approval: 2018-16R-F2024 and 2018-13R-S2024 Date: January 13, 2022

Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

Optimization of a Novel QRT-PCR Assay for Relative Quantification of CCK2R Splice Variants in Pancreatic Cancer

42

Natalie M Johnston & John F Harms†

Pancreatic ductal adenocarcinoma (PDAC) is a particularly aggressive cancer and its behavior is driven in part by the hormone, gastrin, via its preferential receptor, CCK2R. A splice variant of CCK2R, called $CCK2_{i4sv}R$, encodes a hyperactive receptor associated with elevated tumor growth, and arises from failure to splice the 4th intron. To test the hypothesis that the relative abundance of CCK2R and $CCK2_{i4sv}R$ expression will present prognostic value, we developed a novel SYBR Green qRT-PCR assay capable of differentiating the variant transcripts. Employed against RNA isolated from patient samples representing both PDAC and normal pancreas, primer-dimer and occasional non-specific amplification were observed in samples with low or no receptor expression. We hypothesized primer modifications and annealing/extension temperature optimization would eliminate these artifacts in no-template conditions. Analyses demonstrate that primer-dimer artifacts were heterodimeric. Artifact frequency was significantly reduced by slight modifications to each of three reverse primers while redesign of the shared forward primer significantly compromised selectivity against contaminating genomic DNA. Having validated the new primer combinations using no-template and plasmid-based qPCR, qRT-PCR analysis of a panel of control RNAs and low-expression samples is ongoing.

Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

Expression of LCK and LYN in Activated Microglia

68

Mason J Kennedy & Jennifer K Ness-Myers Ph.D.†

Glial cells function to support and protect neurons and are intricately involved with neuronal communication at the synapses. Recent studies have shown that activation of glial cells play a critical role in neuropathic pain signaling. Neuropathic pain and the way it is transmitted throughout the brain is not well understood. One type of glial cell in the central nervous system is microglia. They are specialized immune cells that function in regulating inflammation, apoptosis, phagocytosis of cellular debris, synaptic connectivity, and synaptic pruning. During tissue damage or disease, they become activated and migrate to the regions of inflammation. These cells also play a role in neuropathic pain signaling, which is not well understood. Fractalkine, a chemokine, attracts immune cells to sites of infection and causes inflammation. The fractalkine pathway in microglia has recently been implicated in neuropathic pain. Previous analysis in our lab determined that Lck and Lyn have been reported to have the highest expression in the microglia of primary rat brains compared to other glial cells. Lck is a Src-family kinase involved in multiple intracellular signaling pathways, including migration. Initial studies were conducted to determine the effect of microglial activation and fractalkine treatment on gene expression of the Src-family kinases Lck and Lyn.

IACUC Approval: 2018-13R-S2024 Date: May 24, 2021

Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

Generation of Neutralizing Monoclonal Antibodies Against Bacteriophage T4

52

Lily X Velazco, Hunter Zondory, & Lawrence M Mylin†

Antibodies protect by various mechanisms, but induction of antibodies that block infection by binding to pathogen surface structures is a goal of current vaccines. Past Messiah University Microbiology courses included experiences wherein students blocked infection of *Escherichia coli* B by bacteriophage T4 using polyclonal T4-specific goat antiserum. Unfortunately, the polyclonal serum is no longer available. We have undertaken to generate mouse monoclonal antibodies that neutralize phage T4 to use in the same laboratory experiences. Our strategy was to immunize Balb/c mice with concentrated T4 suspensions from which endotoxin (lipopolysaccharide) had been depleted by gentle organic extraction. Mice were injected twice over two weeks with ~ 1.6 – 3.5 x 10^{10} pfu of T4r+ phage. Serum was prepared from blood collected by cheek vein puncture and assessed for T4-neutralizing activity in a 96-well plate scale-screening assay. Briefly, small amounts of *E. coli* B and T4 were combined in each well. Ongoing infection by T4 limited the density of bacterial growth in a well when measured

at 6 – 8 hours. The presence of neutralizing antibodies prevented infection and instead allowed the bacteria to grow to near-saturation. The use of serially diluted serum samples allowed relative neutralizing titers to be determined. This presentation will describe the development of the 96 well plate-scale screening assay and how it was further adapted to tolerate the presence of antibiotics that will be in supernatants of hybridoma cultures (Gentamicin, or the mixture of Penicillin and Streptomycin). Exponentially growing *E. coli* B cells were transformed with plasmids encoding ampicillin and either gentamicin or streptomycin resistance. Infection by T4 was confirmed in the presence of the relevant antibiotic, as well as the ability of each transformant to proliferate if T4 was neutralized by goat antisera under similar conditions. Production and screening of hybridomas are in progress.

IACUC Approval: 218-15R-F2024 Date: November 22, 2021

Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

Generating Neutralizing Monoclonal Antibodies Against Bacteriophage T4: Designing a Screening Assay

53

Hunter Zondory, Lily X Velazco, & Lawrence M Mylin†

Antibodies protect by various mechanisms, but induction of antibodies that block infection by binding to pathogen surface structures is a goal of current vaccines. Past Messiah University Microbiology courses included experiences wherein students blocked infection of *Escherichia coli* B by bacteriophage T4 using polyclonal T4-specific goat antiserum. Unfortunately, the polyclonal serum is no longer available. We have undertaken to generate mouse monoclonal antibodies that neutralize phage T4 to use in the same laboratory experiences. Our strategy was to immunize Balb/c mice with concentrated T4 suspensions from which endotoxin (lipopolysaccharide) had been depleted by gentle organic extraction. Mice were injected twice over two weeks with ~ 1.6 – 3.5 x 1010 pfu of T4r+ phage. Serum was prepared from blood collected by cheek vein puncture and assessed for T4-neutralizing activity in a 96-well plate scale-screening assay. Briefly, small amounts of *E. coli* B and T4 were combined in each well. Ongoing infection by T4 limited the density of bacterial growth in a well when measured at 6 – 8 hours. The presence of neutralizing antibodies prevented infection and instead allowed the bacteria to grow to near-saturation. The use of serially diluted serum samples allowed relative neutralizing titers to be determined. This presentation will describe the development of the 96 well plate-scale screening assay and how it was further adapted to tolerate the presence of antibiotics that will be in supernatants of hybridoma cultures (Gentamicin, or the mixture of Penicillin and Streptomycin). Exponentially growing *E. coli* B cells were transformed with plasmids encoding ampicillin and either gentamicin or streptomycin resistance. Infection by T4 was confirmed in the presence of the relevant antibiotic, as well as the ability of each transformant to proliferate if T4 was neutralized by goat antisera under similar conditions. Production and screening of hybridomas are in progress.

IACUC Approval: 2018-15R-F2024 Date: November 22, 2021

Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

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Biology, Organismal & Ecological

Hybridization and Evaluation of Spring Varieties of Flax (*Linum usitatissimum*) in South Central PA

49

Katelyn M Boyce & Glafera Janet B Matanguihan†

Heart disease and cancer are currently the top two causes of death in the United States. With doctors increasingly recommending changes in diet and lifestyle, the demand for accessible and nutritious food is rapidly growing. Within the past several years, “superfoods” have surged in popularity, and more evidence is coming out in support of their potential health benefits. One of these is flaxseed oil, which contains high levels of fatty acids that show potential for decreasing the risk of heart disease, lowering cholesterol, preventing cancer, and managing diabetes. The majority of oilseed flax cultivation in North America occurs in North Dakota and Canada, but the growing superfood market is making its agricultural expansion into new regions more likely. Flaxseed (*Linum usitatissimum* L.) shows great potential for its introduction to south-central Pennsylvania. The overall goal of this research is to explore the sustainable cultivation of flax in the area. Initially, two projects will focus on 1) collecting preliminary data on the performance of spring flax cultivars under Pennsylvania field conditions and 2) establishing hybridization protocols in the greenhouse as the foundation to investigating the genetics of flaxseed oil production. Data collected will form the basis of flaxseed growing guidelines for the area, which are not well-established, so that local farmers will be more inclined to include it in their crop rotations.

Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

Breaking Down Barriers: Understanding the Impacts of Small Dam Construction on Biodiversity of Aquatic Macroinvertebrates

50

Kayla M Herr & Jeff S Erikson†

Freshwater ecosystems are a valuable resource for human life as they provide economic, cultural, aesthetic, scientific, and educational resources that other ecosystems cannot. Freshwater environments are critical in preserving biodiversity as they sustain a wide range of both aquatic and terrestrial life. Although these freshwater habitats are essential for human and animal life alike, humans continue to alter these fragile environments by means of overexploitation, water pollution, and flow modification through dam construction. Aquatic macroinvertebrates are a key part of aquatic life and can be collected to assess the health of freshwater habitats that have been

modified by humans. The main objective of this study is to investigate the effect of small dams on the biology of streams in the Yellow Breeches Watershed in Mechanicsburg, PA through aquatic macroinvertebrate sampling and analysis. Research was performed by collecting multiple water and macroinvertebrate samples from two Yellow Breeches Creek tributaries, both above and below the small dams, and analyzing the samples in the lab. Expected results include an increase in the abundance and biomass of macroinvertebrates but a decrease in richness and biodiversity downstream from dam sites. Additional predictions include an increase in tolerant macroinvertebrate species and a decrease in intolerant species downstream from dam construction.

Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

Dietary Analysis of the Long-tailed Salamander, *Eurycea longicauda*

45

Joshua C McCoy & Randy W Cassell†

This study examines the diet of the Long-tailed Salamander, *Eurycea longicauda*, in south-central Pennsylvania and attempts to determine whether its diet varies seasonally. Little is currently published on the diet of the Long-tailed Salamander, which mainly inhabits leaf litter and rocky crevices on the forest floor. Because of the Long-tailed Salamander's habitat, it was hypothesized that its diet consists largely of leaf litter-dwelling and crevice-dwelling invertebrates belonging to the following taxa: *Gastropoda, Acari*, *Isopoda, Diplopoda, Collembola*, *Coleoptera, Hymenoptera*, and *Diptera*. It was also hypothesized that non-hexapod species would make up a greater portion of the diet during portions of the year when hexapods are in diapause. To test these hypotheses analysis of the gut contents of wild-caught Long-tailed Salamanders was conducted. Long-tailed Salamanders were caught using a visual encounter search. After capture, sex and snout-vent length (SVL) were recorded, and gut contents were removed using a non-lethal gut-flushing technique. Following stomach evacuation, salamanders were returned to the site of capture. Samples were collected throughout the year and compared to identify seasonal patterns in prey species variation. It was found that three specimens collected in September fed almost exclusively on Isopods, with Collembolans and Diplopodans also present in one individual. Additional data will be collected throughout the spring, summer, and fall of 2022.

Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

Aquaponic Growth of Ginseng and Potatoes

44

Jessie T Wynne & David K Foster†

American ginseng (*Panax quinquefolium*) is a highly coveted medicinal herb native to forested regions of the eastern United States. This study is to determine if growing American ginseng in

an aquaponic system has the ability to increase medicinal ginsenosides present in the plant. Seeds and live roots were cold stratified (6 months at 4°C) to break thermal dormancy resulting only in emerging hypocotyls. The aquaponic system was monitored for dissolved oxygen (DO), nitrate (NO^{-}_{3}), phosphate (P), temperature, and pH. Nitrate had an upward trend from 124.89mg/L to 213.90mg/L. while other parameters remained relatively constant. Potatoes were grown to test the system and were planted at water level (0cm), 5.08cm, and 10.16cm above water level, the most productive growth occurring with tubers planted at water level. All Ginseng roots were transferred from the cold stratification on 03/22 and then planted in the aquaponic system at water level. All Ginseng seeds were transferred from the cold stratification to the greenhouse on 03/22 and were planted in potting soil. They were monitored daily and kept moist. Ginseng seeds began to germinate on 4/3/22.

Funding for this work provided by The Gary and Sylvia Emberger Research Scholarship .

Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

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Biochemistry

Machine Learning as Supplementation to Molecular Docking in the Discovery of Novel PTP1B Inhibitors

69

Marina B Stevenson & Anne M Reeve†

Protein tyrosine phosphatase 1B (PTP1B), as one of many protein phosphatases that maintain signaling cascades, negatively regulates the cellular response to insulin. If dysfunctional, it prematurely shuts down the cascade required for a cell to begin the uptake of glucose. This activity implicates PTP1B in the increasingly prevalent conditions of type 2 diabetes and obesity. Thus, an inhibitor of this protein is highly sought after for its potential therapeutic and monetary benefits. PTP1B's reputation as "undruggable" precedes itself, however; its highly conserved active site cannot be targeted without significant cross-reactivity elsewhere. Molecular docking simulations can be invaluable in the search for new binding pockets to target. This project involved the construction of a predictive model using data generated from the open-source molecular docking program AutoDock Vina. Multiple experimental compounds including stilbenes, chalcones, and flavones were docked on 1,000 conformations of PTP1B, along with positive controls and decoys, and the best five were processed further. A key decision was to gather data on amino acid type and distance surrounding predicted poses instead of relying on the program's calculated affinity, which is more prone to error. In-house Python scripts were written to process the resulting information, with supervised classification algorithms employed to determine if new compounds might be leads. This project will continue with upgrades to AutoDock Vina, allowing for more realistic aqueous simulations, and explorations of both docking and classification parameters and their impact on the model's predictive power.

Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

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Chemistry

Ionic Liquids as Both Solvent and Reagent in Electrophilic Addition Reactions

65

Hannah E Artz & Roseann K Sachs†

Ionic Liquids (ILs) are an environmentally friendly alternative to organic and aqueous reaction solvents. ILs do not emit hazardous gasses, are readily recycled and reused, and often do not require an excess volume of harmful reagents and purification solvents. The IL anion's capacity to participate in a reaction as the nucleophile source is a much less understood area of this research, and it may advance the use of ILs in organic synthesis, particularly for addition and substitution reactions. Markovnikov hydrohalogenation of alkenes is one addition reaction that is generally taught as an introduction to organic chemical reactions; however, this reaction is difficult to successfully complete in the laboratory. ILs overcome the challenges posed in those traditional methods and can be used as both a reaction solvent and halogen source to successfully complete the Markovnikov addition of H-X across a double bond. The hydrohalogenation reaction was completed over 100 times using a variety of ionic liquids including imidazolium, pyridinium, pyrrolidinium, and piperidinium cations. Products were isolated using organic extraction and analyzed with NMR and GC-MS. Bromide anion ILs were consistently successful with all substrates, iodide was most efficient under nitrogen, and chloride was successful with additional heat. Hydrohalogenation of styrene was successful in all ILs used and most successful in the imidazolium-based bromide ILs. Reactions with cyclic aliphatic substrates were less successful with lower yields. Finally, hydrohalogenation of styrene derivatives was recently investigated with moderate success after modification of reaction conditions.

Funding for this work provided by Ray Crist Undergraduate Summer Research Program.

Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

Methylimidazolium Bromide as a Recyclable Ionic Liquid for Electrophilic Addition Reactions

66

Caleb D McClymont & Roseann K Sachs†

Ionic liquids (ILs) have unique properties which present them as superior environmentally friendly solvents that can limit the quantity of waste that is produced when performing a chemical reaction. Unlike common traditional solvents, ILs do not release harmful vapors into the environment. ILs can be efficiently recycled and reused, limiting the waste being produced.

Also, ILs can function as both a catalyst and reagent, greatly reducing the need for additional hazardous reagents. One area of research that warrants further investigation is the IL's ability to function as a solvent in electrophilic addition reactions where the halide of the IL acts as the nucleophile. This is the focus of our research. Methylimidazolium bromide is our IL of interest due to its ability to also act as an acid. This removes the need to add sulfuric acid to the reaction. After the product is isolated the IL can be regenerated simply by adding one equivalence of hydrobromic acid. This gives this IL greater potential as a recyclable solvent in which to carry out these reactions.

Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

Modeling Interstellar Medium: a Computational Approach to Predicting Polycyclic Aromatic Hydrocarbons

70

AJ Swanson & Samuel J Stoneburner†

Polycyclic aromatic hydrocarbons (PAHs) are located in the interstellar medium found in space. The interstellar medium is located around and in between different star systems and is made up of various particles of matter. Multiple compounds, including PAHs, have been studied to figure out how each of these are formed and the information that they can give us, like how they formed while surrounding various planets and stars. Over the past 20 years, the Ames Research Center PAH IR Spectral Database of multiple PAH calculations was created to hold different theoretical and experimental infrared (IR) spectra of these compounds.

This project involves the study of the theoretical methods that were used on the PAHs in the Ames database. Currently, all the PAHs in the Ames database used the basis set 4-31G and the density functional theory B3LYP. The basis set used was relatively cheap and this project considers alternate basis sets and methods looking to improve the comparison with the experimental values. All calculations were done without changing the functional B3LYP. There are vast numbers of theoretical PAHs in the database, and the PAHs selected were ones that had an experimental counterpart so there is a reference for comparisons. The effects of the different basis sets have been inconsistent up to this point and need further investigation. The functional PBE is currently being tested for possibly improving the accuracy. A different theory, VPT2, was tested and ruled too expensive for the resources available.

Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

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Engineering

Stormwater Management for Greenwood Hills Bible Camp

71

Abby Bartels, **Caleb J Hilton**, Warner C Hockenberry, Caleb R Light, Daniel O Thomas, & Thomas S Soerens†

The stormwater team addresses flooding and erosion issues. In the spring of 2022, the team analyzed erosion problems for Greenwood Hills Bible Camp near Chambersburg PA and designed a system to capture and divert the runoff that is causing erosion. The design includes collection of the runoff with French drains and rock channels and conveyance of the water through a culvert with discharge down-gradient of affected houses. The system should lessen the erosion affecting the camp road and fix nuisance flooding and erosion at the residences. In the fall of 2021, the team partnered with the City of Harrisburg and Capital Region Water to address flooding in the Allison Hill neighborhood of Harrisburg Pennsylvania and designed a plan to mitigate this problem for neighborhood residents.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presented in: Engineering AM Poster Session from 11:20 to 12:00 pm and in: Engineering PM Poster Session from 3:20 to 4:20 pm

A Modular Functional Electrical Stimulation (FES) System for Gait Assistance in Pediatric Cerebral Palsy

72

Wyatt P Bingaman, **Andrew T Clancy**, Nick Hamann, Callan W Heise, Timothy Lee, Ryan J Farris P.E., & Ph.D.†

Foot drop, the inability to lift the forefoot during gait, is a common symptom of disorders such as diabetes, stroke, spina bifida, and cerebral palsy. This condition makes walking difficult and unsafe, often resulting in stumbles and falls due to lack of ground clearance. The current standard of care is orthotic bracing, which presents donning and doffing challenges, restricts ankle motion, and contributes to social stigma in many parts of the world. Functional electrical stimulation (FES) is an alternative approach which uses small amounts of electrical current delivered through skin-surface electrodes to stimulate peripheral nerves, thus generating muscle contraction and ultimately functional movement of a human limb. When packaged in a wearable device with onboard sensors capable of detecting gait phase, stimulation current can be applied to the lower leg to cause the foot to lift during the swing phase of gait. While several FES foot-drop systems are commercially available, they cost upward of $13,000 and provide a level of adjustability and complexity not needed for many conditions. The Messiah FES team is working to develop a low-cost, portable, easy-to-use, and durable electrical stimulation device to restore legged ambulation to children with mobility impairments resulting from cerebral palsy, spina bifida, and other conditions with similar effects. Our clinical partner is CURE Ethiopia, with our primary contacts being Dr. Tim Nunn and Dr. Laurence Wicks at the CURE Ethiopia Children's Hospital in Addis Ababa, Ethiopia.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presented in: Engineering AM Poster Session from 11:20 to 12:00 pm and in: Engineering PM Poster Session from 3:20 to 4:20 pm

Muscle Activated 3D Printed Prosthetic Arm

73

Paige M Campbell, **Antonio P Santelli**, **Caleb J Wright**, Lindsay L Haseltine, Jaymie R Monday, Meghan L Sampson, & Tim Howell †

Due to the rapid growth of children and the cost of myoelectric technology, children are not given the same opportunities to use myoelectric prosthetics as adults. The Muscle Activated Prosthesis (MAP) team seeks to reconcile this by creating an affordable, trans-radial, myoelectric prosthesis that utilizes the flexibility of 3D printing technology for a fourteen-year-old congenital amputee named Lily. The MAP team has completed the design and prototype of a myoelectric prosthesis with a material cost of approximately $1,000 as opposed to the $10,000-$20,000 cost of clinically accepted myoelectric prosthetic upper limbs. The 3D printed prosthetic arm prototype incorporates electromyography (EMG) electrodes, a motor and tendon system, an open-source prosthetic hand design, a custom printed circuit board (PCB), and lithium-ion battery power. The opening and closing of the prosthetic hand is controlled by the myoelectric signals from the user's forearm contractions which can be tested by the team using our adaptive prosthetic attachment. All these components result in an affordable prosthetic that has the potential for customization and adaptation to different sized limbs.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presented in: Engineering AM Poster Session from 11:20 to 12:00 pm and in: Engineering PM Poster Session from 3:20 to 4:20 pm

Designing a Locally Manufacturable Wheelchair for Nepal

74

Pauline Deutcheu Tchouako, Ethan M Barnes, Levi D Hauger, Joshua J Holley Mr., Jacob Petrovich, & Timothy J Van Dyke†

People with disabilities in developing countries often lack the basic equipment needed to assist them in their daily lives. International Nepal Fellowship (INF) is a Christian medical organization located in Nepal that provides medical care and assistance to people with disabilities and other conditions. Currently, INF imports expensive wheelchairs that undergo a prolonged border process before being received. INF has reached out to the Collaboratory to

design a wheelchair that can withstand the challenges of Nepal's terrain and can be manufactured from local materials. The Nepal Wheelchair team has set out to design a wheelchair that can fulfill their needs. In previous work, the team researched wheelchair designs and took a trip to Nepal. From this trip, more information was gained, an initial prototype was constructed, and locally available materials and parts from Nepal were brought back. This year, as a result of knowledge gained through constructing the second prototype, many design changes were tested and implemented. The team researched standards and created testing procedures to ensure the changes to the rear wheel mount, caster wheel mount, footrest, and seat design would uphold the strength and durability of the wheelchair. These design changes have enhanced patient safety and experience in the wheelchair while still keeping the design easily manufacturable. The team also researched options for adding push rims and through using a roller bender were able to construct them. Moving forward, the team will continue to finalize manufacturing documentation and take a second trip to Nepal this May.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presented in: Engineering AM Poster Session from 11:20 to 12:00 pm and in: Engineering PM Poster Session from 3:20 to 4:20 pm

Fluency Assistance Device (FAD): Masker Upgrades

75

Timothy Fair, **Elijah Wood**, Jake T Finkbeiner, Chad M Long, Jon R Sweeton, & Harold R Underwood†

There are around seventy million people internationally who have a stutter, a form of fluency disorder. Some fluency assistance devices are available to the public, but most are highly expensive or unreliable. The Fluency Assistive Device (FAD) team seeks to assist a niche community of these individuals for whom therapy has not worked, and who currently rely on a device known as the Edinburgh Masker. To best reach this community, FAD is partnering with Dave Germeyer, who has invaluable experience repairing these masker devices for his clientele. FAD is redesigning the masker to increase its portability, functionality, and cost-effectiveness by developing an improved analog and new digital version. The Analog Masker v1.3 focuses on updated components and consolidated circuitry to eliminate troublesome wiring of the original. The Digital Masker v1.0 employs a Bluetooth-enabled microcontroller to achieve masker functionality, offering the flexibility of alternative fluency assistance algorithms to assist a broader group of users. An updated prototype of the Analog Masker v1.3 was fabricated and tested for power consumption and overall functional output characteristics versus the original Edinburgh version. The Analog Masker v1.3 has also been fully packaged and enclosed to produce a client testable unit. Bluetooth audio output for the Digital Masker has almost been completed, and two of the alternative algorithms have been coded for the masking output. One of these algorithms, Delayed Altered Feedback (DAF), now produces the expected output in response to an audio test input. Clarity and integrity of the DAF signal output have also been

improved. The Masking Altered Feedback (MAF) algorithm that emulates the behavior of the Edinburgh original on the Digital Masker v1.0 is under development.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presented in: Engineering AM Poster Session from 11:20 to 12:00 pm and in: Engineering PM Poster Session from 3:20 to 4:20 pm

Force Characterization and Manufacturing of a Dynamic Unilateral Clubfoot Brace

76

Brittney D Fouse, **Sam J Rasinske**, **Stevie R Snodgrass**, Jacob R Cornwell, Michelle Lo, Clint M Meekins Jr, Leigha R Southall, & Tim Howell †

Clubfoot is a musculoskeletal birth defect characterized by an inward twisting of an infant's feet. Currently, a series of casts are used to correct clubfoot and the Steenbeek brace is used to maintain the correction. However, this method has issues with compliance, comfort, and social stigma. Mr. Jerald Cunningham, CPO, designed and is utilizing a unilateral clubfoot maintenance brace called the Cunningham Clubfoot Brace. He expects his brace to reduce treatment time, lessen social stigma, and increase child mobility. Hope Walks, in Kijabe, Kenya, is interested in implementing this new maintenance brace at their clinics. However, there is not enough published research on its biomechanics and patient success rates to confirm Mr. Cunningham's findings.

The Cunningham Clubfoot Brace Collaboratory project seeks to validate the effectiveness of this design through biomedical testing and increase brace accessibility through sustainable manufacturing. The team is measuring the biomechanical forces applied by the brace with multiple force sensors on the Cunningham and Steenbeek braces. Mr. Cunningham plans to use injection molding to increase brace production. The team is completing Finite Element Analysis to determine how the brace's properties change with injection molding. The team is also completing fatigue analysis with the Cunningham Brace to quantify its reusability. Furthermore, the clinical study in Kenya and Dr. Emily Farrar's retrospective research paper will contribute to the published research on the Cunningham Brace. The collaborative efforts of the team will increase further understanding of the Cunningham Brace and its acceptance as an alternative clubfoot maintenance brace.

IRB Approval: 2019-001 Date: September 15, 2021

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Presented in: Engineering AM Poster Session from 11:20 to 12:00 pm and in: Engineering PM Poster Session from 3:20 to 4:20 pm

Village Water Ozonation System

77

Ruth C Galyen, **Caleb L Bruner**, Olivia R Allbee, Nate Binko, Benjamin R Gates, Seth M Kline, Sam B Stone, Ray Knepper†‡, & Michelle L Lockwood†

The Village Water Ozonation System (VWOS) team's core mission is to provide economically sustainable and culturally sensitive drinking water solutions for communities, to empower them with the ability to properly maintain their drinking water supply, and to transform people's lives by decreasing the occurrences of waterborne diseases. Currently, the VWOS team is partnering with Friends in Action to implement two drinking water treatment systems this summer for the community living on Rama Cay, an island in Nicaragua. The wells on the island have a high salt content and are contaminated with bacteria which makes the water unsafe to drink; therefore, these two systems consist of a Reverse Osmosis unit, a UV light and other filters to ensure clean water. VWOS is also partnering with Forward Edge International to serve Mama Beth's Children's Home in Kijabe, Kenya. Mama Beth's serves approximately 250 children every day but their water source is heavily contaminated with bacteria. VWOS is designing a chlorination system that will provide safe water for the students with plans to implement it in the summer of 2023.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presented in: Engineering AM Poster Session from 11:20 to 12:00 pm and in: Engineering PM Poster Session from 3:20 to 4:20 pm

Sustainable Agriculture

78

Cassie P Gehenio, **Miggy Matanguihan**, **Josh R Rosengrant**, **Jacob Wong**, Jacob T Dean, Madalyn A Heckman , Gabriel J Tiday, Aleesa Wu, & Michelle L Lockwood†

The Sustainable Agriculture team is addressing malnutrition through aquaponics. Aquaponics is a soil-free farming method that reduces growing periods and water consumption by 90% compared to traditional methods. The Sustainable Agriculture team works alongside its clients, Youth with a Mission and Trans World Radio, to develop and implement universal and scalable aquaponics prototypes. This year, the team designed and constructed nine working prototypes for a sensitivity analysis. The team also constructed two unique airlift pumps to create alternatives for their clients. They also produced a digital system monitor for tracking temperature, pH, and dissolved oxygen in the aquaponics prototypes for our clients at Youth with a Mission.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presented in: Engineering AM Poster Session from 11:20 to 12:00 pm and in: Engineering PM Poster Session from 3:20 to 4:20 pm

EMMS: Increasing Hope and Transforming Lives Through Improved Access to Electrical Power

79

Zach L Gillen, **Samuel N Goertzen**, Bennett A Andrews, Adam Dressler, Kyle Green, Caitlin Ross, Seth Wilcox, & Tom Austin†

Developing countries often face a challenge involving energy conservation. Energy Monitoring and Management Systems (EMMS) was tasked to make an energy meter in order to provide a practical way of controlling energy consumption and create a tool for teaching energy conservation. This meter should be able to measure energy usage over a period of time and prevent further energy usage after a specified amount has been consumed. In this poster, the team will explain what they have been doing in recent semesters to work towards their goal of testing and preparing this meter for implementation in Zimbabwe this summer, as well as how they have been improving the user experience through website implementation.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presented in: Engineering AM Poster Session from 11:20 to 12:00 pm and in: Engineering PM Poster Session from 3:20 to 4:20 pm

Designing a Solar PV System for Tree 4 Hope

80

Josh Ginck, **Michael Stefanchik V**, Riley Harro, Jonas E Kolb, Christian Pilawski, Noah A Rood, Garrison Shields-Seelig, & Harold R Underwood†

The Solar Photovoltaics (PV) team designs and installs solar electricity systems in developing countries where power is less reliable or non-existent. Starting in 2020, the Solar PV team began collaborating with Tree 4 Hope—a nonprofit organization that partners with an orphanage near Guatemala City, Guatemala. Over the past year, the team has designed a solar system to be installed at the orphanage which will provide them with a cleaner and cheaper source of electricity. Thus far, the overall 5 kW solar panel system design including lead-acid batteries has been completed. Key components of the system consisting of the system controller, two charge controllers and the inverter have been programmed and tested, by plugging them into existing elements of the solar lab system, in preparation for installation in Guatemala. This poster details

the progress accomplished this year in the design, testing, and programming of the Solar PV system including wiring considerations and communication with in-country suppliers for installation at the orphanage during May of this year.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presented in: Engineering AM Poster Session from 11:20 to 12:00 pm and in: Engineering PM Poster Session from 3:20 to 4:20 pm

Improving Access to Clean Water Through Autonomous Monitoring of Hand Pump Operation

81

Jared M Groff, **Matt J Caldwell**, Josiah J McCarthy, Lydia Reber, & Randall K Fish†

Millions of people in developing countries rely on hand pumps for access to clean water. Proper maintenance of these pumps is impossible without timely reporting on the pump's operation and state of repair. The Intelligent Water System, which improves access to clean water by autonomously monitoring and reporting on the health of hand pumps, has been under development for several years. The next stage for the IWP team is to prepare for field testing in Zimbabwe. Because of this, the team has been working on improving the accuracy of the calculations made by the Intelligent Water System as well as simplifying the installation procedures to allow installation by in-country pump technicians. This poster shows the progress made by the IWP team during this stage of development including the improvements in the volume calculation algorithm as well as the installation jig and procedures.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presented in: Engineering AM Poster Session from 11:20 to 12:00 pm and in: Engineering PM Poster Session from 3:20 to 4:20 pm

Kenbrook Bridge Project

82

Logan J Horst, **Noah W Thrush**, Jordan T Barner, Luke T Fetterman, & Brian D Swartz†

The Kenbrook Bridge Team seeks to address Kenbrook Bible Camp's need for maintenance and emergency access across a small stream on the property that separates their main office location from cabins on the northwestern portion of the campus. Kenbrook Bible Camp's mission is to facilitate a closer connection to God, self, others, and nature for all guests. The bridge site was selected by the Kenbrook staff based on the greatest need for accessibility. An existing

footbridge in this location cannot support passage of heavy equipment used for camp maintenance nor the ATV used for emergency response. The bridge team proposes a 16-foot-long by 8-foot-wide concrete culvert for the site. The culvert has been designed in compliance with AASHTO structural requirements and all elements of the structure are detailed in a complete drawings sheet set, serving as a reference for on-site construction in May.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research.

Presented in: Engineering AM Poster Session from 11:20 to 12:00 pm and in: Engineering PM Poster Session from 3:20 to 4:20 pm

Rapid Orthotics for CURE Kenya - Mechanical Design and Official Testing of 3D Printed Sockets

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Rachel Huang, **Lauren N Seubert**, Joey D Andrews, Rachel E Bruns, Ryan G Class, & Jamie R Williams Ph.D.†

Rapid Orthotics for Cure Kenya (ROCK) collaborates with CURE, a non-profit orthopedic workshop in Kjabe, Kenya, to implement a 3D printing system for manufacturing custom prosthetics and orthotics. The goal is to reduce the production time and cost for the current transtibial sockets being manufactured in the orthotic workshop to give the patients a way to integrate into society and reduce stigma from their communities. The team designed a system for manufacturing transtibial sockets by converting a scan of the residual limb to a digital file customized by the orthopedic technicians and converted to a file to be 3D printed. The team designed a procedure to ensure the safety of the sockets within the constraints and offsets of the ISO 10328 Standard. The standard requires twelve official tests specifying the type and conditions to be conducted for the Ultimate Strength and Static Proof tests. The team has designed a testing rig that interfaces with the Materials Testing System machine at Messiah University to apply the necessary forces according to the complex geometry outlined in the standard. Additionally, research has determined the optimized 3D printing settings to increase the quality and consistency of the sockets. To smoothly institute the system developed in the orthopedic workshop, the team has developed a Training Manual outlining the step-by-step procedure for the system. Using this system, the team completed all twelve tests with a passing socket result which will contribute to determining the steps for next semester and for the summer site team trip.

Funding for this work provided by The Collaboratory for Strategic Partnerships and Applied Research and by The Collaboratory for Strategic Partnerships and Applied Research.

Presented in: Engineering AM Poster Session from 11:20 to 12:00 pm and in: Engineering PM Poster Session from 3:20 to 4:20 pm

Better Pumps: Promoting Reliable Water Infrastructure for Everyone

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Andrea Hunsberger, **Benjamin J Brandt**, Josh Card, Reese N Johnston, Joshua L Maxson, Jonathan G Wyrick, Tony Beers†‡, Matthew Schwiebert†‡, & David T Vader†

Approximately 90 million people in Africa lack access to safe drinking water, despite having water infrastructure installed in their community. The India Mark II and the Afridev handpumps are among the most widely used handpumps in the world. Sadly, studies show that approximately 30% of these handpumps are non-operational due to failures of the bearings, seals, head flange, and other common components. The Better Pumps team of the Collaboratory provides engineering support for partners who are working to improve handpump sustainability. We have partnered with Tony Beers and AlignedWorks to validate a bearing test methodology for the India Mark II handpump. By modifying the loading conditions in our handpump test machine, we were able to replicate failures observed by AlignedWorks in a field trial of their bearing design. However, these modifications caused our test machine tabletop to noticeably deflect, so we made modifications to stiffen the tabletop. We partnered with Matt Schwiebert and Living Water International to test new seal designs for the India Mark II and Afridev handpumps. Seal performance data collected by the team was used to validate a new design in advance of field trials by Living Water International. We developed and performed clear cylinder testing on the seals to visualize the leak paths. A new Afridev testing apparatus is being designed to test the longevity of the Afridev bearings and seals. Test methodologies and results are reported.

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High Quality, Low Cost Egg Incubator for BIC Church in Choma, Zambia

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Joshua R Mah Mr., **Josiah T Zehr**, Aaron Bashore, Matt D Eells, Shekinah Ellis, Brandon Koehnke, Lane Magness, Claudia M Tolley, Cooper Willoughby, Cadee A Wood, Dan Elliott†‡, & Philip M Tan Ph.D.†

The Egg Incubator team is partnering with the Brethren in Christ Church located in Choma, Zambia to design a high-quality, low-cost chicken egg incubator to supply the pastors and church members with a means of food and income. The design will need to take into account the accessibility and cost of the tools and materials. The current prototype features separate heating and humidity systems, a control system to maintain a set temperature and humidity, and tilting egg racks. The heating system consists of two stovetop coils to produce heat and a fan to transfer it to the air. The humidifier utilizes an atomizer in a pan of water to create a mist that mixes with

the hot air to create humidity. The control system uses a proportional integral derivative controller (PID) to keep the temperature at 37 ± 1 °C and the humidity at 60–70%. The egg racks are tilted by a motor that runs every 6 hours to prevent the embryos from sticking to the shell. With a fully functioning prototype, the team has begun to incubate 60 real fertilized eggs. During the 21-day incubation process, a final prototype iteration is being designed and will be built on-site in Zambia in May 2022.

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Wear Testing of a Mechanized Percussion Well Drilling System for Water Access in West Africa

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Matthew D Merlo, **Matthew J Siegrist**, **Jacob S Wildasin**, Robert H Donley, Matthew R Higgs, & J Scott Heisey †

The Mechanized Percussion Well Drilling (MPWD) Collaboratory project is assisting in the development of a mechanized well drilling system for drilling shallow water wells in West Africa. Our client, Mr. Joseph Longenecker with Open Door Development (ODD), desires to make water wells accessible to all in this region, but has experienced difficulty drilling through hard soil layers. To overcome this problem, the MPWD team has worked closely with Mr. Joseph Longenecker to develop a mechanized percussion well drilling rig using a rubber friction wheel drive system that is capable of drilling through these harder layers.

Currently, the MPWD team is working to provide recommendations to improve the useful service life of our client's new, mechanized rig design. The MPWD team's most recent work includes the design and fabrication of a testing rig to simulate the operation of our client's full-size rig. The testing rig will allow our team to conduct fatigue testing on a model of the driveline system to analyze the wear patterns on the rubber friction wheel and to estimate its expected service life. The team has also performed a series of finite element analyses on the mast design of our client's rig to evaluate working stresses under static loading and buckling, along with fatigue analysis, to confirm safe operation of the rig and to identify any elements that might require upgrades.

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Adjustable Prone Trolley Design for People Suffering from Spinal Cords Injuries in Nepal

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Abby Miller, **Lukas Sonon**, Katie Anthony, Blake N Clemmer, Ryan J Friend, Jared T Pavlovich, Connor Welch, & Timothy J Van Dyke†

For people who suffer from spinal cord injuries in Nepal, rehabilitation and care are often difficult to receive, especially for those for whom fewer resources are available. Thankfully, International Nepal Fellowship (INF), a non-profit serving Nepal for nearly 70 years, aids patients with spinal cord injuries at Green Pastures Hospital and Rehabilitation Centre in Pokhara, Nepal. A crucial part of any rehabilitation is adequate exercise to improve circulation and prevent sores and muscular atrophy. Yet, due to the nature of the injury, using a traditional wheelchair is not an option to fulfill this need for those with spinal cord injuries. Therefore, Green Pastures uses prone trolleys so that these patients can exercise. A prone trolley is a horizontal cushioned board where the patient lies flat on their stomach and is able to move themselves using the wheels attached to the cushioned board. Despite the importance of the prone trolley, the trolleys at Green Pastures Hospital have a few critical issues. The major issue is that the prone trolleys are internationally imported, which not only means that delivery can take months, but also that the trolleys are also difficult to repair when damaged. Both these factors severely hamper Green Pastures Hospital's ability to provide spinal cord injured patients with the care they need. The Nepal Prone Trolley team, a part of Messiah University Collaboratory, seeks to develop and design a fundamentally better prone trolley for INF. The goal of our project is to design a prone trolley that can be fabricated by the INF staff with locally sourced materials. The advantage of this new design is that it will be easier to obtain and can easily be repaired when needed. After creating a design that satisfies our goal and fulfills the criteria of a functional prone trolley as defined by INF, we were able to fabricate a prototype of the prone trolley using resources and techniques available in Pokhara. Moving forward, we will conduct testing and redesign the trolley so that our finalized prone trolley design will be able to transform how Green Pastures Hospital aids their spinal cord injury patients.

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SkinSafe: Comparing *Staphylococcus aureus* Growth Across Liner Types in Kenya

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Hailey C Miller, **Keera L Dupler**, Michelle Zheng, & Philip M Tan Ph.D.†

The interface between an amputee's residual limb and prosthetic liner is at risk for high levels of bacterial growth which can lead to infection. Silicone liners have the advantage of patient comfort, but they may have a sealing effect that could exacerbate bacterial growth, which is particularly a concern in places lacking clean water such as Kijabe, Kenya. To investigate this concern, the SkinSafe team has conducted a prosthetic liner study using a bacterial skin model which suspends a liner and a layer of agar above a self-regulating heat and water source to capture the dynamic behavior of the skin–liner interface. *Staphylococcus aureus* was grown on this model using three different liners: the Ossur Iceross silicone liner, the Namaste silicone liner, and the sock–EVA liner. Final growth concentrations will be compared between the three liner types to determine whether silicone liners require additional hygiene protocols for use in Kenya.

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Prosthetic Knee for CURE Kenya: Design and Manufacturing

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Josiah D Moyer, **Josh D Mundis**, Isaiah D Bryner, Nathan E Jaloszynski, Sarah N Kelchner, Carter D Urich, & Jamie R Williams Ph.D.†

The Prosthetic Knee team is partnered with the CURE International Hospital in Kijabe, Kenya. In the region surrounding our client's facility, there is a large number of lower-extremity amputations due to various infections and diseases. Often, these patients choose to undergo a more invasive transfemoral amputation to enable them to use a less expensive above-knee prosthesis. The goal of the project is to present the orthopedic workshop at CURE with a manufacturable prosthetic knee design in May of 2023 that provides through-knee amputee patients with a more affordable, aesthetically pleasing, and lightweight prosthetic option, thereby removing the need to undergo an additional amputation above the knee. The poster presents the overarching elements of the prosthetic design in addition to the recently integrated locking and damping components, which aid in the functionality of the knee.

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A Low Cost, Portable Fluorescence Correlation Spectrometer for Disease Diagnosis

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Brittany Shirk, **Michael A Geyer**, **Jon Sison**, Al W Mokris, Jessica E Paulus, & Randall K Fish†

People being treated for HIV need to periodically test to determine if their antiviral medication is effectively keeping their viral loads at a safe level. Individuals living in rural areas of developing countries would be more likely to get these viral load tests if an instrument existed which reduced costs and was small and rugged enough to be brought to the client rather than require the client to travel for hours to a clinic. The Diagnostics for Viral Disease team is developing such a device in cooperation with Dr. Edgar Simulundu and the Macha Research Trust in Zambia. Our design is based on advanced fluorescence spectroscopy utilizing a fluorescence protein probe, confocal optics, and low-cost, low-power electronics.

This poster reviews work done in three subsystems of the overall instrument. First, we have optimized the program used during burst analysis spectroscopy for identification of individual viruses in dilute samples. Second, we have confirmed the operation of the amplifying and discriminating sections of the photon processing circuitry which converts light pulses into a digital signal ready to be processed in the signal analysis subsystem. Finally, we have completed the Field Programmable Gate Array (FPGA) and Raspberry Pi programming allowing successful transfer of the results of the signal processing in the FPGA to the Raspberry Pi for display to the end user. Going forward we will integrate these subsystems into a fully functional exploded prototype ready for the final stage of condensing the design into a portable prototype that can be tested and delivered to our client.

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A Sustainable Mobility Solution for Persons Living with Disability in Burkina Faso

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Joey Sinsel, **Timothy M Glavin Mr.**, Katie Bunch, Rachel Delate, Rachel Rashford, John Meyer†, & David T Vader†

The Sustainable Mobility project of the Collaboratory empowers people living with a disability in rural West Africa to pursue educational and work opportunities and more fully participate in family and community life. Our electric, 3-wheeled, off-road wheelchair has transformed the lives of clients through partnerships with the Center for the Advancement of the Handicapped in Mahadaga, Burkina Faso, and the Center of Hope in Fada, Burkina Faso. Now, to reach more people in new locations and with more partners, Sustainable Mobility is working to reduce manufacturing time and cost by authoring image-driven fabrication guides to enable local

fabricators to build trikes. We seek to put local fabricators to work building tricycles wherever they are needed.

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Presented in: Engineering AM Poster Session from 11:20 to 12:00 pm and in: Engineering PM Poster Session from 3:20 to 4:20 pm

A Low-Cost Microprocessor-Controlled Stance-Control Knee Orthosis for Pediatric Mobility Impairments

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Jordan M Witt, **Levi M Fertig**, Jacob M Barton, Ethan R Cornwell, Ryan J Farris P.E., & Ph.D.†

Knee-ankle-foot orthoses (KAFOs) are commonly prescribed for individuals with knee instability or quadriceps weakness resulting from a variety of conditions such as spinal cord injury, stroke, spina bifida, and cerebral palsy. A locking KAFO fixes the leg fully straight and is the most prescribed orthotic intervention for these conditions. However, the functional benefits of lower extremity orthoses are maximally realized in stance-controlled knee-ankle-foot orthoses (SC-KAFOs) which allow free knee motion during swing but lock during stance. Existing SC-KAFO options are generally unreliable or expensive, and thus an unmet need exists for a reliable, versatile orthosis which can be manufactured at relatively low cost. The SC-KO team is working to meet this need by developing an intelligent stance-controlled knee orthotic with an any-angle locking mechanism controlled by a microprocessor based on information received from onboard inertial gait-phase sensing. The resulting device will allow for reliable knee locking for support during the stance phase, easy unlocking even under load for the free swing phase, and predictable, safe behavior on stairs and uneven terrain. The system is being developed as a knee-only orthosis but can be adapted for a full knee-ankle-foot orthosis, with ankle support being prescribed as needed. The first system developed will be configured for pediatric use to address mobility impairments arising from cerebral palsy and spina bifida with CURE Ethiopia serving as the clinical partner for the development and testing.

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Exercise Science

Using the M-Trigger to Determine the Relationship Between Gluteus Medius Maximum Voluntary Isometric Contraction (MVIC) and Performance on the Y-Balance Test in Collegiate Track and Field Runners

93

Connor R Daudt, **Grace Doran**, & Matthew D Lewis†

Purpose: To better understand the role of the gluteus medius (Gmed) in dynamic stability, this study was conducted to evaluate the relationship between Gmed activation and reach distances on the Y-Balance Test (YBT). The m-Trigger, a novel biofeedback device was used to gather electromyographic data. Previous research has established this device as a viable low-cost alternative to more expensive surface electromyography (EMG) systems.

Methods: Prior to data collection, students completed the informed consent process. After completion of a standardized warm-up, baseline Gmed strength was quantified via a side-lying hip abduction maximum voluntary isometric contraction (MVIC). Gmed activation was quantified for all three reach directions of the YBT using the m-Trigger and surface electrodes. Gmed activation is expressed as a percentage of MVIC and reach distance is standardized to leg length for comparison between subjects. A Pearson Product Moment Correlation coefficient will be calculated to determine the relationship between the following pairs of variables: 1) MVIC and YBT Gmed activation 2) %MVIC and reach distance (%LL) and 3) MVIC and reach distance (%LL). Differences by gender will also be evaluated. Data analysis is in progress. Results and conclusions will be reported at the SEH Symposium.

Subjects: Participants included 22 collegiate track and field runners from Messiah University with a mean height of 172.9 cm ± 9.8 and mean weight of 65.4 kg ± 7.5. There were 11 female and 11 male participants, with a mean age (20.4 yrs. ± *1.3*).

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Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

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Nursing

The Effect of Bereavement Interventions on Depression, Anxiety, and Grief After Perinatal Loss

94

Emma K Augustine, **Jessica M Heiman**, **Amber MacKay**, **Melanie Rakerd**, **Sarah Reed**, Kimberly H Fenstermacher PhD†, & Tara S Jankouskas†

Background and Significance: Women who have experienced perinatal loss are at high risk for complicated grief, anxiety, and depression. Perinatal loss is defined as the death of an infant during pregnancy, childbirth, or up to one month after birth. Mothers who experience perinatal loss are often undertreated for their psychological and emotional complications.

PICO Question: In women who have experienced perinatal loss do support groups and other bereavement interventions, compared with no support, lead to decreased levels of depression, anxiety, and grief?

Methods: CINAHL, Medline, and PsychInfo were searched with the limit of 2016-present yielding 3,590 articles. Nine articles were selected and appraised using the Johns Hopkins Evidence-based Practice for Nurses and Healthcare Professionals Model and Guidelines. There was one level I RCT, one level II systematic review, five level III articles, and two level V articles with quality ratings of A and B.

Findings: Evidence consistently supports the need for care extending beyond the couple's stay in the hospital. Findings suggest that mothers experience higher levels of grief than fathers. Counseling and support groups are beneficial for six months following perinatal loss. Consistent evidence supports spending time and creating memories with the baby to decrease grief, depression, and anxiety levels.

Recommendations: Based on the evidence, research recommends that obstetric nurses should encourage mothers to hold their infant, take part in support groups within six months, and create memories such as photos of the baby to decrease anxiety, depression, and grief associated with perinatal loss.

Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

Evidence Based Non-Pharmacological Recommendations to Decrease Delirium in the Hospitalized Pediatric Population

95

Audrey C Bassett, **Sydney Raschke**, **Katie Oberholtzer**, **Madison J Ehrhart**, & **Madison Eich**

Background and Significance: Delirium is a disruption of the mind that leads to states of confusion, agitation, and decreased awareness (Mayo Clinic, 2020). Bettencourt & Mullen (2017) recognized delirium in up to 30% of pediatric intensive care patients which can lead to increased costs, length of stay, mortality, decreased quality of life, delayed recovery, the impedance of care, and a hypermetabolic state (Thom, 2017).

PICO Question: Among pediatric patients at risk for delirium, what are the effects of nonpharmacologic prevention/intervention methods on patient outcomes?

Methods of Literature Search: Medline, CINAHL, and professional society websites were searched. Of the 345 articles retrieved, 16 articles were reviewed dated from 2017-2020. Based on the Johns Hopkins Nursing Evidence-Based Practice Model, the evidence used ranged from Levels I-V with an A or B quality. Two C-quality studies were excluded.

Findings from EBP Project: Evidence supports using mother's voice recordings, blindfolding before surgery, and tablet distractions decrease emergence delirium (ED) ($p<0.05$) (Byun et al., 2018; Lin et al., 2018; Pan et al., 2019; Stewart et al., 2019; Yang et al., 2020). Nonpharmacologic bundle interventions including screening tools prompted by the electronic health record, family involvement, environmental factors, early mobilization, anxiety-reducing measures, clustering care, sleep hygiene, and reorientation can decrease pediatric delirium (Bettencourt & Mullen, 2017; Hoch, 2019; Holly et al., 2018; Ista, & van Dijk, 2020; Patel et al., 2017; Silver & Traube, 2019; Simone et al, 2017; Staveski et al., 2018).

Recommendations for practice: There is good and consistent nonexperimental evidence for the implementation of nonpharmacological strategies for pediatric delirium prevention. Therefore, bundled protocols need further experimental study. For ED, there is high quality experimental evidence indicating that anxiety-reducing measures before and after surgery are effective and, therefore, recommended to prevent ED.

Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

From Breastfeeding to Bottle: Evidence Based Recommendations to Initiate Formula Supplementation in Neonates Experiencing Weight Loss

96

Madisyn Coburn, **Annelise Hayden**, **Audrie Hartman**, **Rebekah F George**, Tara S Jankouskas†, & Kimberly H Fenstermacher PhD†

Background and Significance: Formula supplementation is often initiated during birth hospitalization even in mothers who intend to exclusively breastfeed. There are multiple reasons for this intervention, but no consistent practices have been established for when supplementation should begin and for what conditions it is warranted. Neonates may be unnecessarily supplemented resulting in negative breastfeeding outcomes.

PICO Question: In healthy full-term breastfed neonates experiencing weight loss, is hospital-initiated formula supplementation necessary for appropriate weight gain?

Methods: Data were collected via search through CINAHL, PubMed, and MEDLINE. Inclusion criteria were articles in English published within the last five years with full-term, healthy infants as the subjects. Articles mentioning human-milk supplementation instead of formula supplementation were excluded from the review. 346 articles were found and 10 articles were chosen. Articles were appraised using the Johns Hopkins Nursing Evidence-Based Practice Model, and consisted of 1 Level I Quality A, 8 Level III Quality B, and 1 Level IV Quality B.

Findings: There are no conclusive data on when formula supplementation should be initiated during weight loss. There was consistent data supporting an association between formula supplementation and non-exclusive breastfeeding with an increased rate of weight loss in non-exclusive breastfed infants.

Recommendations: Evidence does not support a practice change. Further research is warranted to implement evidence-based formula supplementation protocols. Additional studies should be conducted to understand the trajectory of expected weight loss during birth hospitalization and the effect of supplementation on neonatal weight gain. This information is crucial to formulate effective supplementation protocols.

Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

Reduction of Restraints and Seclusion Through Sensory Modulation

97

Elise Davenport, **Hannah Showalter**, **Felicity Bailey**, **Carley JM Gambone**, & **Ellie Longshaw**

Background and Significance: Restraint and seclusion use for undesirable behavior are problematic because they can lead to physical injury for patients or staff. Patients with mental health problems may have sensory dysregulation that contributes to the escalation of undesirable behaviors (Adams-Leask et al., 2018).

PICO Question: For patients diagnosed with mental health disorders, how does the use of sensory modulation therapy techniques influence the frequency of behavior outbursts and use of seclusion and restraints compared to not using sensory modulation therapy during inpatient modulation?

Methods: Literature was reviewed using PubMed, PsychINFO, and CINAHL. Eleven articles utilized of 343 retrieved were published from 2015-2021, ranging from Level II- Level V with A or B quality.

Findings: There is consistent evidence ($p < 0.01$) that restraint use, forced medications, and seclusion decreased across the Level II studies using sensory modulation (Adams-Leask et al., 2018; Anderson et al., 2017; Azuela and Robertson, 2016; Gardner, 2016; Rentala et al., 2021). Sensory modulation effectively reduces patient escalation, stress levels, and challenging behaviors, and improves work performance in patients with PTSD (Brown, 2020; McGill & Breen, 2020). Techniques can include tactile, visual, or auditory tools such as fidget spinners, weighted blankets, colored lights, and bean bags. (McGill & Breen 2020; Wigglesworth, 2016); These can be personalized to unique patient needs (Hitch, Wilson, & Hillman, 2020). Increased nursing knowledge regarding restraint use is needed before implementing sensory modulation therapy (Azuela and Robertson, 2016; Rentala, 2021; Hasan & Abulattifah, 2019).

Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

Improving Outcomes of Non-Intubated COVID-19 Patients (CP) Using Self-Proning Techniques

98

Rebecca D Hill, **Sarah M Good**, **Sarah M Pstrak**, & **Melody McCrary**

Background of the Problem: CP suffer from respiratory insufficiency leading to intubation and mechanical ventilation support. The prone position (PP) improves oxygenation in other pulmonary conditions (Powers et al., 2021). It is important to determine a proning protocol to improve patient oxygenation status and outcomes for CP.

PICO Question: In adult non-intubated CP, is self-proning more effective than not proning for improving patient outcomes?

Methods of Literature Search: Our sources were found in Medline and CINAHL which ranged in date from 2013-2021. Of the 218 articles retrieved only 7 articles addressed the PICO question and were used. Search terms included: COVID-19, SARS-COV-2, prone, proning, and prone positioning. The evidence included Level I, II, and V with an overall quality averaging a B based on the Johns Hopkins Model.

Findings from EBP project: Findings showed good but conflicting evidence. CP had significant improvement in SpO2, PaO2, SPO2:FiO2, and PaO2:FiO2 ratios during proning periods *(p*<0.01), these improvements were not maintained during the post-proning period (Dubosh et al., 2021; Guérin et al., 2013; Johnson et al., 2021; Padrão et al., 2020; Powers et al., 2021; Taboada et al., 2020). Some study findings showed no difference for changes in oxygenation, intubation rates, and ICU transfers (Johnson et al. 2021; Taboada et al., 2021). Oxygenation was improved at 48 hours (*p*=0.036); however, improvements were not sustained at 72 hours (*p*=0.077) (Johnson et al., 2021).

Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

Improving Nursing Student Veteran Care Competency Through Simulation

99

Allyson C Hoffmann, **Ariana Dunkerton**, **Abigail Huebner**, **Chelsey Seeley**, Brenda Elliott†, Tara S Jankouskas†, & Kimberly H Fenstermacher PhD†

Background and Significance: In nursing schools, there is inconsistent inclusion of veteran-centered content. Veterans are a vulnerable population that is at higher risk for a variety of mental health illnesses. Changing the curriculum to include veteran-centered content would allow nursing students to give care in a more holistic manner.

PICO Question: In nursing students, does a veteran-centered simulation compared to a non-veteran-centered simulation improve perceived competency to care for veterans?

Methods: Databases searched included PubMed, CINAHL, and Medline. Out of 63 results, seven articles were selected that answered the PICO question. Articles dated from 2012-2021. Based on the Johns Hopkins Nursing Evidence-Based Practice Model, the evidence used was Level III, quality A and Level V, quality B ratings.

Findings: The findings supported that the use of simulation increased student perception of competency. Simulations varied from focusing on asking if a patient is a veteran to the psych/mental health issues they were experiencing. Simulations were used once within a program or up to 40%. Safety, communication, assessment, comfort, and confidence were the elements of competency that were explored in the articles. The articles reported consistent evidence in stating veteran-centered simulations increased student competency of veteran-centered care.

Recommendations: Most of the evidence was Level V, thus further research on this topic is recommended. Doing an RCT in a nursing school where students are randomized to care for a veteran and non-veteran could provide further evidence to support the EBP question. To show perceived competency, pre-post measures should be completed.

Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

Targeted Temperature Management (TTM) in Post Cardiac Arrest (CA) Patients

100

Katie Wilkin, **Cassidy L Hoffman**, **Tyler J Wilkinson**, **Emily Allbee**, & **Kyla M Gehr**

Background of the Problem:

Survival rates and neurologic functioning following cardiac arrest are poor. The use of therapeutic hypothermia is widely used in those patients who suffer cardiac arrest prior to hospitalization. However, the efficacy of its use for in-hospital cardiac arrest is controversial. This project aims to explore the favorability of initiating TTM in patients with cardiac arrest during their hospital stay (Wang et al., 2020).

PICO Question:

In adult in-hospital cardiac arrest patients, does TTM lead to better survivability and neurological outcomes than those who do not receive TTM?

Methods of Literature Search:

188 articles ranging from 2015-2021 were retrieved and 11 were used. Based on Johns Hopkins Model, the evidence ranged from Level I, III, and V. Articles included were A or B quality.

Findings from EBP project:

Evidence supports that TTM increases neurological outcomes by 16% and survivability by 14%, p=0.03 (Omairi et al., 2021). Arrich et al, (2016) showed significantly better outcomes at 33 °C versus 36 °C (p=0.04), Chandrasekaran et al., (2015) had insignificant results. Two studies by Lascarrou et al., (2019) had significant neurological outcomes (p=0.04 and p=0.001) with no improvement on survival. Some retrospective studies reported poor neurological outcomes, no difference in survivability or worse survivability with TTM although most were insignificant (Wang et al., 2020; Chan et al., 2016; Irisawa et al., 2018; Huang et al., 2017; Gorecka et al., 2017; Hsu, et al., 2018).

Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

Implementation of Resilience Programs to Reduce Burnout Among Critical Care Nurses

101

Bryce W Woland, **Kim Mowery**, **Taylor Snyder**, **Morgan Furjanic**, Jessica Merkert†, Tara S Jankouskas†, & Kimberly H Fenstermacher PhD†

Background and Significance: In critical care settings, nurses not only face large workloads, but also witness traumatic events daily. This leads to compassion fatigue and burnout, which leads many critical care nurses to leave bedside practice. Critical care nurses need resources to reduce burnout and continue bedside practice.

PICO Question: In critical care nurses, does the implementation of a resilience program reduce compassion fatigue and burnout compared to no resilience program?

Methods: A literature review was conducted using CINAHL and Medline. The article dates ranged from 2014-2021. 178 articles were found with 7 articles used. The Johns Hopkins Nursing Evidence-Based Practice Model was used to classify articles by evidence level and quality rating.

Findings: Evidence supports the use of resilience programs to decrease compassion fatigue and burnout among critical care nurses. Engagement in resilience and mindfulness programs increases compassion satisfaction and decreases burnout (Flanders et al., 2020, Morrison et al., 2017). Resilience decreases the negative impacts of burnout and compassion fatigue, and increases mental health stability (Arrogante & Aparicio-Zaldivar, 2017; Jackson et al., 2018). Peer coaching relationships can help nurses reduce moral distress and enhance resilience (DeGrazia et al., 2021).

Recommendations: Resilience programs should be implemented in all critical care settings. A wide variety of resilience programs are effective, therefore the design of the resilience program can be tailored to meet the needs of the individual critical care unit.

Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

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Nutrition & Dietetics

Perceived Stress Does Not Have an Impact on Dietary Behavior in Messiah University Students Enrolled in a Wellness Course

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Kaitlyn DeStefano, **Heidi Nolt**, **Sabrina Garman**, & Amy B. Porto†

Dietary behaviors can be influenced by various factors, including stress. Exposure to stress over a long period of time can result in negative health consequences. The aim of this study was to examine the relationship between perceived stress and eating habits in university students using the Perceived Stress Scale (PSS) and the Healthy Eating Assessment (HEA). Undergraduate students at Messiah University enrolled in a wellness course for the 2022 Spring semester were invited to participate. The PSS and HEA were administered electronically to interested students three times throughout the spring semester: at the beginning of the semester; three weeks into the semester; and eight weeks into the semester: four weeks into the semester; eight weeks into the semester; and eleven weeks into the semester. Of the 250 students enrolled in a wellness course, 18% completed the first round of data collection, 14% completed the second round, and 6% completed the third data collection. Data were analyzed in Microsoft Excel using linear regression models. R^2 values from the 1st, 2nd, and 3rd data collections were 0.10, 0.11, and 0.02, indicating a weak relationship between perceived stress scores and changes in dietary behavior. More research is needed to assess the changes in perceived stress and eating habits over time.

IRB Approval: 2021-033 Date: January 4, 2022

Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

Short-term Ashwagandha Supplementation Produced Inconclusive Acute Stress and Anxiety Data in College Students

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Context: Stress remains a primary public concern across all demographics and age groups. College students in particular suffer from outsized stress loads throughout their academic careers. Adaptogens, such as Ashwagandha (ASW) root, may represent a possible supplementation methodology to decrease both objective and subjective measures of acute stress.

Aims: The aim of this study was to evaluate the efficacy of a short-term high-concentration full-spectrum extract of ASW in reducing stress and anxiety in college-age students.

Design: Prospective, parallel, double-blind, randomized, placebo-controlled trial.

Materials and Methods: A total of 17 college-age subjects (mean age = 20.82, SD = 1.79, 5 female, 12 male) were enrolled in the study after inclusion and exclusion criteria were met. They were randomized to either the treatment group or the placebo control group and asked to take one capsule per day for a period of 30 days. In the treatment group, each capsule contained 600 mg of high-concentration full-spectrum ASW extract. Two in-person lab sessions were conducted to measure subjective and objective stress response to an acute stress stimulus before and after the supplementation period.

Statistical Analysis: Paired *t*-tests were used for both subjective and objective measures.

Results: No significant reductions in stress measurements were observed. Additionally, the chosen acute stress protocol did not elicit an acute stress reaction in approximately half of the participants. As a result of this discrepancy, the remaining statistical analyses were viewed with skepticism.

Conclusion: The findings of this study do not provide significant evidence either in support of or against the research hypothesis. Additional research examining the efficacy and reliability of acute stress protocols in college-age participants is warranted.

IRB Approval: 2021-031 Date: February 2, 2022

Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

Preprandial Caffeine Administration Has No Effect on Blood Glucose Response in Messiah University Students

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Blood glucose control is important to avoid serious health complications. Caffeine is one of many factors that can potentially affect blood glucose levels. The purpose of this study was to determine the effect of caffeine on blood glucose response. Twelve Messiah University students (n=4 males and n=8 females) between the ages of 18-25 participated in this randomized single blind crossover study. Participants were recruited via word of mouth and classroom announcements. A baseline blood glucose measurement was obtained via finger stick following an overnight fast. Subjects immediately consumed 14 oz of coffee [caffeinated (315mg) or decaffeinated]. They then received a meal consisting of 75g of carbohydrates, after which their blood glucose level was measured three additional times in one-hour intervals. Participants returned the following week to repeat the procedure with the opposite treatment. The area under the curve between the caffeinated and decaffeinated treatments showed no statistical significance ($p>0.1$). Results of this study suggest the presence of preprandial caffeine does not have an effect on blood glucose response.

IRB Approval: 2021-034 Date: January 24, 2022

Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

Habitual Breakfast Skipping Contributes to Lower GPA but Not Caffeine Intake in Messiah University Students

59

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Background: Breakfast has been labeled as the most important meal of the day. However, it is also the most frequently skipped. Regular consumption of a high quality breakfast has been associated with a healthy lifestyle and dietary habits, which are related to improved academic performance. Additionally, increased caffeine intake may be linked to breakfast skipping due to its impact on the quality and quantity of sleep.

Objective: To determine whether regular versus irregular breakfast consumption affects academic performance and caffeine intake.

Methods: Researchers created an online survey containing questions concerning breakfast habits, caffeine intake, and academic performance. The survey was administered via the Messiah University course management platform and on-site recruitment. Four hundred and thirty-four Messiah students between the ages of 18 and 23 responded. Data were analyzed using a two sample t-test.

Results: The GPA of breakfast eaters was 3.67 ± 0.02 compared to breakfast skippers 3.47 ± 0.48 ($p<0.0001$). No significant difference ($p=0.20$) was found for the frequency of caffeine intake of breakfast eaters (3.31 ± 2.66 days) compared to breakfast skippers (3.53 ± 2.45 days).
Conclusions: While caffeine intake appears to have no effect on breakfast habits, consuming breakfast regularly may contribute to a higher GPA.

IRB Approval: 2021-030 Date: January 22, 2022

Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

Eating Attitudes Assessment of Children Enrolled in the Salvation Army's After School Program

60

Sarah L Taylor, **Rachel H Marcroft**, **Heather E Mayo**, & Amy B. Porto†

The prevalence of disordered eating symptoms is increasing in adolescents and eating disturbances are being reported at young ages. Disordered eating has serious health and physiological consequences, thus it's imperative to have a reliable survey instrument for young children for early identification and prevention. The aim of this descriptive study was to assess the food preoccupation, dietary patterns, and eating attitudes in elementary-aged students by

using the Children's Eating Attitudes Test (ChEAT). Survey items are categorized into four subscales: (1) concerns about weight, (2) limiting food intake, (3) pressure to eat, and (4) concerns about food. Students enrolled in The Salvation Army's Roller Enrichment Academy were invited to participate in the study. Of 26 enrolled, 15% provided parent permission and child assent. The ChEAT was orally administered over 2 sessions to participants (n=4), aged 7-10. Results indicated subscales 1 and 4 had the highest scores (4 ± 5.48 and 4 ± 2.45, respectively). Item 25 (I enjoy trying new rich foods), contributed 56% to the total score of subscale 4. The participant with the highest total score (23 out of 78) appeared to be the most comfortable during survey administration. The participant who appeared to be the least comfortable during survey administration had the lowest total score (1 out of 78). These results suggest comfort level may be associated with participant willingness to answer survey items. However, more research is needed to explore eating attitudes in young children, so that disordered eating patterns can be better understood in this population.

IRB Approval: 2021-029 Date: February 21, 2022

Presented in: Natural and Applied Health Sciences Poster Session from 2:40 to 4:00 pm

Acknowledgments

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Support Sources

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Collaboratory/Engineering Department Project Review Panelists

Once a semester, each team in the Collaboratory takes part in a formal engineering design review in which faculty from the Department of Engineering and others, including professional engineers from industry, hear an in-depth report about the work that the team has been doing, are able to ask questions about the work and give their insights and suggestions based on their experience working as engineers. While these project reviews are a bit nerve-wracking for the students, they really help to make sure that projects are progressing along a path which will lead to eventual success of the project. Because of the time that the following individuals from outside the Department of Engineering have volunteered, these projects are much more successful than they could have been otherwise. Thank you!

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