POSTER ABSTRACTS SELECTED FOR PRESENTATION AT JANUARY 2016 CSU BIOTECHNOLOGY SYMPOSIUM

CSUPERB is committed to increasing the disciplinary diversity of work presented at the annual CSU biotechnology symposium.

CSUPERB defines biotechnology as a fusion of biology and technology. BIO (https://www.bio.org/what-biotechnology) lists biotechnology examples, applications and sectors; CSUPERB explicitly adds to these lists health IT and medical device research and development. We welcome and encourage poster abstract submissions from CSU faculty in all disciplines related to the current practice of biotechnology, including but not limited to life sciences, physical sciences, clinical sciences, math, computer science, agricultural science, engineering, and/or business.

The CSUPERB Faculty Consensus Group committee uses a "blind" selection process to select abstracts for presentation. No author names, department addresses or campus affiliations are visible to reviewers. Last year 74% of the 356 poster abstracts submitted were accepted.

We know it is nearly impossible for a selection panel to assess scientific merit or technological breakthroughs based on a short abstract. We also know the "amount" of work put into a project is very difficult to assess from an abstract. In addition we've discovered that investigators from different disciplines write in very different styles. In answer CSUPERB uses three very simple and, hopefully, "discipline agnostic" abstract selection criteria. All selection criteria are listed at the website: http://www.csuperb.org/symposium/poster-info/ It is also important to note that success of a design, test or experiment is not required! Lastly, CSUPERB does not correct typos, formatting issues or misspellings before abstracts are reviewed or the abstracts are published on the internet.

The main criteria the CSUPERB committee uses to select abstracts for the symposium is: **"Poster abstracts should include original data and results…**The most competitive abstracts make it clear what has been accomplished, what methods were used, and what conclusions have been drawn from the data presented." Unsuccessful abstracts usually fail on this criteria or make it very difficult for the committee to figure out what was tested.

Investigators, department chairs and deans have asked us to compile an "analysis" of successful poster abstracts for potential applicants. In answer we list here a set of abstracts presented at the 28th annual CSU Biotechnology Symposium representing a wide range of disciplinary work. Yellow highlights call out the key sentence(s) that address the main CSUPERB poster abstract selection criteria. We included authors and affiliations to give credit for the work in the list here – but remember – this information is not available to the selection committee.

We hope this document helps applicants understand what the selection committee will be looking for this fall!

Project Title: Aproximating Neuron Activity via Lifetime Charge in Artificial Neural Networks
Author List:
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Abstract: The field of artificial neural networks (ANN) is the study of machine learning algorithms that are inspired by biological neural networks. There has been renewed interest in the field due to advancements in deep learning methods, such as IBM's Watson, and convolutional neural networks, such as Facebook face recognition algorithms. In biotechnology, ANNs are often used for conveying tactile feedback in neural prostheses. Despite the great strides made by state-of-the-art algorithms, a major drawback is an inability to apply gradient descent because of the discontinuous nature of spiking stimulus. To this end, we propose the Lifetime Charge Artificial Neural Network that is capable of simulating a temporal stimulus, while also maintaining the ability to traverse the fitness space with gradient descent. The method is less computationally intensive than other current ANN algorithms, enabling deployment on low cost embedded computing hardware. In contrast, contemporary ANNs rely on high-performance computing to run efficiently (CURRENNT). Tenfold randomly sorted testing of the publicly available Iris data set (UCI Machine Learning Repository) showed an average accuracy of 96% classification rate with a standard deviation of 2.9%. Future work will be focus on deployment of the ANN on embedded systems for prosthetics.

Project Title: Cerebral blood flow during exercise: Does right and left matter?
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Abstract: A very tight cerebral blood flow hemodynamic is essential for brain function. At rest, there is a symmetry between the right and left middle cerebral artery (MCA) flow. Assymetry left/right is typically evaluated for clinical diagnosis of stroke or during surgery, thus a better understanding of the cerebral hemodynamics during stress is important. Purpose: To assess the CBF symmetry during a metabolic stress. Methods: 8 college-aged sedentary subjects performed a light (LE) and moderate (ME) constant-load cycling exercise for 10 minutes. Middle cerebral artery (MCA) blood flow velocity (MCA Vmean), peak and pulsatility index (PI) was continuously monitored for the left and right side. The proximal segment of the MCA was insonated with two 2-MHz Doppler probes placed on the temporal lobe and hold by a headset. Tracings of the envelope for all MCA hemodynamics parameters were obtained automatically using the Doppler software (Sonara, Carefusion). Results: MCA Vmean was 48.8 vs. 51.8 at rest, 48.8 vs.43.9 for LE and 44.3 vs. 45.8 for ME (cm s-1) for right and left side respectively. Peak was 78.7 vs. 77.6 at rest, 85.5 vs. 79.5 for LE and 84 vs.45.8 for ME (cm s-1) for right and left side respectively. Finally, PI was 1.02 vs. 0.94 at rest, 1.43 vs. 1.17 for LE and 1.37 vs.1.74 for ME for right and left side respectively. A two-way anova analysis revealed no intensity effect but a side effect (p=0.025). Conclusion: For this pilot study, a change in cerebral blood flow symmetry

seems to occur during exercise. This could help us better understand cerebral hemodynamics during stress, and have clinical implications.

Project Title: Synthetic promoters that facilitate tight regulation of gene expression in bacteria
Author List:
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Aviles, Milo; Undergraduate, Biology, San Francisco State University, Presenting Author
Ruegg, Thomas; Joint BioEnergy Institute
Thelen, Michael; Joint BioEnergy Institute
Hillson, Nathan; Joint BioEnergy Institute
Chen, Joseph; Biology, San Francisco State University
Abstract: The alpha-proteobacterium Sinorhizobium meliloti forms symbiosis with compatible legume plants by inducing root nodule development, infecting such nodules, and performing nitrogen fixation, a process that significantly impacts agriculture. This symbiotic relationship between the bacteria and the plant serves as a model for understanding microbe-host interactions, both mutualistic and pathogenic. We are studying the activities of eight different synthetic promoters in S. meliloti and comparing their expression levels with that of two known and previously characterized promoters, one which is induced by taurine, and the other by anhydrotetracycline. The promoters are transcriptionally fused to uidA, which encodes beta-glucuronidase, a reporter enzyme. S. meliloti carrying these specific transcriptional fusions on plasmids were grown in the presence and absence of inducer A. Expression levels were then assessed by measuring the enzymatic activity of the reporter. Our results show that all eight promoters can be regulated with inducer A. Some of the promoters exhibited particularly large dynamic ranges of expression, with extremely low levels of activity in the absence of the inducer and high levels of activity in its presence. The functionality of select synthetic promoters appears to surpass that of the taurine- or anhydrotetracycline-dependent promoter. Our study has significant implications in the engineering of bacterial strains for biotechnology purposes. The design principles behind these synthetic promoters can act as guidelines for implementing tightly regulated gene expression at low cost in industrial settings.

Project Title: Development of Hybrid Strains of Saccharomyces cerevisiae by Cell Fusion
Author List:
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Abstract: Since the Neolithic age, brewer's yeast (Saccharomyces cerevisiae) has been widely utilized for food and beverage production. Pure culture strains of S. cerevisiae have been utilized in brewing since the end of the nineteenth century. The implementation of genetically modified, hybrid S. cerevisiae strains in the brewing process has been shown to improve several characteristics of the S. cerevisiae strains, including introduction of more desirable flavors as well as increased ethanol production.
The short-term goals of this project are to develop hybrid S. cerevisiae strains by sporulation of various industrial S. cerevisiae strains such beer, wine, sake, and cider yeasts, identification and mating of a- and α-haploid types from each strain, and stabilization of hybrid strains. The long-term goal is to use these hybrid strains to commercialize novel sake, beer, or wine products.

Currently, we have collected eleven industrial strains of S. cerevisiae including beer, sake, wine, and cider yeasts. Three strains have been sporulated by growing in the SPO++ sporulation medium, where the yeast cells are exposed to conditions of extreme starvation for nitrogen in the presence of a non-fermentable carbon source, such as acetate. After a 2-7 day incubation period, sporulation efficiency was examined by light microscopy. Cells were treated with Zymolase to lyse the spore-containing ascus and then incubated at 55oC for 10 min to kill the vegetative cells. A serial dilution method was then used to spread haploid candidates on YPD agar medium. PCR was used to screen candidates for a- and α-haploid types of the strain. To date, we have isolated three α-haploids from a Sake strain, and three α-haploids from a Champagne strain. Currently, we are actively searching for an a-haploid type from these strains. Once we have a-haploids, we will fuse the two opposing mating type haploids to make a hybrid strain. The hybrid strains will subsequently be stabilized by sub-culturing in either beer or sake base medium for months with continuous screening for hybrids that maintain flavor and/or high alcohol production. We are currently collaborating with a local beer brewery on pilot productions and sensory tests with newly isolated fusion yeast strains.
Project funded by Korea Rural Development Administration (KRDA), South Korea

Project Title: Biocementation of Long Beach Sands for Soil Strength Improvement
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Abstract: The main goal for this research was to increase the strength of soil samples of Long Beach sand using a mixture of chemicals and bacteria. By testing the soil samples in a laboratory testing program based on unconfined compression tests, the effects of the proposed mixture on the sand strength was studied. The soil samples were collected near the intersection of East Ocean Blvd. and Coronado Ave. in Long Beach and 40 pre-cut 2-inch diameter by 6-inch long molds were used to make sand cylinders. Chemical compounds with a mixture of Calcium Chloride and Urea were prepared using five different concentrations: 1 M, 0.5 M, 0.1 M, 0.05 M, and 0.01 M. Bacterial isolates were prepared using selective media containing high urea content at high pH and were enriched using selective broth and agar. The bacterial isolate on the agar plates turned phenolphthalein indication to pink, which indicated the presence of urease produced from the isolated microbes. When the bacteria and chemical mixture was added to the samples, the solution had the potential to increase the sand cylinders strength. The chemical mixture alone did not cause any impact on the sand strength. In the testing program, each of the five chemical concentrations had a pair of samples: one control with only the chemical concentration and one with the mixture of chemicals plus bacteria. After 7 and 14 days, the sand samples were extracted from the molds and tested using unconfined compression tests. Comparing the failure load of the control samples with the samples of the bacteria-chemical mixture, slight improvements of the soil strength were observed corresponding to the concentration of chemicals 0.05 M and 1 M plus bacteria. The strength of conventional sand samples without the proposed biocementation process under unconfined compression tests is zero because there of the lack of sand cohesion. A maximum strength of approximately 4 lbs

was achieved using the proposed Biocementation process. These results were shown to be highly affected by the method of extrusion, the salt concentration of the sand, the curing time of the sand samples for bacteria development, and the concentration of chemicals and bacteria mixture. The authors would like to acknowledge CSUPERB for the support during this research.

Project Title: Synthesis and Purification of BAFF-R RNA Aptamer
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Abstract: Background:
B-cell activating factor, BAFF, is a member of the TNF ligand superfamily. TNF, tumor necrosis factor is a multifunctional cytokine with a wide range of functions, one being inducing necrosis, death, of tumor cells. Overexpression of BAFF bound to BAFF-R has been identified in Non Hodgkin's Lymphoma, NHL. NHL stems from the lymphocytes and spreads throughout tissues. This cancer can be either aggressive, fast growing, or non-aggressive, slow. RNA interference among the BAFF – BAFF-R interaction lowers the expression of these genes. This idea leads to the hypothesis that aptamers have therapeutic capabilities. An aptamer is a single stranded DNA or RNA that can bind to select target areas with high specificity. Binding of the BAFF-R aptamer to the BAFF-R protein blocks and limits the binding of the BAFF protein to the receptor. This hinders and slows the productions of the malignant cells. Since the malignant cell growth is usually much faster than normal B-cells, this approach allows normal B-cells to catch up and aide in preventing these malignant cells from taking over.
The overall objective of this research project is to successfully synthesize and purify the RNA aptamer that interacts with the BAFF-R protein.
Methods:
Upon obtaining two DNA oligonucleotides from Bio-Rad, a DNA template was created and amplified by DNA Polymerase Chain Reaction (PCR) method. Once the template was created, a 10% agarose gel purification was performed using gel electrophoresis. After the gel confirmed the expected band size of 100 base pairs, a gel extraction procedure using an extraction kit followed. The extracted and purified templates were then transcribed using EPICENTER transcription kit. The newly transcribed RNA strands were run on a denaturing 2.5% polyacrylamide gel using electrophoresis once again to obtain the expected band size.
Results:
Agarose gel electrophoresis and purification obtained an expected band size of 100 base pairs indicating the correct DNA template. Following, the polyacrylamide gel confirmed the expected RNA aptamer size of 81 bases. The above results confirmed the success of using PCR and transcription methods.
Conclusion:
The BAFF-R RNA aptamer of 81 bases has successfully been synthesized, and purified. Further studies considering structure analysis, and mutations, etc., can ensue.
Acknowledgements:
Sonoma State Chemistry Department Scholarship for Funding, Dr. Lares and the Sonoma State Faculty

Project Title: Sip-Puff based Assistive Technology Device
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Abstract: Limited movement or paralysis of the upper limbs caused by spinal cord trauma or diseases like Amyotrophic Lateral Sclerosis (ALS) can result in frustrating restrictions on a patient's ability to operate devices such as tablets, smartphones, or personal computers. As the physical limitations of each individual can vary, most patients are assisted by a specialist caretaker in order to determine the most effective means of access with minimal physiological input. This study presents sip-puff based assistive technology device that utilize suction (sip) and blowing (puff) as a switch to interact with mobile and PC devices. The proposed design incorporates two individual vacuum switches which simultaneously detect suction and expulsion of air known as a sip/puff switch. At idle, a constant pressure is maintained within the switches. Once the user sips or blows into the air tube, the corresponding switch is activated. Through this methodology, it is possible to differentiate between multiple signals related to the amount of time that the sip/puff action spans. A quick sip action can be mapped to one type of input while a long sip action can be mapped to another. This holds true for the puff action as well. In testing, five test subjects were required to input a sentence with 44 characters by using the sip/puff device. On average, users who completed the task recorded only 1 failed sip input attempt, while an average 14.667 puff input attempts failed to register. It was also determined that short puffs were the quickest of available inputs with an average completion time of (mm:ss.ms)1:08.2 +/- 7.59% compared to short sip 2:04.3+/- 47.7% and long puff (3:11.5). Furthermore, the device can be further calibrated by adjusting pressure thresholds to improve responsiveness. Preliminary results suggest that the sip/puff device is capable of being used as a multi-functioning switch for assistive technology devices.

Project Title: Bisphosphorylimides as Organocatalysts for Asymmetric Friedel-Crafts Reactions
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Abstract: Background: As a growing number of chiral, non-racemic bioactive molecules flood the pharmaceutical industry, the importance of efficient enantioselective synthesis and purification of these compounds also increases. Enantioselective organocatalysis has emerged as a powerful synthetic tool complementary to traditional metal-containing catalytic

transformations. Organocatalysis has several noteworthy advantages over traditional metal-containing catalysis. For example, some metals are highly toxic and may build up in biological systems over time, whereas there are typically fewer toxicity issues with organocatalysts. Also, organocatalysts can be tolerant of air and water, and the reactions are typically easy to perform. Taking this into account, we have developed an asymmetric Brønsted acid catalysis of the Friedel-Crafts reaction of sesamols, a naturally occurring component of sesame oil that shares the chemical structure of many pharmaceutical compounds, with Boc-protected-benzaldimines using axially chiral bisphosphorylimides. Currently, bisphosphorylimides are underutilized despite their notable potential for catalysis. The chemical scaffold of bisphosphorylimides is highly structured and ordered, mimicking the active site of an enzyme. The long-term objective is the enantioselective synthesis of bioactive natural products, unnatural amino acids, and other various building blocks useful in the synthesis of chiral bioactive molecules.
Results: The model bisphosphorylimide organocatalyst has been successfully synthesized (38% yield over 4 steps) from enantiopure BINOL using an improved hydrogenation method developed in our laboratory. The catalyst shows catalytic ability with three different Boc-protected aryl-imine electrophiles in the Friedel-Crafts reaction: Ar = phenyl (45% yield), tolyl (69% yield), and Ar = anisyl (65% yield). Further reaction condition optimization using the model bisphosphorylimide is currently being performed. Furthermore, two derivatives of the organocatalyst with bulky aromatic substituents (R = phenyl, triphenylsilyl) have been prepared using the Suzuki reaction in high yields (96% yield) and fully characterized. These modified catalysts are currently being used to determine the substrate scope of the reaction.
Acknowledgements: We thank CSUPERB (New Investigator) for support of this work.

Project Title: Composite Mechanics of Annulus Fibrosus of Intervertebral Disc
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Abstract: The intervertebral disc (IVD) is a heterogeneous structure composed of three elements: cartilaginous endplate, nucleus pulposus (NP), and annulus fibrosus. However, each element performs a specific physiological and mechanical function; the overall structure is responsible for transferring loads along the vertebral column. Previous research studies on the mechanics of the IVD and annulus fibrosus have suggested that the composition of the annulus can be considered as a composite material. Anatomically, the annulus is a multi-lamella ring-like structure that consists of twenty lamellae and forty fiber bundles made of collagen and proteoglycan. In such as, the collagen fiber is the loading bearing member that are suspended by proteoglycan matrix. It has been reported that the annulus is mechanically stiffer near the periphery of the disc than at the nuclear-annular interface. The change in the stiffness is attributed to the variation in the fiber orientation, which varies from 45° near the NP to 25° at the most outer lamella. Despite the ongoing research on the mechanical characterization of IVD, there are only two current technologies; i.e. fusion surgery and disc orthroplasty, to replace degenerated IVD, which has been associate with lower back pain. In fusion surgery, on one hand, the range of motion of a motion segment is compromised since two or three successive vertebrae are fixated, i.e. fused, together. On the other hand, the available disc orthroplasty solutions are clinically unproven and mechanically unreliable because it is based on articulating joint structure while the natural disc is not. The focus of this research is to fundamentally understand the mechanical and structural properties of the native annulus fibrosus and use

mechanics of composite materials to elucidate its performance. The approach was to create a mechanics-based design tool that allows researchers to predict the mechanical properties to match the experimentally determined ones. The outcomes of this research include: 1) understanding of the significance of fiber orientation on the axial and transverse moduli as well as on resistance to axial rotation, and 2) predicting the failure strain and overall mechanical behavior. The latter matched experimental results previously reported in the literature. The outcomes of this research will guide future studies on the synthesis and design of new synthetic annulus fibrosus to replace existing clinically unreliable solutions.

Project Title: Customized biomimetic scaffolds created by inkjet 3D printing for tissue engineering

Author List:
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Abstract: 3D bioprinting is a rapid prototyping technique that can create complicated 3D structures by inkjet printing of a liquid binder onto powder biomaterials for tissue engineering scaffolds. Direct fabrication of scaffolds from 3D bioprinting, however, imposes a limitation on material choices by manufacturing processes. In this study, we report an inkjet 3D bioprinting approach wherein a positive replica of desired shapes was printed using gelatin particles, and the final scaffold was directly produced from the printed mold. To create patient-specific scaffolds that match precisely to a patient's external contours, we integrated inkjet bioprinting technology with imaging technologies and successfully created custom scaffolds mimicking human mandibular condyle using polycaprolactone (PCL) and chitosan (CH) for potential osteochondral tissue engineering. To test the ability of the technique to precisely control the internal morphology of the scaffolds, we created orthogonal interconnected channels within the scaffolds using computer-aided-design (CAD) models. Because very few biomaterials are truly osteoinductive, we modified inert 3D printed materials with bioactive apatite coating. The feasibility of these scaffolds to support cell growth was investigated using bone marrow stromal cells (BMSC). The BMSCs showed good viability in the scaffolds, and the apatite-coating further enhanced cellular spreading and proliferation. This technique may be valuable for complex scaffold fabrication.

Project Title: Evaluating Metacognitive Awareness and Self-Evaluation Skills in Introductory Molecular Biology Students

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Abstract: The purpose of this study was to examine the effect of metacognitive awareness, the awareness of one's cognitive processes, on the evaluative skills and exam performance of introductory biology students (n=119). Metacognitive practices include effective planning,

selecting of appropriate study strategies, self-monitoring, and adjusting learning strategies when necessary. While the majority of studies to date focus on younger students, there is a growing body of evidence supporting the claim that college students exhibiting more highly developed metacognitive skills are more successful in their academic endeavors. Research also suggests that integrating metacognitive activities into the curriculum can help students train and improve these very skills.
In our study, we assigned the Metacognitive Awareness Inventory (MAI), a video on metacognition and a reflective essay to a sub-set (n=61) of students at the beginning of the semester to gauge their level of metacognitive awareness. All students in the class were asked to demonstrate comprehension monitoring and self-evaluation skills, two metacognitive practices, by predicting their exam scores before and after taking the Unit 1 exam. Students were then provided multiple opportunities to improve monitoring and self-evaluation skills, through activities embedded in the curriculum, and asked to make exam score predictions again on the Unit 3 exam. Linear regression analysis comparing students' actual exam scores to their predicted exam scores revealed a strong tendency to over-predict on the Unit 1 exam. However, the number of over-predictors decreased significantly by the Unit 3 exam. T-test analyses comparing mean exam scores between the two populations indicated that under-predictors had the higher exam averages. For the MAI subset, Pearson's correlations revealed no significant association between MAI scores and actual or predicted exam scores, revealing a disconnect between students' perceived and actual metacognitive skills. Although no correlations were found, qualitative data from student reflections identified several important themes regarding students' perceptions about metacognition. For example, over 95% of students who completed the MAI discovered new ways to improve study habits and learning strategies. Additional research is needed to understand the types and frequency of curricular activities that have the greatest impact in promoting metacognition in introductory biology students.

Project Title: Purified Platelet-Rich Plasma Technology Inhibits Bacterial Growth and Biofilm Formation

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Abstract: The promise of using stem cells or tissue engineering as novel regenerative technologies that enhance wound healing is dampened by microbial contamination of plastic or metal-based materials including those used to fabricate surgical implants, prosthetics, and sealants. Bacterial persistence on these surfaces is most often mediated by the conversion of planktonic cells to a biofilm community in which organisms are encased in a self-initiated extracellular matrix of proteins, DNA, and polysaccharides that provides resistance to immune system mediators and antibiotics. A critical barrier to the development of novel therapeutics and therefore wound healing is thus a lack of non-antibiotic alternatives that either inhibit the highly regulated stages of biofilm development or aid in the dispersion of cells from the maturely formed biofilm architecture. Recent studies indicate that platelets derived from human and murine donors release, in addition to a myriad of growth factors attributed to thrombin generation and fibrin formation, antimicrobial peptides and other immunomodulatory agents

that halt bacterial growth. Here we show that platelet-rich plasma (PRP) collected and purified from human samples using patented technologies developed at Stem Cell Partners significantly inhibits growth of prominent skin microbiota Gram positive and Gram negative species Staphylococcus aureus and Pseudomonas aeruginosa, respectively. In brief, PRP processed using MicroAire and Autologous Thrombin devices demonstrated bactericidal activity when added to broth assays for inoculums as high as 109 CFU/ml whereas bacterial growth was unimpeded by the presence of platelet-poor plasma (PPP). Similarly, polystyrene and polypropylene beads coated with PRP induced zones of inhibition when bacteria were added to solid agar media. Our results also demonstrate that PRP prevents biofilm formation and disperses pre-existing biofilm communities in a high throughput 96-well format. Collectively, these data show PRP to be a robust antimicrobial agent and suggest potential for its inclusion in novel therapeutic technologies designed to enhance wound healing. These studies represent an industry partnership between Stem Cell Partners and CSUS and were supported by an undergraduate research experience award.

Project Title: Using Music to Analyze Protein Sequences

Author List:
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Abstract: Proteins are typically represented as strings of characters encoding amino acids.
Humans process knowledge and information in a variety of different ways;
one of them being auditory. There are similarities between the structures of proteins and music; both are composed of phrases organized into themes [1].
The first aim is to convert amino acid sequences to music. We want to generate pleasant music while preserving relationships between amino acids properties. A good musical mapping makes it easier to listen to what is generated, and easier to remember repeated sections.
Unlike previous mappings that have missed musical structures, we introduce instrumentation commonly found in pop music.
Our keyboard mapping of amino acids to musical notes is embellished by using drums to dictate the size of the amino acid, by guitar to differentiate between charged, uncharged, aliphatic, and aromatic amino acids and lastly by four different melodies to differentiate between non-polar, polar, positively and negatively charged amino acids. Our mapping follows common musical structures, making biology, music, and computer science more appealing to a wider range of audiences.
The second aim is to analyze protein sequences that have been converted to music according to the mapping described above. We create a database of recordings of orthologs: similar proteins found in different organisms. The database will also contain recordings of pairwise alignments of orthologous proteins. By juxtaposing and recording two orthologous proteins simultaneously, but with different instrumentations, one can hear the conserved regions between the two proteins. The conserved region is a theme and the various orthologous proteins that contain this theme, play it as variations on that theme.
Lastly, we plan on extending this work to the study of protein pattern recognition. Rather than running hidden Markov Models (HMMs) built for the analysis of protein sequences [2], we plan to run original HMMs from speech recognition on the musical encodings of protein sequences and then perform inverse mappings to identify patterns in proteins. We believe that this approach will yield better results since HMMs were originally designed for speech recognition.

[1] Dunn J. Clark M. (1999) Life Music: Sonification of Proteins. Leonardo V.32(1):25-32.
[2] Durbin R. et al., (1999) Biological Sequence Analysis: Probabilistic Models of Protein & Nucleic Acids. Cambridge University Press.

Project Title: Extraction of Polyphenols and Antioxidants from Avocado Seeds and Skins
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Abstract: Avocado seeds and peels are generally wastes from avocado plantations and processing plants and are usually removed at a cost. As reported in literature, avocado seeds and peels contain multiple ingredients that have beneficial effects on human health and could potentially be converted into commercial products. In this work, we tested several solvents for their extraction performance and have identified an environmentally friendly option. It was found that the solvent could extract up to 9.0% dry weight of seeds and 17.0% dry weight of peels, respectively. We also recommend follow-up studies that could lead to the development of commercial products from avocado seeds and peels.

Project Title: Study of Mechanical Properties of Left Ventricle using Finite Element
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Abstract: According to the CDC, 735,000 people in the United States experience a heart attack (myocardial infarction) every year and out of which 30% of these have previously suffered a myocardial infarction (MI). With each successive event, mortality rates drastically increase. These episodes generate damaged tissue in the heart which adversely affect heart function and make diagnosis and treatment options difficult [1]. This study presents a finite element model of left ventricular function to gain insight into the mechanical changes that result from an infarct that may lead to increased risk of subsequent heart failure. This information would be a useful adjunct for physicians treating patients suffering from cardiovascular disease with a prior episode of infarct. Magnetic resonance imaging (MRI) was used to create a 3 dimensional left ventricle (LV) computer model. Simulations were conducted using an iterative, mathematical program to predict the mechanical behavior of the LV. Regions of simulated infarct damage were incorporated into the analyses by altering material properties for a specific region. Three infarct cases denoted case 1, 2 and 3 and consisting of a 7%, 15% and 50% infarct region by volume respectively were evaluated. The decrease in end-diastolic volume for cases 1, 2 and 3 were 4%, 6% and 12%, requiring an increase in LV pressure (hypertension) of 2.5, 5 and 12 mm Hg to restore normal end-diastolic volume (EDV). The trend was consistent with patient's experiencing decreased tissue compliance. The higher LV pressure resulted in an increase in wall stress opposite the infarct for case 1, 2 and 3 of 40 %, 85% and 200 %. This trend was consistent with

tensile testing of myocardial tissue [2]. The results are potentially useful in determining a relative severity in MI patients and identifying high stress locations in the LV.
[1] Centers for Disease Control and Prevention (CDC; 2015) Heart Disease. http://www.cdc.gov/heartdisease/facts.htm
[2] Holzapfel, Gerhard, and Ray Ogden. "Constitutive Modelling of Passive Myocardium: A Structurally Based Framework for Material Characterization." Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 367.1902 (2009): 3445-3475.

Project Title: The Effect Of Mitral Valve Prosthesis Design On Intraventricular Fluid Dynamics: An In Vitro Study

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Abstract: Abstract: Bioprosthetic as well as mechanical heart valve prostheses can be implanted as a treatment to mitral valve failure, but vary greatly in their effect on the flow dynamics of the left ventricle (LV). Our goal in this study is to quantitatively compare the effect of mitral valve prosthesis (MVP) design and orientation on the flow field of the LV and assess the potential for thromboembolic complications. Particle Image Velocimetry of a cardiovascular mock loop is used to measure the flow field in a silicone model of the LV. A porcine bio prosthetic valve is placed in the aortic position, and a variety of different MVP are tested in the mitral position including a porcine bioprosthetic valve (BPV), a tilting disc valve (TDV) in two different orientations (free wall and septum), and a bileaflet mechanical valve (BMV) in the anatomical position. Vortex circulation, Kinetic Energy (KE) and other indices are calculated for comparison and assessment of the impact of MVP on LV flow. For all studies the aortic pressure is maintained at 60.3 ± 3 mmHg and cardiac output at 3.50 ± 0.01 L/min yielding an ejection fraction of 27% which is representative of a heart failure patient. For the BPV, the normal diastolic vortex pattern is observed consisting of two counter rotating vortices in the LV midplane. The large clockwise (CW) vortex exits through the aortic valve while the counter-clockwise (CCW) dissipates next to the LV free wall. The TDV shows a similar vortex pattern when oriented towards the free wall – CW vortex circulation increases during diastole, then declines to a minimum during systole. The CCW vortex is much smaller and dissipates more quickly. When the TDV is oriented toward the septum, the vortex pattern completely reverses, with the CCW vortex dominating the flow field, and a greatly diminished CW vortex. KE of both vortices follows the same trend as the circulation. Our study shows that the normal LV vortex pattern can be preserved with BPV and TDV when the jet is oriented toward the LV free wall, but is completely reversed in the septal orientation. This method enables the systematic comparison of intraventricular flow dynamics following MVP in a well-controlled setting, and allows the assessment of flow indices to ascertain clinical relevance.
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Project Title: Power Efficient Circuits for Bio-inspired Synapse-based Neuromorphic System

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Abstract: Bio-inspired neuromorphic computing system that emulates human brains has gained great interests due to its high-efficiency computation. Meanwhile, the recently developed memristor-crossbar-array technology, which is able to efficiently emulate the plasticity of biological synapses and accommodate matrix multiplication, has been demonstrated its potential for synapse based neuromorphic computing. The hardware implementation of a bio-inspired system has always been a research focus. In this research, a cyclical-sensing integrate-and-fire circuit scheme (C-IFC) using IBM 130nm CMOS technology was developed. The circuit efficiently and accurately facilitates memristor-crossbar-array matrix multiplication. The performance of the described C-IFC is evaluated with a 32×32 memristor-crossbar-array. With the optimized memristor-crossbar-array structure, the described C-IFC has shown great promise in accelerating matrix multiplication in a bio-inspired synapse-based neuromorphic computing system.

Project Title: Biofeedback Device with Real-time Gait Analysis: A Functionality Test
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Abstract: Stroke patients exhibiting gait asymmetry require rehabilitation to improve walking and reduce injury from fall. A device, called 'Walk-Even', which consists of force sensor embedded insoles, a wireless module, and a microcontroller, has been developed which analyzes gait and provides feedback to correct gait asymmetry in real-time. To test Walk-Even's accuracy in measuring the key gait parameters, two preliminary experiments were conducted on healthy adults to compare Walk-Even with a commercial device known as Mobility Lab. During the experiments, participants wore both devices simultaneously while performing a straight walk at a self-selected pace. Three conditions were tested: normal walking and two conditions of simulated asymmetrical walking. Asymmetrical walking was simulated by attaching a 7-lb weight on the participant's ankle or attaching an Ankle Foot Orthosis (AFO) on one leg. The gait time (the time it takes for a person to complete one walking cycle) and stance time (the time when the person's foot is on the ground) were measured. The asymmetry ratio, defined as one minus the ratio between the stance time of the affected leg to the normal leg, was then calculated. From the first experiment, data analysis showed that both the gait time and asymmetry ratio between both devices resulted in low correlation coefficients per walking condition. To improve the gait detection accuracy, a new calibration algorithm was developed and tested in the second user experiment. The algorithm collects initial data about the subject's no-load and full-load foot pressures in order to determine the threshold values needed to accurately measure the gait parameter. From the second experiment, the correlation coefficients for gait time and asymmetry ratio improved to greater than 0.9 per condition. Thus, the gait parameters obtained

from Walk-Even device were comparable to the gait parameters measured from a commercial device.
Next, the device will be tested on stroke patients to assess the effectiveness of its biofeedback. Due to the affordability, portability, and user-friendly interface, Walk-Even could be a possible alternative to expensive commercial devices in analyzing gait asymmetry, and another option in traditional physical therapy treatment to correct gait asymmetry.
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Project Title: Nanodiscs Stabilize Anabaena Sensory Rhodopsin for Transcriptional Regulation Studies
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Abstract: Anabaena Sensory Rhodopsin (ASR) is a retinal containing photoactive membrane protein, from the cyanobacterium Anabaena sp. PCC 7120. ASR undergoes an orange light-induced conformational change associated with release of a bound transducer protein ASRT. This protein complex has been proposed to directly control the transcription of the cpc-genes involved in chromatic adaption. However, direct binding of DNA with ASR has not been demonstrated. Hindering such binding studies is the lack of a system to stabilize ASR in an accessible native-like phospholipid bilayer. To overcome this barrier we isolated and characterized ASR from engineered E. coli for construction of self-assembled protein lipid nanodiscs. Our ASR nanodiscs were soluble and allow for protein access from the top and bottom of the bilayer. Our UV-visible spectrophotometric spectra show that isolated ASR nanodiscs possess a retinal absorbance shift in response to light exposure (≈548-537nm). Dynamic light scattering of ASR nanodisc fractions, separated by size exclusion chromatography, displayed two populations of distinct diameters (21.9 +\- 6.3 and 31.1 +\- 12.5 nm). The two populations may represent different oligomeric states of ASR in nanodiscs. We conclude that ASR is stabilized in the soluble lipid bilayer of the nanodiscs and represents a practical platform to enable further investigation of ASR's unique role in the transcriptional control of chromatic adaptation. Our next steps will involve examination of the lipid environment and to investigate DNA binding. Results of these studies may allow for future use of these proteins as photo-active transcriptional regulators.
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