WASHINGTON STATE UNIVERSITY

SUMMER UNDERGRADUATE RESEARCH SYMPOSIUM

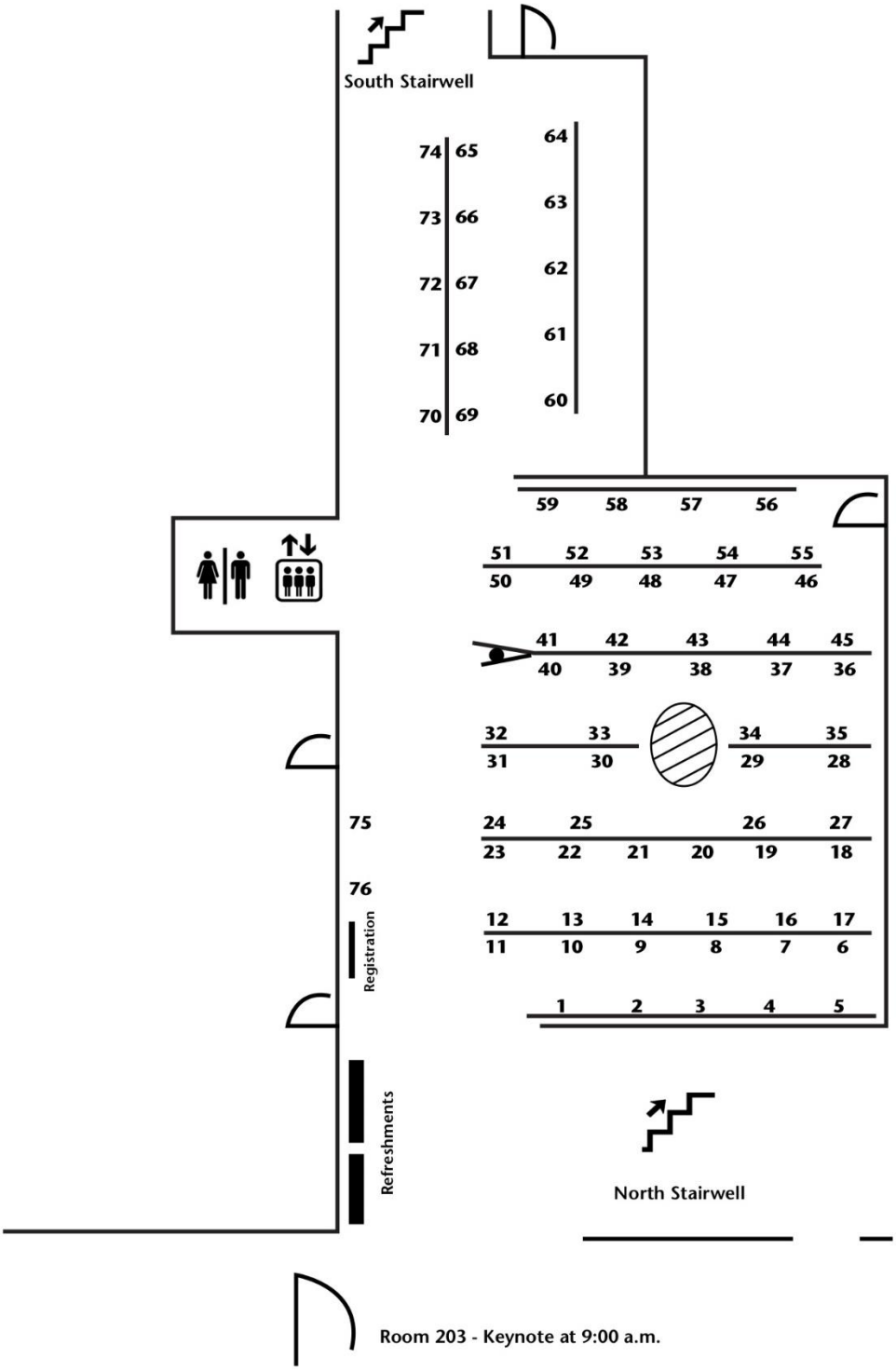
Friday, Aug. 2 | 10 a.m. to 1 p.m. | CUE Atrium

KEYNOTE SPEAKER: Amit Bandyopadhyay
9:00 a.m. | CUE 203

Office of
Undergraduate Education
Washington State University

Event Floor Plan

Atrium Poster Map



Index of Presentations

Poster No.	Presenter	Research Program	Project Name
1	Anna Huckabee	Research Opportunities for Native Undergraduate Students	Quantifying Endogenous Protein Phosphorylation in Myocardial Tissue from a Transgenic Mouse Model of Hypertrophic Cardiomyopathy
2	Samantha Morgan	Engineering Tools for Disease Diagnostics and Treatment	Investigation of sensitization effect of mobile domain peptide of cTnI on cardiac myofilament calcium sensitivity
3	Colin Warn	Gerontechnology-focused Summer Undergraduate Research Experience (GSUR)	LSTMs for Indoor Sensor Prediction
4	Elizabeth Moeser	Marine Environmental Physiology	Temperature and oxygen preference of the intertidal copepod Tigriopus californicus
5	Anna Mikkelsen	Bioplastics & Biocomposites	An Ester Bond Containing Hempseed Oil Derived Epoxy for the Preparation of Room Temperature Curing Vitrimer Coating with Repairing and Removing Properties
6	Christopher Ibarra	Neurobiology of Drug Addiction	The Role of the Dorsal Hippocampus in Early Stage Memory Reconsolidation
7	April Stewart	Northwest Advanced Renewables Alliance (NARA)	Biofuel Curriculum and Education: Biofuel Lesson Implementation in Early Childhood and Elementary-Aged Students aged 3-12
8	Kyleigh Rhodes	Bioplastics & Biocomposites	Material properties of injection molded basalt/hemp hybrid fiber reinforced polypropylene
9	Cecilia Diaz Alonzo	Gut-Brain Communication and Addictive Behavior	Optical Imaging Approach to Understand Cannabis-Induced Feeding Behavior
10	Michael Martin	Undergraduate Research in Smart Environments	Improving the Accuracy and Analysis of the Digital Memory Notebook (DMN) Dashboard
11	Abib Hooker	Bioplastics & Biocomposites	Vibration Welding of Biocomposites

Poster No.	Presenter	Research Program	Project Name
12	Zachary Kowalewski	Northwest Advanced Renewables Alliance (NARA)	Advanced Oxidation of Hydrothermal Liquefaction Aqueous Effluent using Microscale Based Reactors and Characterization using High Pressure Liquid Chromatography
13	Chantal Shine	Undergraduate Research in Smart Environments	Nutrition Monitoring
14	Esteban Espino	Multidisciplinary Undergraduate Research Training in Wearable Computing	Survey Data and Empatica E4 Wristwatch Help Show How Physiological Markers of Stress Affect Alcohol Dependent Patients
15	Marco Arceo	Gerontechnology-focused Summer Undergraduate Research Experience (GSUR)	Alcohol Relapse Prevention Through Electrodermal Activity and Heart Rate Analysis
16	Asiamay Diaz	Marine Environmental Physiology	In vivo analysis of astaxanthin in environmentally stressed tidepool copepods Tigriopus californicus
17	Alan Ramirez	Bioplastics & Biocomposites	DES Treatment of Corn Stover Hydrolysate for the Production of High Purity Lignin
18	Cullen Burke	Northwest Advanced Renewables Alliance (NARA)	Characterization of Biomass-derived Pyrolytic Lignins for Downstream Upgrading
19	Stephanie Schoch	Gerontechnology-focused Summer Undergraduate Research Experience (GSUR)	Data-Driven Activity Step Segmentation with Change Point Detection
20	Va Diep	Multidisciplinary Undergraduate Research Training in Wearable Computing	Development of At-Home Balance Control Assessment and Tracking Smartphone App for Pregnant Women
21	Antoinette Avorgbedor	Sustainable High-value Horticulture & Processing Systems in Washington State	Protective netting conserves water by replacing evaporative cooling used for apple sunburn control in Washington State
22	Ian DeBois	Bioplastics & Biocomposites	Performance Evaluation of Basalt/Hemp Fiber Thermoplastic Hybrid Composite

Poster No.	Presenter	Research Program	Project Name
23	Dana Van Fossen	Northwest Advanced Renewables Alliance (NARA)	Extraction and Characterization of Nanocellulose from Post-consumer Denim Jeans (Part 1)
24	Mai Nguyen	Sustainable High-value Horticulture & Processing Systems in Washington State	Testing the efficacy of eco-friendly cleaners against Escherichia coli and Listeria innocua on household surfaces
25	Nathaniel Sprecher	Undergraduate Research in Smart Environments	Detecting Erroneous Entities in Attributed Graphs with a Graph Neural Network
26	Rogine Gomez	Bioplastics & Biocomposites	Mycelium-Based Lightweight Foam from Spent Distiller Grains from Whiskey Industry
27	Joseph Summers	Multidisciplinary Undergraduate Research Training in Wearable Computing	Initial Prototype Development of a Novel Catheter Navigation System for Endovascular Medical Procedures
28	Peter Schultheis	Sustainable High-value Horticulture & Processing Systems in Washington State	Improving Monitoring Techniques for an Economically Important Legume Pest
29	Thomas Ekstrom	Bioplastics & Biocomposites	Flexible polyurethane foam production with deep eutectic solvent lignin as a partial substitution of polyol component
30	Liam Herbst	Bioplastics & Biocomposites	Biobased ABS
31	Elisa Jensen	Engineering Tools for Disease Diagnostics and Treatment	Comparison of Methods for Detection of Atrazine in Spiked Samples
32	Reece Keller	Multidisciplinary Undergraduate Research Training in Wearable Computing	Engineering Solutions to Problems in Wearable Computing
33	Stephen Iezzi	Undergraduate Research in Smart Environments	The Application of Deep Learning Methods to Epigenomic data
34	Joshua Storey	Plant Cell Biology and Biochemistry	Analysis of a Novel Regulator of Plant Cell Division, MACET4
35	Kelvin Dam	Sustainable High-value Horticulture & Processing Systems in Washington State	Cluster modelling of small grain supply chains: analysis of the Cascadia Grains Conference

Poster No.	Presenter	Research Program	Project Name
36	Omozusi Guobadia	Engineering Tools for Disease Diagnostics and Treatment	Investigations of chondrocytes' nutraceutical intake and the effect of ascorbic acid on 2D and 3D culture
37	Sarah Norman	Gerontechnology-focused Summer Undergraduate Research Experience (GSUR)	Medication Routine Effectiveness in Community Dwelling Older Adults
38	Peter Meyer	Bioplastics & Biocomposites	Unsaturated Diacids for the Synthesis of Bio-Enhanced Nylon 6,6
39	Alex Trevithick	Multidisciplinary Undergraduate Research Training in Wearable Computing	Dynamic and Therapeutic Modifications of Physical Spaces in Response to Real-Time Emotion Classification with Deep Learning LSTM on Raw EEG Data
40	Natalie Sanchez	Ecology and Evolution of Plant-Microbe Symbioses	Phenotypic Effects of Various Rhizobia Strains on the Biomass Allocation of Trifolium barbigerum
41	Sean Luchessa	Multidisciplinary Undergraduate Research Training in Wearable Computing	LIDS
42	Thida Tea	Sustainable High-value Horticulture & Processing Systems in Washington State	Biochar influences compost pile temperature and available nitrogen
43	Cassidy Peru	Ecology and Evolution of Plant-Microbe Symbioses	The Effect of Varying Nitrogen Sources on the Growth of Azotobacter vinelandii Over Time
44	Nicole Johnson	Engineering Tools for Disease Diagnostics and Treatment	Neck Loads Increase During Tablet Computer Use
45	Lucy Mujugira	Multidisciplinary Undergraduate Research Training in Wearable Computing	Comparing data from different sensor modalities
46	Breanne Searing	Plant Cell Biology and Biochemistry	Highly conserved region on MACET4 protein promotes microtubule nucleation
47	Karla Bonic	Engineering Tools for Disease Diagnostics and Treatment	Cloning, Mutagenesis, and Expression Optimization of Tropomodulin

Poster No.	Presenter	Research Program	Project Name
48	Sarah Harkins	Sustainable High-value Horticulture & Processing Systems in Washington State	Determination of Effective Number of Pasteurization Units for Bottled Hard Cider
49	Samantha Bennett	Electrocatalysis	Investigation of the α-Fe2O3 (0001) Surface via DFT Implemented using an Atom-Centered Basis
50	Steven Zhang	Northwest Advanced Renewables Alliance (NARA)	Assessment of the Impact of Rising Global Temperatures on the Microbiomes of Poplar Trees
51	Sahithee Batchu	Engineering Tools for Disease Diagnostics and Treatment	Non-enzymatic Diabetes Sensors: Analyzing Glucose Sensitivity, Detection Range, and Interference of Metallic Nanoparticles
52	Natalie DeLand	Sustainable High-value Horticulture & Processing Systems in Washington State	Clustering the Varieties of Dried Peas based on their Composition and Functional Characteristics
53	Fiona Keogh	Gerontechnology-focused Summer Undergraduate Research Experience (GSUR)	Predicting Uptake of the Digital Memory Notebook based on Competency
54	Anna Schraufnagel	Bioplastics & Biocomposites	High Performance Bio-Based Plastics
55	Beatriz Jimenez	Ecology and Evolution of Plant-Microbe Symbioses	The effects of rhizobia strain identity on the flowering time of wild clover
56	Jordan Hummel	Sustainable High-value Horticulture & Processing Systems in Washington State	Organic Fertilizers and Cattle Grazing Density: Effects on Soil Fertility and Sustainability of Pastures
57	Rachel Hannah	Northwest Advanced Renewables Alliance (NARA)	Mechanochemical-assisted deconstruction of lignocellulosic biomass on a pilot scale to improve enzymatic digestibility and cellulosic sugar yield
58	Michele Counts	Engineering Tools for Disease Diagnostics and Treatment	3D Printing of a Structural Scaffold with Controllable Mechanical Properties for Articular Cartilage Tissue Engineering
59	DeMarcus Turner	Research Opportunities for Native Undergraduate Students	The effect of rhizobia on flowering time and fitness in Trifolium barbigerum

Poster No.	Presenter	Research Program	Project Name
60	Karla Bustamante	Multidisciplinary Undergraduate Research Training in Wearable Computing	Ecological Momentary Assessment mobile app for real-time behavioral measures
61	Austin Marino	Undergraduate Research in Smart Environments	Multiple Language Usage in Open Source Github Repositories: How Computer Languages are being Utilized in Real-World Applications
62	Martin Niemiec	Engineering Tools for Disease Diagnostics and Treatment	Bidirectional Isotachophoresis for the Detection of Disease Biomarkers in Exosomes
63	Amanda Bye	Northwest Advanced Renewables Alliance (NARA)	3D Printed Biocompatible Glycerol Vitrimer
64	Tara Goble	Plant Cell Biology and Biochemistry	Identification of microtubule-associated protein dynamics in MACET4
65	Terreill Robertson	Engineering Tools for Disease Diagnostics and Treatment	The Influence of Ascorbic Acid on Chondrocytes Encapsulated in Agarose Hydrogels
66	Zachary Cutler	Undergraduate Research in Smart Environments	RepeatAnalyzer Interactive Website
67	Rhea Sablani	Engineering Tools for Disease Diagnostics and Treatment	Application of Paper-Based Isotachophoresis (ITP) Technology for Isolation and Detection of Exosomes
68	Joshua Blair	Northwest Advanced Renewables Alliance (NARA)	Nano Cellulose Reinforcing Regenerated Fibers From Cotton Waste
69	Evelyn Bohnee	Research Opportunities for Native Undergraduate Students	Genetic and phenotypic characterization of the silent knight 1 (silk1) mutant
70	JiaMin Wu	Bioplastics & Biocomposites	Increasing Biolistic Transformation Efficiency Through Amine Structure
71	Bryce Morgan	Sustainable High-value Horticulture & Processing Systems in Washington State	USDA Dry Bean Nutritional Evaluation
72	Asim Fauzi	Undergraduate Research in Smart Environments	Integrating Action Response in RAS
73	Gabreil Santana	Plant Genomics and Biotechnology	Mutualistic Bacteria and Seed Counts in Trifolium barbigerum

Poster No.	Presenter	Research Program	Project Name
74	Lauren Smith	Undergraduate Research in Smart Environments	Measuring Resiliency in Power Grids Using Graph Metrics
75	Amanda Antoch	Ecology and Evolution of Plant-Microbe Symbioses	Back to the future: Methods to recover historic rhizobial strains from herbarium specimens
76	Leonardo Orozco	Molecular Interaction Between Peas and Root-Rot Disease	Understanding the Role of the Anthocyanin Synthesis Pathway in the Tolerance Exhibited Towards Fsp in Purple-seeded Pea Lines

Abstracts

Poster # 1

Quantifying Endogenous Protein Phosphorylation in Myocardial Tissue from a Transgenic Mouse Model of Hypertrophic Cardiomyopathy

Presented by: Anna Huckabee

Program: Research Opportunities for Native Undergraduate Students
Co-authors: Peter O. Awinda, Bertrand C.W. Tanner
Home Institution, Major, Class Standing: University of Idaho, Pre-med/Human Health and Performance, Senior

Heart disease remains the leading cause of death each year in the United States. Familial hypertrophic cardiomyopathy (HCM) is a heritable form of heart disease due to genetic mutations in the proteins of cardiac muscle cells. The HCM heart condition leads to a thick heart wall, making the heart unable to fill with blood and pump appropriately. This study focused on the arginine-to-lysine (N47K) mutation, expressed at the 47^{th} position in the amino acid sequence of myosin regulatory light chain (RLC). In this study we wanted to look at phosphorylation levels in proteins troponin T, troponin I, myosin binding protein-C, and RLC, with and without the presence of the N47K mutation. Due to the fact that these regulatory proteins contribute to HCM, we wanted to see if they were expressed differently due to the N47K mutation. As genetic controls, we used transgenic mice that were modified to express the human RLC isoform. The WT-RLC mice expressed 60% wild-type mouse RLC isoform and 40% of the human RLC isoform, where the N47K mice expressed 100% human RLC isoform in the heart. Using 11 transgenic mouse hearts (6 N47K and 5 WT-RLC) we homogenized the frozen cardiac tissue samples, and measured biochemical protein characteristics of these samples using SDS PAGE-BioRad mini TGX gel electrophoresis. The gels were then stained first with Pro-Q Diamond Phosphostain to investigate relative protein phosphorylation levels, and then with Sypro-Ruby stain to investigate relative protein content or expression. After, compiling the data and analyzing it, we found that there is little to no correlation between the amount of mutation and protein phosphorylation levels.

Poster # 2

Investigation of Sensitization Effect of Mobile Domain Peptide of cTnI on Cardiac Myofilament Calcium Sensitivity

Presented by: Samantha Morgan

Program: Engineering Tools for Disease Diagnostics and Treatment
Co-authors: Alexander Pettit Estell, Peter Awinda, Wenji Dong
Home Institution, Major, Class Standing: Georgia Institute of Technology, Chemical and Biomolecular Engineering, Senior

Since cardiac muscle contraction and relaxation are regulated by Ca^{2+}-binding to troponin complex (Tn), improving cardiac performance in response to heart failure by enhancing calcium sensitivity of the cardiac muscle has become a prospective drug target. Upon binding to Ca^{2+}, Tn, composed of troponin C (TnC), I (TnI), and T (TnT) proteins, exposes myosin binding sites on the actin, allowing for myosin-actin interaction to generate force. This force leads to the contractile movement of the heart to push blood through the circulatory system. Previous research has identified the mobile domain (MD) of TnI as the portion directly modulating Ca^{2+} sensitivity and thus an ideal site for intervention. This study seeks to demonstrate significant improvement in the calcium sensitivity of cardiac papillary fiber strips in the presence of a peptide of the MD via in vitro and in situ Ca^{2+} titrations.

In order to create a steady gradient of calcium concentration [Ca^{2+}], a gradient mixer was constructed off of a base machine, calibrated with a fluorescent dye experiment, and evaluated with a numerically developed design equation. A force transducer system was also calibrated to record fiber tensions as [Ca^{2+}] increases. Ultimately, a test peptide was incubated with skinned muscle fibers and exposed to calcium in a stepwise gradient. As research continues, peptides will be vetted and optimized and the tension recorded with the force transducer. These data will be used to derive information on the potential role of the MD in the >cardiac regulation, and whether the peptide can be used as a Ca^{2+} sensitizer for heart failure treatment.

Poster # 3

LSTMs for Indoor Sensor Prediction

Presented by: Meghna Dutta, Julianna Froderberg, Colin Warn

Program: Gerontechnology-focused Summer Undergraduate Research Experience (GSUR)

Co-authors: Aaron S. Crandall, Alireza Ghods

Home Institution, Major, Class Standing: Dutta: Pullman High School, N/A, N/A; Froderberg: Pullman High School, N/A, N/A; Warn: Washington State University, Mechanical Engineering, Junior

Predictive models that can forecast future indoor building status can help organizations cut costs, mitigate their carbon footprint, and more efficiently allocate resources. This study explores the efficacy of Long Short-Term Memory (LSTM) computing algorithms for forecasting daily indoor sensor values at several mixed use, high occupancy facilities.

The data was collected using the Smart Home in a Box system of sensors developed by the Center for Advanced Studies in Adaptive Systems at Washington State University. The facilities had the sensors installed for at least several months, and upwards of several years.

The LSTM algorithm from the Keras library of tools was trained on these sensor-derived data sets. The sensor data included temperature, light, and room usage. The algorithm is then able to predict the next day's average indoor temperature and room usage. Prediction results are quantified using RMSE, accuracy, precision, recall and F-1 scores. The results of this work indicate that an LSTM-based algorithm for indoor status prediction is a promising approach.

Poster # 4

Temperature and Oxygen Preference of the Intertidal Copepod Tigriopus californicus

Presented by: Elizabeth Moeser

Program: Marine Environmental Physiology

Co-authors: Khuong Van Dinh, W. Wesley Dowd

Home Institution, Major, Class Standing: University of Southern California, Environmental Studies, Senior

The copepod *Tigriopus californicus* occurs abundantly in tidepools along the rocky coastline where temperature and dissolved oxygen conditions are highly variable. These copepods frequently experience extreme temperature and oxygen conditions, with high temperature and high oxygen often occurring simultaneously. It is predicted that the frequency and severity of both extreme conditions will increase with ongoing climate change. While there is accumulating evidence of the physiological response of this species to extreme conditions, the behavioral responses to such conditions are not known. Specifically, it is unknown whether *T. californicus* will actively seek "comfort zones" of temperature and oxygen in heterogeneous habitats; alternatively, it also has been hypothesized that some invertebrates might benefit from periods of low oxygen. The present study aims to investigate how *T. californicus* respond to isolated and combined temperature and dissolved oxygen gradients. To accomplish this, copepod location preference was observed across four distinct gradients: (i) temperature gradient only, (ii) dissolved oxygen gradient only, (iii) high temperature and high dissolved oxygen to low temperature and low dissolved oxygen, and (iv) low temperature and high dissolved oxygen to high temperature and low dissolved oxygen. Preliminary trials ranging from 23-29°C and 80-160 torr, respectively, have shown that copepod position is predominantly determined by water temperature. The copepods preferred the cooler water temperatures irrespective of oxygen level. Ongoing work will extend the range of both gradients. It will be possible to determine whether there is an adaptive behavioral response to multiple stressors in *T. californicus.*

Poster # 5

An Ester Bond Containing Hempseed Oil Derived Epoxy for the Preparation of Room Temperature Curing Vitrimer Coating with Repairing and Removing Properties

Presented by: Anna Mikkelsen

Program: Bioplastics & Biocomposites
Co-authors: Jinwen Zhang, Tuan Liu, Shuai Zhang
Home Institution, Major, Class Standing: University of Minnesota, Biochemistry, Senior

Organic coatings are widely used in both domestic and industrial settings, providing protection and decorative applications. Although the conventional petroleum-based bisphenol-A epoxies (DER) show excellent properties in terms of adhesion, durability and chemical resistance, its irreversible covalent crosslinked networks does not allow for easy self-repairability and removability. To address this problem, the introduction of vitrimer chemistry, in which dynamic covalent linkages constitute the crosslinked network, is a promising approach to the typology reconstruct, realizing the self-repairability and removability of the epoxy coating. In this work, an ester bond-containing hempseed oil derived epoxy (HO-EP) was developed to partially alter DER in the room temperature curing with diethylenetriamine (DETA) and triethanolamine (TEA). After curing, the new HO-EP combined with DER showed a desirable glass transition temperature (T_g), surface hardness (i.g. gauge and pensile hardness) and adhesion ability. In addition, the self-reparability was stimulated at the elevated temperature (> 150 °C) *via* dynamic transesterification reactions (DTERs), which resulted in the repairing of the scratches on the coating surface. Furthermore, the removal of HO-EP/DER epoxy coating was also demonstrated with 1% NaOH solution in the room. This study has established HO-EP as an effective, greener alternative to conventional epoxy resin coatings which could largely extend the service life of epoxy resin coating, making the coating more sustainable and environmentally friendly.

Poster # 6

The Role of the Dorsal Hippocampus in Early Stage Memory Reconsolidation

Presented by: Christopher Ibarra

Program: Neurobiology of Drug Addiction
Co-authors: Shi Min Tan, Jobe Ritchie, Alexis Lacey, Jennifer Wong, Jessica Higgenbotham, Rita Fuchs
Home Institution, Major, Class Standing: Washington State University, Neuroscience, Senior

Drug addiction is a substantive dilemma in our current society. Drug relapse is a major issue that must be overcome in order for progress to be made. Our research aims to find the connection between the Dorsal Hippocampus (DH), a brain region involved in memory reformation, and drug relapse. Specifically, we tried to find when the DH is active in the process of reforming memories that are connected to a certain context (e.g. a box that has vanilla scent, a flashing light, a grated floor, etc.) Rats were given cocaine in a certain context (Context 1) for 10 days where their amount of cocaine seeking (how much they wanted cocaine) was measured by how often they pushed the lever that would give them cocaine through an IV. Rats were then put into a completely different context (Context 2) (e.g. pine scented, constant light, a barred floor) for 7 days. On *Reactivation* day, rats would be put back into context one for 15 minutes, then taken out and put into a light box. Here, they received a laser light directly into their DH, which activated a pre-implanted virus that then *d*eactivated the DH. After two more days of being in Context 2, rats were placed back into Context 1 on *Test* day, then sacrificed and their brains removed for imaging.

The purpose of *Test* and *Reactivation* days were to essentially jog the memory of the rat after being in Context 2. The light activation into the DH right after *Reactivation* meant that we were disrupting the brain region used for reforming memories right after the memory was reactivated. So, then on test day, you would expect a smaller amount of lever presses. We think right after *reactivation* is the time window within which the DH reforms memories related to drug use.

Poster # 7

Biofuel Curriculum and Education: Biofuel Lesson Implementation in Early Childhood and Elementary-Aged Students Aged 3-12

Presented by: April Stewart

Program: Northwest Advanced Renewables Alliance (NARA)

Co-authors: Shelley Pressley

Home Institution, Major, Class Standing: Washington State University, Elementary Education, Senior

Biofuels is a complex topic but can be taught to students of all ages. The use of biofuels in industry and personal life continue to increase, children must have a base understanding of and interaction with biofuels. Biofuel curriculum was implemented on students aged 3-12. aged 3-5 were provided literature about energy, discussed biofuels and energy, and did a biofuel craft. Students aged 6-12 conducted two experiments to introduce bioethanol and biodiesel creation, had discussions, were shown a biofuel video, and provided physical examples to observe. Students aged 10-12 conducted three experiments regarding biodiesel, bioethanol, and hot air balloons that are fueled with biofuels. Materials science experiments, a craft, literature, and gasoline and diesel for viewing. Students aged 3-5 stated that fire is an energy, drew many items interacting with fire, and experimented with energy creation. Students aged 6-12 experimented and discussed the creation of biofuel-based diesel, ethanol, and gasoline. Students 10-12 experimented and discussed the creation of vehicles that use biofuels. A foundation of biofuel understanding and manipulation can be successfully built at these young ages. Future work would include more literature on biofuels, increased use of visuals and technical terms, formal assessment, and repetition.

Poster # 8

Material Properties of Injection Molded Basalt/hemp Hybrid Fiber Reinforced Polypropylene

Presented by: Kyleigh Rhodes

Program: Bioplastics & Biocomposites

Co-authors: Bharath Nagaraja

Home Institution, Major, Class Standing: University of Michigan, Materials Science and Engineering, Senior

As consumers demand eco-friendly products, industries are working to develop materials that are more sustainable. Recyclable thermoplastic polymers are in increasing demand within the automotive industry, but alone lack the critical mechanical properties needed for parts such as bumpers and door panels. In order to increase these properties, fibers are added to reinforce the polymer, but must have a strong interfacial bond to take advantage of their full capacity. The material properties of basalt and hemp fiber reinforced polypropylene (PP) composites have been investigated with a focus on how the alteration of fiber composition and the addition of maleic anhydride grafted polypropylene (MAPP) will affect the properties. Recycling of the composites has also been simulated to determine how the properties will be affected when re-processed. Mechanical testing of the strength, modulus and ductility will be done to compare the variation within the ratios. Rheological behavior and dimensional stability will also be analyzed to observe the ease of manufacturability and impact of environmental degradation. These results will provide an insight into the influence of fiber ratio on the performance of the injection molded composite material for a desired application.

Poster # 9

Optical Imaging Approach to Understand Cannabis-Induced Feeding Behavior

Presented by: Cecilia Diaz Alonzo

Program: Gut-Brain Communication and Addictive Behavior

Co-authors: Emma Wheeler, Sumeen Gill, Julianna Brutman, Jon Davis

Home Institution, Major, Class Standing: Washington State University, Neuroscience, Senior

The use of cannabis for recreational and medicinal use has grown throughout the years with limited information known about how it functions in the brain. Although many states have legalized cannabis for both medicinal and recreational purposes, it is still considered illegal by the federal government. Cancer patients experiencing loss of appetite leads to an increase mortality rate from body wasting. In fact, over one-third of all cancer related deaths can be attributed to cachexia, or body wasting, not the cancer itself. For patients with chronic diseases, such as cachexia in cancer patients or AIDS, medical marijuana is prescribed to increase their appetite. Investigating further the impact that this schedule I drug has on the body and how it plays a role in appetite stimulation is important for opening up new avenues for treatment of chronic illnesses. Our lab used cannabis plant matter (CPM) employing a novel vapor chamber system to administer the cannabis through pulmonary route. This was crucial to our investigation since the majority of the clinical population administer cannabis via inhalation. Our preliminary results have indicated that exposing rats to vaporized CPM increases their feeding behavior after two hours. This change was accompanied by the observation of an increase in ghrelin, the only gastrointestinal (GI) hormone that stimulates feeding behavior. Specifically, we also observed rapid changes in the genetic landscape of the brain's appetite center, the hypothalamus, one hour after exposure, which may have reflected the increased desire to feed. After exposing rats to cannabis, we used *in vivo* calcium imaging techniques to characterize hypothalamic neural activity as mice feed. We hypothesized that exposure to vaporized CPM increases feeding behavior by promoting excitatory neurotransmission in the hypothalamus leading to increase appetite and feeding behavior.

Poster # 10

Improving the Accuracy and Analysis of the Digital Memory Notebook (DMN) Dashboard

Presented by: Michael Martin

Program: Undergraduate Research in Smart Environments

Co-authors: Larry Holder and Maureen Schmitter-Edgecombe

Home Institution, Major, Class Standing: Buena Vista University, Computer Science, Senior

The Digital Memory Notebook (DMN) is an iOS scheduling and journaling application used by participants with early onset Alzheimer's or cognitive impairment. The general purpose of DMN is to properly assist a participant's memory in relation to scheduled events or day to day activities. In order to accurately assess how participants utilize and benefit from the application, an easy to use, intuitive, and informative dashboard was created. This dashboard gives researchers on the DMN project a way to accurately view and evaluate their participants data. The dashboard also provides valuable insight to a participant's health, behavior, and cognitive ability to any caregiver that may be assisting participants. To accomplish this, multiple PHP scripts were created to access data and output specific variables in a meaningful way. JavaScript was also employed for the dashboards navigation and to display insightful graphs expressing different aspects of the participants actions. One of the goals of this project is to perform sentiment analysis with Python's Natural Language Processing on the participants textual data. The desired result is to use this analyzed text to predict participants overall happiness and give researchers another insight to a participant's actions. Here we will evaluate which model works the best for our data and how we can achieve the most accurate results. Once the algorithm is in place and data is processed, this day to day prediction will be added to the dashboard as an intuitive graph.

Poster # 11

Vibration Welding of Biocomposites

Presented by: Abib Hooker

Program: Bioplastics & Biocomposites

Co-authors: Curtis Covelli

Home Institution, Major, Class Standing: Saint Augustine's University, Chemistry, Senior

Vibration welding is a type of welding that uses frictional work to fuse two pieces of plastic together using pressure. Plastics are common in the automotive industry to replace heavy expensive metals. The most commonly used is glass-filled PP (Polypropylene). Materials used in this study were PLA (Polylactic Acid) and PBS (Polybutylene), PP, and rPP (recycled Polypropylene). PP was mixed with 20% AF (Agave Fiber) to make a bio-composite. PLA/PBS were mixed with AF to make a bio-composite which is biodegradable/compostable. In this research there were five formulations, rPP, PLA/PBS, PP, PP/AF, PLA/PBS/AF. An experimental factorial design with three different pressures, four different weld times, and four amplitudes was used. The formulations were extruded to have the same thermal histories. The plastic was then pelletized and placed in an oven to dry. To keep the same thermal histories the balance of the pellets that were not used were then extruded again. The first and second formulations were then chopped into pellets and then placed to dry. After drying for a period of time the pellets were then injection molded into dog bone samples. These samples were then cut in half and then vibration welded. The welded samples were then tensile tested to measure the maximum strength of the samples which ranged between 5-15 Mpa (Megapascals). The purpose of this research is to find the optimized weld parameters for maximum weld strength of bioplastic formulations.

Poster # 12

Advanced Oxidation of Hydrothermal Liquefaction Aqueous Effluent using Microscale Based Reactors and Characterization using High Pressure Liquid Chromatography

Presented by: Zachary Kowalewski

Program: Northwest Advanced Renewables Alliance (NARA)

Co-authors: Iva Tews, Manuel Garcia-Perez

Home Institution, Major, Class Standing: Carnegie Mellon University, Chemical Engineering, Junior

Wet oxidation is a process that allows for removal of organic pollutants from contaminated water effluents. In this process, oxygen is flowed through the effluent to oxidize the organic compounds into carbon dioxide and water. Such purification methods are crucial in processes such as hydrothermal liquefaction, where large volumes of dilute effluent are generated from biocrude oil production. Current research is focused on the catalysts available to improve the efficiency of oxidizing these organic molecules. However, at optimal oxidation rates with catalyst, most modern reactor designs are still limited by the diffusion rate of oxygen through the effluent. At small enough scales (<100 mm), diffusion limitations faced by traditional tube reactors can be minimized, improving the rate of oxidation by making the process reaction-rate limited instead of diffusion-rate limited. For this purpose, a modular microscale-based reactor was designed for removal of phenol from aqueous solution. A UV-C lamp is used to catalyze photolysis; solutions are run through the reactor at 20°C, 1 atm and with five, ten, and fifteen-minute residence times. A 1000 ppm phenol solution composed of phenol dissolved in water acts as a model contaminated effluent. In the second phase of this experiment, titanium dioxide will be deposited onto the reactor walls to aid in photocatalysis and the phenol conversion to CO_2 and H_2O. Samples are analyzed utilizing High Pressure Liquid Chromatography (HPLC) analysis to quantify the concentration of both phenol and oxidation intermediates, such as hydroquinone and catechol. From these concentrations, the extent of oxidation will be determined, and the effectiveness of the microreactor design and titanium dioxide catalyst will be concluded.

Poster # 13

Nutrition Monitoring

Presented by: Chantal Shine

Program: Undergraduate Research in Smart Environments

Co-authors: Alinia Parastoo, Niloofar Hezarjaribi

Home Institution, Major, Class Standing: University of North Carolina at Chapel Hill, Computer Science, Junior

The purpose of this research project is to find a user's eating habits over time. The goal of this project is whether the hypothesis--eating patterns change over time--is accurate or not. If eating patterns are consistent, then intelligent algorithms can predict what the user will eat next based on their diet history. This way, food logging applications like EZNutripal can eliminate consistent food recordings by the user. Two adults were asked to record their food intake in a notebook for four weeks. At the end of the four weeks, analyses were performed. Results from the study show a user’s eating patterns are consistent.

Poster # 14

Survey Data and Empatica E4 Wristwatch Help Show How Physiological Markers of Stress: Affect Alcohol Dependent Patients

Presented by: Esteban Espino

Program: Multidisciplinary Undergraduate Research Training in Wearable Computing
Co-authors: Ramesh Sah, Michael Cleveland, Hassan Ghasemzadeh
Home Institution, Major, Class Standing: Columbia Basin College, Electrical Engineering, Sophomore

The purpose of this research is to analyze data received from phone surveys and a wristwatch to discover how daily experiences of alcohol dependent patients coincide with stress. With the data analyzed from the surveys and sensors an algorithm will be built that will help predict periods of relapse risks. The phone survey asks people about alcohol, their moods, and stress during their day. The wristwatch known as the empathic E4 helps to provide information about the person like the person's heart rate, blood pressure, temperature, a 3-axis accelerometer, and an electrodermal activity (EDA) sensor that measures electrical properties of the skin. The survey responses will be transformed into binary for the computer to use in the algorithm for the long goal term. The sensor data will provide physiological data which will be visualized and analyzed. Using exploratory data analysis for the physiological data it will show causes and effects from the different data collected. When the data has been analyzed we will be able to predict how physiological markers of stress affect self-reported emotions and cravings for alcohol.

Poster # 15

Alcohol Relapse Prevention through Electrodermal Activity and Heart Rate Analysis

Presented by: Marco Arceo

Program: Gerontechnology-focused Summer Undergraduate Research Experience (GSUR)
Co-authors: Ramesh Sah, Hassan Ghasemzadeh, Michael Cleveland
Home Institution, Major, Class Standing: Washington State University, Computer Science, Senior

The world is consuming more alcohol and the number of people who are addicted to alcohol and wish to relinquish their drinking habits but ultimately relapse is increasing. Restraining from alcohol is the hardest task when recovering from alcoholism due to the psychological effects of alcohol abstinence. Cravings refer to the compulsion to drink alcohol during this process. Wearable technology like the Empatica E4 can be used to monitor physiological stress responses such as electrodermal activity (EDA) and heart rate (HR), among others. Acquiring the data from this wristband allows for an analysis that can be used to warn those abstaining from alcohol about potential relapse risk due to increased stress. This study was conducted with two participants who were given the responsibility of wearing an E4 wristband for two weeks. Their priority was to create event markers (TAG) by clicking on the wristband when they experienced moments of heightened stress. In addition to wearing the wristband, the participants were asked to answer a phone survey about cravings and emotions four times each day. The data from the E4 device were analyzed for quality and frequency in software such as MATLAB and EDA explorer to confirm the reliability and validity of the physiological measures. Our ultimate goal is to collect additional data to generate a better understanding of the correlation between physiological stress (e.g., EDA and HR) and alcohol cravings to assist in the prevention of relapse.

Poster # 16

In Vivo Analysis of Astaxanthin in Environmentally Stressed Tidepool Copepods Tigriopus californicus

Presented by: Asiamay Diaz

Program: Marine Environmental Physiology

Co-authors: W. Wesley Dowd

Home Institution, Major, Class Standing: Washington State University, Pre-Vet Zoology, Junior

Changes in the environment often prove stressful to organisms. This is difficult to quantify at a cellular level, especially when the animal is still alive. The main objective of this experiment is to understand how tidepool copepods (*Tigriopus californicus*) are affected cellularly from environmental stressors *in vivo* using microscopy techniques. Copepods have a reddish-brown pigment that provides physiological functions. The pigmentation arises from conversion of a chemical in the diet to astaxanthin; therefore, dietary levels of the precursor could be important in physiological performance. The pigmentation also is an antioxidant. Therefore, this molecule may function in other forms of realistic variation of environmental stressors. The goal of this project is to quantify astaxanthin and determine if the molecule is oxidized (responding to stress) in environmental scenarios. This would provide a non-lethal indicator of the animal's stress level. Confocal microscopes quantify these parameters by exciting the pigmentation at a specific wavelength and measuring accurately the time lag for the pigment to fluoresce. This technique is known as Fluorescence Lifetime Imaging Microscopy (FLIM). We will expose animals fed one of two diets - carotenoid-free (Instant Algae, Shellfish Diet 1800) or carotenoid-restored (TetraMin Tropical Flakes) - to specific stressors and observing which stressors induce a change in fluorescence. For each diet, the sample population will be split into three treatment groups. One group will be a control, the second will undergo temperature stress (heat baths), and the final group will undergo exposure to varying concentrations of hydrogen peroxide (H_2O_2), a reactive oxygen species. The expected results are the animals on the carotenoid-restored diet will show higher survivability coupled with higher levels of oxidized astaxanthin following stressful exposures. If successful, this tool could be used to repeatedly monitor biochemical stress levels in living copepods under a variety of conditions.

Poster # 17

DES Treatment of Corn Stover Hydrolysate for the Production of High Purity Lignin

Presented by: Alan Ramirez

Program: Bioplastics & Biocomposites

Co-authors: Xiao Zhang, Dylan Cronin

Home Institution, Major, Class Standing: University of California, Merced, Materials Science and Engineering, Senior

The world's dependence on petrochemical plastics is rapidly making the Earthuninhabitable. The production of alternative, biobased-plastics, from sustainable sources has thepotential to alleviate the negative environmental impact of our current industrial practices. Harvesting corn, the most highly produced agricultural material in the country, yields a major byproduct called corn stover. This material has the potential to be utilized in the emerging biorefinery industry, wherein it can be used as a biomass-to-ethanol feedstock via enzymatic hydrolysis and fermentation. In addition to ethanol, this process will also yield a hydrolysate rich in sugars, residual hemicellulose, and lignin. In this study, deep eutectic solvents (DES) were investigated for their ability to extract and partially depolymerize lignin from corn stover hydrolysate, yielding a high purity lignin appropriate for a range of bioplastic applications. DES composition, reaction time, temperature, and feedstock treatment were tested for their effects on lignin yield and purity. DES treatment of the hydrolysate yielded both lignin and a residual solid mixture composed predominantly of cellulose. Based on lignin yields at 90 °C, an increase in reaction time did not significantly increase lignin extraction. However, an increase in temperature to 150 °C as well as an increased reaction time had a positive influence on delignification rates. Under the most favorable conditions, a 35.9 wt% lignin yield was achieved from the dried hydrolysate feedstock. This study has contributed to the relatively new field of biomass treatment using DESs as viable green solvent alternatives to traditional lignocellulosic fractionation methods. The results of this work suggest that corn stover hydrolysate has the potential to be utilized as a feedstock for the production of high purity lignin, using a novel moderate-temperature DES treatment method.

Poster # 18

Characterization of Biomass-derived Pyrolytic Lignins for Downstream Upgrading

Presented by: Cullen Burke

Program: Northwest Advanced Renewables Alliance (NARA)

Co-authors: Evan Terrell, Manuel Garcia-Perez

Home Institution, Major, Class Standing: Willamette University, Environmental Science, Junior

The utilization of biomass-based pyrolysis oils, or bio-oils, presents an intriguing opportunity for society to potentially move away from fossil fuels to more renewable sources. For bio-oils to be converted into biofuels that are usable, various chemical components of bio-oils need to be managed, one of these components being pyrolytic lignin (PL). Due to the complex nature and structure of PL and many variations of different potential types of PL, analytical characterization is important. In order to characterize PL, extraction from bio-oil needs to occur first. By using two methods of extraction (cold-water precipitation and a centrifuge method), PL was successfully extracted and analyzed. Analysis was done on both samples of PL and two more technical lignins (kraft 3 and soda). Methods of analysis included thermal gravimetric analysis (TGA), Fourier transform infrared spectroscopy (FTIR), pyrolysis gas chromatography mass spectroscopy (Py-GC MS), elemental analysis, and ultra violet (UV) Fluorescence Spectroscopy. In analysis of both samples of PL, results indicate that the PL samples are similar in composition. Results also show that the technical lignins have key differences in structure and composition compared to both samples of PL because PL has gone through a pyrolysis reaction. In proximate analysis, both technical lignins have a higher fixed carbon content and lower percentage of volatiles than samples of PL. Despite extensive prior study, many factors regarding the nature PL are poorly understood. Research on how it works during bio-oil production, upgrading and/or valorization, and various methods of extracting it from bio-oils at an efficient rate will be an important step in the production of biofuels. The results of this experiment indicate that there isn't one correct way in which to extract PL from bio-oil, and further experimentation on methods in which PL can be extracted with greater efficiency can be explored in the future.

Poster # 19

Data-Driven Activity Step Segmentation with Change Point Detection

Presented by: Jovan Araiza, Stephanie Schoch

Program: Gerontechnology-focused Summer Undergraduate Research Experience (GSUR)
Co-authors: Jovan Araiza, Diane Cook
Home Institution, Major, Class Standing: Araiza: Washington State University, Computer Science, Senior; Schoch: University of Virginia, Computer Science, Post-Bac

Sensor technologies combined with machine learning and computer vision can be harnessed to improve quality of life for individuals with memory impairment. This project builds on ongoing work to monitor, track, and assist older adults with daily activities in their own homes. We propose a method based on unsupervised change point detection to automate segmentation of activity data into individual steps to later track and prompt. To implement and evaluate this method, 13 participants were recruited to perform 10 tasks in a smart environment. Video data and wearable data were collected for each participant during individual task completion. Optical flow algorithms and edge detectors were used to extract participant motion data from the collected video data. Similarly, statistical features were extracted to reflect participant movement from wearable accelerometer and gyroscope sensors. Results were generated for wearable data, video data, and the integration of wearable and video data. Evaluation methods include calculation of the geometric means and evaluation of the confusion matrices for each set of results, as well as survey questions to judge third party perception of video segmentation results.

Poster # 20

Development of At-Home Balance Control Assessment and Tracking Smartphone App for Pregnant Women

Presented by: Va Diep

Program: Multidisciplinary Undergraduate Research Training in Wearable Computing
Co-authors: Robert Catena, Mahdi Pedram, Hassan Ghasemzadeh
Home Institution, Major, Class Standing: Bellevue College, Computer Science, Sophomore

During pregnancy, several factors can be attributed to altering a person's ability to control their balance, thus increasing their risk of falling. Effective methods which include the use of motion capture systems and force plates have been developed to provide accurate and quantifiable assessments of changes in balance control. However, these methods are very limited in respect that such technology has not been broadly implemented for clinical uses, making it difficult for pregnant women to access these methods. The aim of this project is to develop a more accessible method for women and clinicians to detect balance control changes in the form of a mobile-based application to alert them of an increased risk of falling. Assessing balance control is done by using data derived from the accelerometer, gyroscope and magnetometer sensors inside of the mobile device. The data are collected from the sensors while the subject is performing one of two balance tests; the Balance Error Scoring System (BESS) or a simplified version that focuses on sensory integration aspects of the BESS test. Several variables including peak-to-peak (P2P), root mean square distance (RMS), and normalized path lengths are calculated from the data collected during each balance test. Future work will be to compare collected data to motion capture data. These comparisons will help locate correlations between the two types of data which will then be used to develop an algorithm to provide center of mass (COM) motion and individual balance assessment scores. The mobile application will notify the user of balance control changes and an increased risk of falling by comparing individual balance assessment scores over a time period while also having the ability to share quantifiable data for further research purposes and clinical uses.

Poster # 21

Protective Netting Conserves Water by Replacing Evaporative Cooling Used for Apple Sunburn Control in Washington State

Presented by: Antoinette Avorgbedor

Program: Sustainable High-value Horticulture & Processing Systems in Washington State
Co-authors: Lee Kalcsits, Sonia Hall
Home Institution, Major, Class Standing: Cornell University, Biological Engineering, Sophomore

The major apple growing regions in Washington State are Okanogan, Lake Chelan, Wenatchee Valley, Columbia Basin, and the Yakima Valley, making Washington State the largest producer of apples in the United States. However, apple sunburn is a disorder that affects about 10% of apples produced in the state, costing growers millions of dollars. Sunburn is exacerbated by high temperatures of up to 105°F, low rainfall, and high light intensity.

Existing measures and practices to reduce apple sunburn losses include evaporative cooling (EC), shade netting, and kaolin clay-based particle film. Particle films are problematic because they leave unattractive residue on apples, reducing marketability of these fruits. They also require reapplication during the season, as fruit surface area increases. Therefore, EC and shade nets remain more desirable options for sunburn control. The most efficient evaporative cooling system consumes an estimated $620m^3$ of water per acre annually. However, water supply for agriculture in Washington State is dependent on annually shifting climatic factors like precipitation, snowpack and snowmelt. Sufficient water availability during crucial parts of apple growing season could become problematic in the future.

Using 2019 data acquired from the Washington State University Sunrise Orchard, Rock Island, Washington, we sought to quantitatively compare the differences in daily fruit surface temperatures between apples growing under 20% shade nets and apples treated under EC systems. A decrease in fruit surface temperatures of up to 5°C occurred during the hottest parts of the day in apples under netting and EC, compared to apples growing in direct sunlight (controls). This temperature reduction is significant enough to completely prevent sunburn. Therefore, netting could serve as a beneficial alternative for reducing apple sunburn for areas where water conservation is of primary concern to apple producers. Progress continues, to quantify the amount of water conserved by replacing EC with shade netting.

Poster # 22

Performance Evaluation of Basalt/Hemp Fiber Thermoplastic Hybrid Composite

Presented by: Ian DeBois

Program: Bioplastics & Biocomposites

Co-authors: Bharath K. Nagaraja, Hasan Jani

Home Institution, Major, Class Standing: South Dakota School of Mines and Technology, Metallurgical Engineering, Senior

The performance of basalt/hemp hybrid composites is an area of interest for researchers due to biocomposites being an exceptional substitute to glass and carbon fiber composites. Furthermore, biocomposites can be economical, recyclable, and renewable which is considered advantageous in comparison to glass and carbon fiber. The principle objective of this project is to evaluate the mechanical and physical performance of a hybrid composite of basalt and hemp fibers injected with a thermoplastic resin utilizing vacuum assisted resin transfer molding (VARTM). Elium^{Ò} is vitrimer that behaves as a thermoset but provides the properties of a thermoplastic resin. In this experiment, five different hybrid composites were produced to analyze the effect of stacking sequences on strength, toughness, and stiffness as well as dimensional stability. VARTM is an alternative processing method to resin transfer molding (RTM) which utilizes vacuum conditions to enable resin to flow into single or stacked plies of fabric to create a hybrid thermoplastic composite. VARTM molding is commonly used in automotive, aerospace, and industrial applications to produce composites due to its ability to produce a variety of simple and complex parts at low cost compared to other manufacturing methods such as autoclaves.

Poster # 23

Extraction and Characterization of Nanocellulose from Post-consumer Denim Jeans (Part 1)

Presented by: Dana Van Fossen

Program: Northwest Advanced Renewables Alliance (NARA)

Co-authors: Joshua Blair, Tuhua Zhong, Hang Liu

Home Institution, Major, Class Standing: Rowan University, Biomedical Engineering, Junior

Cellulose is a naturally-produced biopolymer that is abundant and readily available from wood, cotton, *etc*. Being able to extract cellulose on the nanoscale and/or re-use cellulose from post-consumer cotton waste is ideal for both humans and the environment alike as consumption and disposal rates continue to rise. Disposal of these products causes discharge of undesirable chemicals, greenhouse gases, and the leaching of toxins (dyes) into the surrounding soil and water. In this study, the objective was to first extract nanocellulose from indigo-dyed denim jeans and compare the material properties found in the denim to those from wood-based products made commercially. Subsequently, we attempted to re-generate cellulose fibers from post-consumer cotton T-shirts, in the meanwhile, used nanocellulose as a reinforcement to create a recycled composite material that had the right material properties to be used for other applications. To do this, sulfuric acid hydrolysis and 2,2,6,6-tetramethylpiperidine 1-oxyl (TEMPO)-mediated oxidation method were applied for nanocellulose production. The material properties of the resulting nanocellulose were characterized by transmission electron microscopy, zeta potential measurement, X-ray diffraction, Fourier transform infrared spectroscopy, and thermogravimetric analysis for structural, chemical, and thermal properties. Nanocellulose was then incorporated into cotton waste solutions and spun into fibers using a wet spinning technique. The fibers were wound on rotating tubes to neatly collect the strands. The material properties of these fibers were then tested, such as tensile strength, thermal stability, microstructures, and crystallinity. Comparisons were made between various solutions with varying nanocellulose contents and were evaluated based on the most desirable material properties suitable for reusability in industry.

Poster # 24

Testing the Efficacy of Eco-friendly Cleaners against Escherichia Coli and Listeria Innocua on Household Surfaces

Presented by: Mai Nguyen

Program: Sustainable High-value Horticulture & Processing Systems in Washington State
Co-authors: Aleksandra Checinska Sielaff, Stephanie Smith
Home Institution, Major, Class Standing: University of Arizona, Microbiology and Food Safety, Senior

Consumers are becoming more aware of what chemicals are being used in many of their household cleaning products. Many brands have developed alternative cleaners that do not contain environmentally-damaging chemicals. However, the efficacy of these eco-friendly cleaners has not been fully researched against foodborne pathogens. In this study we looked at a total of nine different cleaners; two were used as controls (5% distilled white vinegar and 0.6% bleach). To test each cleaner's efficacy, test surfaces were first measured and marked into 10x10 cm and then autoclaved. *Escherichia coli* ATCC 25955 was used as an inoculum for testing. A suspension of cells in 0.85% NaCl was applied to each square and dried for 100 minutes. The cleaner sample was where the cleaner was sprayed for a total of six times- three vertically and three horizontally. There was a total of three replicates for each variable. Each square was then swabbed immediately with a sterile cotton swab pre-moistened with sterile DE neutralizing broth, the swab was then returned to a tube of DE neutralizing broth. Serial dilutions were performed until 10^{-3} and plated onto appropriate media. Resulting colonies were counted the next day. Overall data shows for *E. coli* ATCC 25922 on plastic cutting boards, many of the cleaners are able to significantly reduce the number of colony forming units (CFU). Only a few of cleaners showed slight decrease or an increase of CFU number after application. The next step is to test *Listeria innocua* ATCC 51742 on plastic cutting boards. The results of this study show that some of the eco-friendly cleaners can lower the microbial load on household surfaces, although they are only meant to remove dirt and grease. Consumers should be aware that some cleaners support removal of bacteria, but they still need to perform sanitation after cleaning.

Poster # 25

Detecting Erroneous Entities in Attributed Graphs with a Graph Neural Network

Presented by: Nathaniel Sprecher

Program: Undergraduate Research in Smart Environments

Co-authors: Sheng Guan, Dr. Yinghui Wu

Home Institution, Major, Class Standing: Grove City College, Computer Science, Senior

Graph data has been widely adopted to model networks of richly attributed entities in the modern Big Data era. As such, there is a vested interest in enforcing and ensuring correct attribute values of the entities in these networks. Deep neural networks have attracted much attention for detecting errors in relational data, yet little has been done to detect errors in more involved graph data. This project aims to exploit the emerging Graph Neural Network (GNN) model to detect whether an entity contains incorrect attribute values. GraphSAGE—a state-of-the-art supervised and unsupervised machine learning algorithm—makes several key advancements on the Graph Convolutional Network (GCN), which is, itself, a successor to the basic GNN. We implemented GraphSAGE-based learning and inference algorithms to classify nodes as either containing entirely accurate (clean) attributes or as containing erroneous (dirty) attributes. We performed a set of benchmark tests on GraphSAGE, using two citation networks as testing datasets. We found that GraphSAGE is capable of predicting dirty nodes with high precision and recall, but only when given access to a large percentage of the training dataset. Furthermore, rates of node and node-attribute pollution are highly correlative to GraphSAGE's success. For one of the two datasets, precision and recall range from 1.0 for both, to 0.27 and 0.25, respectively. The independent variables, in this case, are the node pollution rate—ranging from 20% to 5%—and the attribute pollution rate—ranging from 8% to 1%. We intend to investigate a more specialized GCN's ability to more accurately predict errors in graph attributes in future steps.

Poster # 26

Mycelium-Based Lightweight Foam from Spent Distiller Grains from Whiskey Industry

Presented by: Rogine Gomez

Program: Bioplastics & Biocomposites

Co-authors: Hui Li, Karl Englund

Home Institution, Major, Class Standing: California State Polytechnic University, Pomona, Chemical Engineering, Junior

Synthetic plastics are known for their durable and lasting properties, ability to be formed and shaped for various applications, and cost-efficient methods of manufacturing. However, forty-two percent of plastics produced in the United States are for disposable packaging applications, which produces a tremendous amount of waste that negatively impacts the environment. There is an urgent need for a biodegradable material that can be utilized as an alternative to traditional packaging but also maintains the desirable properties of plastics. This current investigation focused on the fabrication of purely natural, lightweight mycelium-based foam from three streams of Spend Distiller Grains (SDG) from whiskey distilleries. SDG is a cereal byproduct from the liquor industries, and its abundance, biodegradability, low cost, and an excellent source of nutrients for the mycelium make it a desirable substrate for this application. Using agricultural fiber as the base mycelium media, SDG was added at weight fractions of 25%, 50%, and 75% to observe the changes in the properties of the final product. The fabricated foams will be characterized in terms of physical properties through density and water absorption measurements, and mechanical properties through compression performance.

Poster # 27

Initial Prototype Development of a Novel Catheter Navigation System for Endovascular Medical Procedures

Presented by: Collin Kummer, Joseph Summers

Program: Multidisciplinary Undergraduate Research Training in Wearable Computing
Co-authors: Collin Kummer, Chung-Ching Lin, Stephen Seslar, Wayne Monsky, Larry Holder, Hassan Ghasemzadeh, Subhanshu Gupta,
Home Institution, Major, Class Standing: Kummer: Washington State University, Computer Engineering, Senior; Summers: Washington State University, Electrical Engineering, Senior

Minimally invasive catheter-based endovascular and intracardiac procedures play an increasingly critical role in modern clinical treatment. The development of a submillimeter wireless tracking system that can be adapted to aftermarket instruments could transform endovascular procedures. Here, we are pursuing and verifying two strategies using commercial products. First, energizing a moving device using ultrasound-based wireless power transfer. The advantage of ultrasound over other methods is that the acoustic waves penetrate longer distances in the body with lower attenuation and achieve larger allowable density. Second, a time-difference-of-arrival (TDOA) for millimeter-scale localization is also investigated. By combining both power transfer and localization under ultrasonic wave propagation, the overall system is less complex and more robust. The localization of the object is accomplished using Texas Instruments BOOSTXL-PGA460 and MSP-EXP430F5529LP evaluation modules. The modules are connected on a one-wire UART bus and each PGA460 board obtains time-of-flight data using a Murata MA58MF14-7N transducer operating in a medium of room-temperature air. The object's position is determined using TDOA method which uses the difference in time-of-flight data from each receiver and known receiver locations to estimate the position of the object. The ability to accurately model the effects of transducer position, size, and frequency is crucial to verification of measured results. The k-Wave Matlab toolbox is used to model the ultrasonic transducers in the far field using a generalized form of the Westervelt equation. Physical measurements are taken with two Tektronix TDS-3014 oscilloscopes and a Tektronix TM504 function generator. Distance is measured by using the 2-mm pitch of a bread-board to maintain consistent spacing with each transducer mounted on a proto-board. A Murata MA40S4S is used as the transmitter and a Kobitone 255-400SR16-ROX as the receiver. Based on preliminary results from modeling and TDOA measurements, we will be refining the design to increase accuracy and efficiency.

Poster # 28

Improving Monitoring Techniques for an Economically Important Legume Pest

Presented by: Peter Schultheis

Program: Sustainable High-value Horticulture & Processing Systems in Washington State

Co-authors: Robert Clark, David Crowder

Home Institution, Major, Class Standing: Washington State University, Agriculture Technology and Management, Junior

Pea aphids are an economically important crop pest in the Palouse agricultural system, and are thus monitored with a variety of passive collection techniques. Pan-traps filled with propylene glycol are typically used to collect aphids at regular intervals in a fixed location. We examined two ways to improve collections: first examining a series of propylene glycol and water dilutions (75%, 50%, and 25%) and second, using live hosts (e.g. sentinel plants) in bucket-style cages. The dilution assay was visited once every four days and measured from the bottom of the dish to the level of the dilution. This data was recorded for four weeks which resulted in seven data collections. Even at the lowest dilution (25%) the pan traps remained functional, but 50% dilutions lasted significantly longer. After planting peas and vetch into the sentinel buckets, we recorded the time that the two host-plants could persist without needing supplemental water. The pea and vetch persisted for over a month without needing additional water, demonstrating that this can be an effective long-term method for aphid collection and observation. These two improvements should help with the effectiveness of pest aphid monitoring.

Poster # 29

Flexible Polyurethane Foam Production with Deep Eutectic Solvent Lignin as a Partial Substitution of Polyol Component

Presented by: Thomas Ekstrom

Program: Bioplastics & Biocomposites

Co-authors: Amir Ameli, Dylan Cronin, Corey Crocker

Home Institution, Major, Class Standing: Seattle University, Mechanical Engineering, Senior

Polyurethane (PU) foam is a commodity material produced in high volume for numerous applications, most notably the furniture and automotive industries. The current industry standard for PU production is entirely dependent on petrochemical feedstocks for the supply of the major polyol and isocyanate components. This work investigates the substitution of up to 30 wt% of the polyol component of PU foams with lignin. By producing PU foam in this alternative manner, the dependence on non-sustainable feedstocks is reduced, whilst yielding a product that may exhibit enhanced physiochemical properties such as biodegradability and ultraviolet light stability. Lignin was pursued as a replacement for polyol because of its high hydroxyl content, which act as the bonding site for the urethane linkage. Lignin is the second most abundant natural polymer on Earth and is currently produced in vast quantities as a waste product of the pulp and paper industry. This makes lignin an attractive option economically for industrial applications. In this work, lignin prepared through a deep eutectic process was partially substituted for the polyol in a common commercial flexible polyurethane formulation in a range of ways. Dry lignin powder was introduced as a drop-in alternative and via heat-treatment with the standard polyol. It was found that using either approach resulted in a highly rigid foam for lignin substitutions of only 10 wt%. To resolve this issue, alternative lignin samples were prepared via oxypropylation derivatization. This process had a plasticizing effect on the lignin, allowing for the production of PU foams of higher lignin concentrations. Lignin substitutions of up to 30 wt% of the polyol fraction were achieved whilst maintaining similar mechanical properties to the industry standard foam composition. This work suggests potential application of lignin in PU foam production.

Poster # 30

Biobased ABS

Presented by: Liam Herbst

Program: Bioplastics & Biocomposites

Co-authors: Dr. Eric Cochran, Baker Kuehl, Michael Forrester

Home Institution, Major, Class Standing: Iowa State University, Chemical Engineering, Sophomore

Poly(L-lactide) (PLLA) is a biodegradable polymer that demonstrates high strength. However, PLLA is very brittle and unsuitable for high impact strength applications unlike petroleum-based plastics such as ABS (Acrylonitrile Butadiene Styrene). In order to compensate for these undesirable traits, poly(n-butyl acrylate) (PNBA), a rubbery phase, can be blended into the PLLA matrix in order to increase the elongation of PLLA. As a general rule, polymers are immiscible so a compatibilizer must be used to increase the interfacial adhesion, the adhesion where the interfaces between the phases or components are maintained by intermolecular forces, chain entanglements, or both, across the interfaces, of the rigid matrix with the rubbery dispersed phase. A diblock copolymer of PLLA-b-PNBA can be synthesized to increase the miscibility of the PLLA and PNBA homopolymers by promoting self-assembly inside of the PLLA matrix. If all goes ideally, the PLLA-b-PNBA will microphase separate into cylindrical micelles providing improved impact resistance and elongation. We demonstrate this toughening effect via transmission electron microscopy (TEM), small-angle X-ray scattering (SAXS), and mechanical impact testing. This method of toughening provides insight into a scalable technique for toughening brittle engineering thermoplastics.

Poster # 31

Comparison of Methods for Detection of Atrazine in Spiked Samples

Presented by: Elisa Jensen

Program: Engineering Tools for Disease Diagnostics and Treatment

Co-authors: Eunice Kwon, Xiaofan Ruan, Fei Yu, Dan Du, Bernard Van Wie

Home Institution, Major, Class Standing: University of Illinois at Urbana-Champaign, Bioengineering, Junior

Atrazine (Atz) is one of the most widely used herbicides globally. Due to its high solubility in water, Atz is a significant pollutant, able to remain in soil and groundwater for up to a year. Furthermore, Atz is a known cause of several environmental and health problems, and the Environmental Protection Agency has issued warnings about its toxicity in animals and humans. It follows that developing methods for accurate, efficient detection of Atz in a Point-of-Care setting is crucial, and in this study several methods were compared. The Enzyme-Linked Immunosorbent Assay (ELISA) and Lateral Flow Immunoassay (LFIA) measure a molecule's presence based on the immunoreaction between antigen and antibody and are used extensively for their high sensitivity. However, ELISA relies on a secondary antibody conjugated to an enzyme for indirect detection of the analyte of interest. Our newly developed Nanoparticle-Linked Immunosorbent Assay (NLISA) method replaces enzyme-coupling dependency with an antibody-conjugated nanoparticle with higher stability and catalytic activity for more direct assessment, saving up to 0.5 -1 hour over conventional ELISA testing. Meanwhile, the LFIA test strips are a paper-based assay that can detect the analyte rapidly in one step. Both NLISA and LFIA provide a cheaper alternative to instrumental assays like High-Performance Liquid Chromatography (HPLC) which require complex sample pretreatment and involve expensive machinery operated by a professional. However, while the materials and procedure used for NLISA and LFIA were much simpler and could theoretically make screening many samples more efficient, these experiments did not manage to obtain quantitative data confirming the trends of previous studies. On the other hand, a standard curve was made through HPLC and used to detect Atz in real berry samples. In the future, more studies are needed to formulate improved, cheaper, simplified testing methods so that Atz can be detected at the Point-of-Care setting.

Poster # 32

Engineering Solutions to Problems in Wearable Computing

Presented by: Reece Keller

Program: Multidisciplinary Undergraduate Research Training in Wearable Computing
Co-authors: Marcus Blaisdell
Home Institution, Major, Class Standing: Seattle University, Electrical Engineering/Physics, Freshman

Our laboratory explores applications of wearable computing to compassionate and smart spaces, combining innovation and research from the fields of electrical engineering, physics, computer science, and architecture. I contribute electrical and technical expertise to the various problems that our research in wearable computing has instigated. One such problem is data collection; part of what our computer science team is developing is a machine learning algorithm (ML) that can both detect and predict the emotional and comfort state of an individual given certain biometric information, but this type of algorithm depends on a tremendous amount of training data used to *teach* the computer what emotion and comfort are in the language of biometrics. For the comfort aspect, I designed a portable temperature and humidity recording device to be used in conjunction with an Empatica E4 biometric wristband in order to correlate biometric data with two significant factors that affect an individual's level of comfort - the temperature and humidity of the surrounding environment. This data will be used to train the ML algorithm to assess comfort factors of a large group of individuals to make changes to an environment to better serve the needs of that group, such as changing the ventilation of the room or adjusting the light intensity the area is subject to. In the process, I am contributing electrical work to an energy optimizing custom ventilation system that will be paired with the ML program to produce a final, responsive and interactive prototype. This research has noteworthy applications to spaces occupied by large amounts of people, such as offices and hospitals. Our engineering solutions will both optimize comfort and energy consumption in a seamless and personalized fashion through the use of individual biometric data to help create sustainable and compassionate spaces for humans.

Poster # 33

The Application of Deep Learning Methods to Epigenomic Data

Presented by: Stephen Iezzi

Program: Undergraduate Research in Smart Environments

Co-authors: Pegah Mavaie

Home Institution, Major, Class Standing: The New Jersey Institute of Technology, Computer Science, Senior

Epigenetics is the study of heritable changes in organisms caused by the modification of gene expression rather than the alteration of the genetic code itself. Currently, there seems to be three main factors responsible for epigenetic changes: DNA methylation, histone modification, and non-coding RNA. In this paper we focus exclusively on DNA methylation and how deep learning can be used to classify methylated DNA regions (DMR) and non-methylated DNA regions (NDMR). The purpose of our research is to determine the most effective deep learning architectures for detecting DMR and NDMR regions in order to discover adverse clinical outcomes relating to an individual. Successfully identifying these regions can be used to determine whether an individual is more susceptible to certain types of cancer, whether their child has an increased chance of having a birth defect, and if the individual is at higher risk of having certain allergies.

Poster # 34

Analysis of a Novel Regulator of Plant Cell Division, MACET4

Presented by: Joshua Storey

Program: Plant Cell Biology and Biochemistry

Co-authors: Breanne Searing, Tara Goble, Sharol Schmidt, Andrei Smertenko

Home Institution, Major, Class Standing: Lewis-Clark State College, Biology, Junior

Plant cell division is facilitated by a specialized structure called the phragmoplast. The function and structure of the phragmoplast depend on microtubules. Microtubules are constructed of stable α- and β-tubulin heterodimers that form a cylindrical and highly dynamic filament that measures approximately 25nm in diameter. Although microtubules are known to be indispensable for cell division, how exactly they make up and maintain the phragmoplast structure remains poorly understood. Our research focuses on a microtubule nucleating protein that localizes in the phragmoplast known as MACET4. The aim of my project is to determine how MACET4 promotes microtubule nucleation. MACET4 primary structure has three evolutionarily conserved domains: I, II, and III. To determine functional importance of each domain for microtubule nucleation, we nucleated microtubules under the influence of different domains, measured the lengths of the produced microtubules, and counted the number of microtubule nucleation cores inside of the given field of view. Also, we measured microtubule dynamics inside of tobacco tissue culture cells (line BY-2) that were transiently transfected with different fragments of MACET4 fused to GFP. We have found that MACET4 fragments containing domains II and III are capable of microtubule nucleation, whereas domain II alone could bind microtubules but lacked any nucleation activity. Thus, it appears that the conserved domains are dependent on each other. Through the rest of my project I will continue research on the role of MACET4 conserved domains in microtubule binding and microtubule nucleation.

Poster # 35

Cluster Modelling of Small Grain Supply Chains: Analysis of the Cascadia Grains Conference

Presented by: Kelvin Dam

Program: Sustainable High-value Horticulture & Processing Systems in Washington State

Co-authors: Laura Lewis, Aba Kiser

Home Institution, Major, Class Standing: The University of Alabama, Food and Nutrition, Senior

The prolific production of small grains crops in the Pacific Northwest contributes to the competitiveness of the agricultural sector and the viability of food systems in the region. The Cascadia Grains Conference (CGC) is an annual conference to promote and support the regional grain economy in the establishment of a collaborative network of stakeholders within the craft brewing and distilling industry. However, there are disconnects across the value chain between regional and localized production of grain and production of craft beer and distilled spirits that contain grain.

The goal of the study is to identify, describe, and analyze industry clusters or groupings according to shared characteristics. Data was collected and analyzed from stakeholders attending CGC through an online questionnaire and post-conference surveys from 2013-2019. The method employed is multivariate statistical techniques and cluster analysis (CA) for insight on delineation (segmentation) and characterization of stakeholders based on preference, capacity, and geodemographic information.

The study of these clusters may facilitate the coordination of activities for a differentiated the approach in addressing disconnects between the large-scale agricultural production and the smaller scale craft grains. Assessing patterns and predicting trends among stakeholders can align region-specific activities based on the heterogeneous profile of clusters.

Further investigation of industry cluster formation and their relationship in surrounding food system related to regional grain economies may improve the understanding of CGC stakeholders. The methodologies applied are used as decision support tools and could be employed by research and extension agencies for coordinating activities related to production systems and creating value. Application of the study helps to characterize production chains for localizing market segments, establishing policy, and improving cost efficiency or outreach/resource efficacy towards value maximization.

Poster # 36

Investigations of Chondrocytes' Nutraceutical Intake and the Effect of Ascorbic Acid on 2D and 3D Culture

Presented by: Omozusi Guobadia

Program: Engineering Tools for Disease Diagnostics and Treatment

Co-authors: Terreill Robertson, Olivia Reynolds, Haneen Abusharkh, Bernard Van Wie, Juana Mendenhall

Home Institution, Major, Class Standing: Morehouse College, Biology/Spanish, Senior

As one of the most common types of arthritis, osteoarthritis is a chronic disease that leads to a degradation of the surrounding cartilage tissue in a given joint. Typically affecting areas such as the knees, hips, and spine, the lack of protection between the joints can lead to stiffness, inflammation, and a lack of mobility. Since there is currently not yet a cure for the disease, treatment plans involve physical therapy, medication, use of supportive devices, and even surgical replacement of the entire knee. Despite these solutions, the need for more effective treatment options is of growing concern and current research is centered on innovative solutions by means of tissue engineering. Injured cartilage tissue leads to early induced apoptosis, swelling, and inflammation as well as proliferation of reactive oxygen species known as free radicals that further damage the tissue. Therefore, the following experiment focuses on studying the effect of nutraceuticals on inflamed chondrocytes as free radical scavengers. It is hypothesized that by incorporating nutraceuticals in the hydrogel scaffold, the hypoxic physiological environment can be neutralized leading the chondrocytes to regenerate.

Chondrocytes were isolated from bovine (bACh) samples and placed into two groups: one 2D micromass group in static culture and one 3D hydrogel group. These groups were further separated into five sections: positive control (PC) and negative control (NC) which were composed of healthy and inflamed chondrocytes, respectively, as well as groups with inflamed chondrocytes and 500 mM, 100 mM, or 10 mM ascorbic acid added to the culture media. Measurements of nitric oxide (NOS) were taking before and after the addition of the nutraceutical. Upon conclusion, the concentration of DNA, collagen, and glycosaminoglycans will be measured to test cell health and production of extracellular matrix components.

Poster # 37

Medication Routine Effectiveness in Community Dwelling Older Adults

Presented by: Sarah Norman

Program: Gerontechnology-focused Summer Undergraduate Research Experience (GSUR)
Co-authors: Catherine Sumida, Alyssa Weakley, Sarah Farias, Maureen Schmitter-Edgecombe
Home Institution, Major, Class Standing: Washington State University, Psychology, Senior

With 40% of the aging population managing 5 or more medications, it is the largest prescription medication consumer base. However, there is a knowledge gap for how older adults manage their medications in real-world environments and how compensatory strategies may affect everyday functioning. Therefore, we aim to develop a measure of real-world medication management and routine efficiency, by examining archival videos of community dwelling older adults, who were instructed to demonstrate and describe their medication routine. The videos were examined to identify complexity (i.e., additional unnecessary actions the participant added to their routine) and 2) compensatory strategies (i.e., aids to assist in medication adherence). Our efficiency score is a sum of the degree of complexity (i.e., each additional action assigned a negative point) and self-reported compensatory strategies (i.e., assigned positive points). Correlations will be used to examine relationships between the efficiency score and 1) neuropsychological measures (i.e., processing speed, attention, and long list delay recall), 2) self-reported memory problems (i.e., Prospective and Retrospective Memory Questionnaire, PRMQ) and 3) the Medication Management Abilities Assessment (MMAA). To test the new measure against a previously established medication regimen complexity measure, we will conduct a correlation between the efficiency score and the Medication Regimen Complexity Index (MRCI). Based on prior research, we hypothesize that participants who self-report memory problems on the PRMQ (i.e., despite their cognitive results) will have more efficient medication routines and will report using more compensatory strategies. We hypothesize that the efficiency scores will correspond to MMAA performances, due to both measures assessing medication management skills. We hypothesize that the efficiency score will not significantly predict MRCI. This research may improve our understanding of the complex relationships that make up real-world medication routine efficiency.

Poster # 38

Unsaturated Diacids for the Synthesis of Bio-Enhanced Nylon 6,6

Presented by: Peter Meyer

Program: Bioplastics & Biocomposites

Co-authors: Dr. Eric Cochran, Dr. Michael J Forrester

Home Institution, Major, Class Standing: Colorado State University, Chemical and Biological Engineering, Senior

Commercial nylon (nylon 6,6) is an important engineering and consumer thermoplastic used in a wide array of industries, from automotive to fabrics.The large range of applications are a result of nylon's strength and resistance to both heat and solvents. Currently, commercial nylon 6,6 is formed from petrochemical-derived monomers of hexamethelenediamine (HMDA) and adipic acid through a polycondensation reaction. Nylon's flaw is its tendency to absorb water, which negatively impacts the mechanical properties of nylon. This project aimed to introduce a biobased 16-carbon unsaturated nylon monomer with the intent of providing an active site for further chemistry. This provides significant opportunity to tune a variety of properties such as hydrophobicity, flame retardance, and cross-linkability or branching. C16:1 diester was obtained from a fatty-acid mixture through chromatography of a crude C16:1 monoester, w-OH ester, and diester. The diester was then hydrolyzed and reacted with HMDA to form a nylon diacid salt. Three blends of 5, 10, and 20 percent C16:1 salts, were melt state polymerized with nylon 6,6 salts. These polymers then underwent a solid state polymerization to increase the molecular weight. Finally, the material was extruded and injection molded into dog bones used for Instron testing. The results indicated that C16:1 nylon significantly increased the elasticity of nylon 6,6 without compromising its strength. A major obstacle is oxidation during processing of the nylon due to the presence of the unsaturate. This oxidation caused mechanical failure during Instron testing. Future research should identify if the longer chains promote hydrophobicity and explore alternate experimental methods to insure the nylon remains in an unoxidized state during processing.

Poster # 39

Dynamic and Therapeutic Modifications of Physical Spaces in Response to Real-Time Emotion Classification with Deep Learning LSTM on Raw EEG Data

Presented by: Alex Trevithick

Program: Multidisciplinary Undergraduate Research Training in Wearable Computing
Co-authors: Mona Ghandi, Salikh Bagaveyev, Marcus Blaisdell, Reece Keller
Home Institution, Major, Class Standing: Williams College, Computer Science/Math, Junior

We implement a deep learning model to classify emotions in real-time based upon EEG data. Training data was collected as raw EEG readings representing five-second windows from an 8-channel OpenBCI helmet. These readings were labeled with ground truth self-classification from participants, who were given a choice of seven emotions: angry, stressed, disgusted, happy, sad, no emotion, and scared. Two long short-term memory (LSTM) layers from Tensorflow constituted the model, which had timesteps equal to ten meaning that time sequences were classified in groups of ten. Utilizing this real-time emotional classification, we train another deep learning model to automatically modify a physical structure, a 9-vent grid model, which dynamically opens and closes in response to participants' current EEG and emotional classification, and the time of day. We collect training data by appending half a second of a participant's EEG data, a seven-dimensional vector representing their emotional state from the aforementioned model, and the hour and minute of the day, and label this data with the ground truth from the user in the form of a nine-dimensional vector representing their current preferred grid configuration. This implementation was individualized for each participant of the project, providing more accurate and individualized physical configurations as participants gave more data.

Poster # 40

Phenotypic Effects of Various Rhizobia Strains on the Biomass Allocation of Trifolium Barbigerum

Presented by: Natalie Sanchez

Program: Ecology and Evolution of Plant-Microbe Symbioses

Co-authors: Brett Younginger, Chandra Jack, Maren Friesen, Renee Petipas

Home Institution, Major, Class Standing: Washington State University, Biochemistry, Senior

Leguminous plants such as the *Trifolium* species are able to form nodules with symbiotic bacteria called rhizobia. Rhizobia are best known for their ability to convert N2 gas from the air into NH4+, a form that plants can use, in a process called nitrogen fixation. Sufficient nitrogen levels in the soil are vital to plant success and nitrogen fixing bacteria are able to raise those levels. In addition to delivering more nitrogen to the host, rhizobia can also influence plant fitness through a diverse range of effects such as altering the root and shoot biomass allocation. In this experiment, 1200 *Trifolium barbigerum* plants were inoculated with one of 80 different strains of rhizobia. Several plant phenotypic measurements were taken, including the shoot and root dry mass, from which the shoot to root ratio was calculated. A few strains appear to have induced greater than average growth in their hosts and further analysis will show the significance of this difference. Analysis of the data will also reveal which strains had the greatest effect on the allocation of resources to the above ground or below ground portions of the plants. In environments where herbivory is a large problem, rhizobia that increase the shoot to root ratio would be advantageous. However, a greater allocation of biomass to the roots would be beneficial in arid environments where a larger root mass is valuable. One of the goals of this project is to assess the ability of different strains to increase the fitness of their host so that further studies can explore how plants choose which rhizobia to partner with.

Poster # 41

LIDS

Presented by: Sean Luchessa

Program: Multidisciplinary Undergraduate Research Training in Wearable Computing

Co-authors: Mahdi Pedram

Home Institution, Major, Class Standing: Washington State University, Computer Science, Senior

It is important to stay hydrated but it can be difficult to keep track of liquid and even caloric intake which is important to maintain good health. Currently there is no technology that keeps track of liquid and caloric intake automatically. Liquid Intake Detection System (LIDS) aims to solve this issue. LIDS is built using multiple sensors, including an accelerometer used to detect when a user is filling their bottle or taking a drink, an ultrasonic sensor to detect the volume of the liquid, a temperature sensor, and an RGB sensor used to detect the color of the liquid which ultimately detects liquid type. The system uses machine learning algorithms in order to classify the liquid type and estimate the caloric value. One limitation that we have is the amount of RAM that the system has. It is important to use memory efficient algorithms in order to preserve the system memory as much as possible. Because of this the number of variables has to be reduced so that there are no extra points of memory usage. Another limitation that the system has is battery life. Since LIDS collects data during usage, it is constantly on and draining the battery. In order to circumvent the battery drainage from sending all the data to a computer via bluetooth, it is necessary to store the data on an SD card. Doing so drastically increases battery life. It is also necessary to turn the censors off while not in use. This is achieved by leaving the accelerometer on (which is the lowest battery usage sensor) and leaving the other sensors off until the accelerometer detects movement that indicates the user is taking a drink or filling the bottle.

Poster # 42

Biochar Influences Compost Pile Temperature and Available Nitrogen

Presented by: Thida Tea

Program: Sustainable High-value Horticulture & Processing Systems in Washington State
Co-authors: Nate Stacey, Andy Bary, Elizabeth Myhre, Doug Collins
Home Institution, Major, Class Standing: Pacific Lutheran University, Biology, Senior

Composting has been known to be an efficient approach for recycling organic wastes as well as to promote soil health and plant growth. Because of its high surface area, biochar added as a compost feedstock could enhance the composting process, final compost qualities, and increase nutrient availability of compost in soil. In this study, biochar was composted with chicken manure and wood shavings at a rate of 0%, 20% and 40% by volume to study the effects of biochar on the composting process and the physicochemical properties of finished compost. Each treatment was composted in aerated bins with three replications per treatment for 34 days. Compost bins with 0%, 20%, and 40% biochar remained above 71 °C for 10 days, 5-6 days, and 4 days, respectively. Nutrient analysis of precompost and finished compost revealed that pH was reduced and nitrate content was increased by biochar addition. All treatments showed a reduction in total carbon, ammonia, and C:N ratio. A seedling emergence assay and respirometry test will provide further information about the impact of each treatment on biological processes, and compost stability and maturity. The addition of biochar to compost altered compost physical properties and temperature dynamics during the composting process and influenced nitrogen availability in finished compost. The use of biochar as a compost feedstock has the potential to produce a high-value specialty product.

Poster # 43

The Effect of Varying Nitrogen Sources on the Growth of Azotobacter Vinelandii Over Time

Presented by: Cassidy Peru

Program: Ecology and Evolution of Plant-Microbe Symbioses

Co-authors: Chandra Jack, Maren Friesen

Home Institution, Major, Class Standing: Washington State University, Biochemistry, Junior

With the growing population the use of synthetic nitrogen to fertilize crops is becoming more popular, which is costly and harmful to the environment. We can leverage our knowledge of nitrogen fixation and metabolism in free-living soil microbes, such as *Azotobacter vinelandii,* to reduce the need for chemical fertilizers. To understand the effect of the nitrogen source on nitrogen metabolism and growth, we cultured *A. vinelandii* in media with ammonium, nitrates, urea, and media without nitrogen, over extended periods of time to produce growth curves and rates for analysis. Additionally, since some strains of *A. vinelandii* exhibit cheating and cooperation, which is when a microbe benefits another, but no benefit is offered in return thus altering the evolutionary fitness of both organisms, we will also perform competition experiments in different nitrogen sources using a 50:50 ratio between the wildtype and a non-fixing strain, which cheats by using nitrogen fixed by the wildtype, where we will look at changes in the frequency of strains in the population over time with and without nitrogen. We predict that there will be greater growth in nitrogen solutions as the decreased need to fix nitrogen enhances microbe fitness, and that the ammonium salts will result in the greatest growth due to their known ability to inhibit nitrogen fixation, and the reduced number of pathways to convert it into a usable form, thus increasing fitness. Additionally, in competition mixes, we predict that with nitrogen the strains will have similar fitness and equal representation. Without nitrogen, we predict the non-fixing strain will be overrepresented in the population due to its ability to utilize nitrogen fixed by the wildtype without spending excess energy. Greater growth may be an indication of nitrogenase inhibition so this information will provide us insight into the mechanisms behind nitrogen fixation and metabolism.

Poster # 44

Neck Loads Increase During Tablet Computer Use

Presented by: Nicole Johnson

Program: Engineering Tools for Disease Diagnostics and Treatment

Co-authors: Anita Vasavada

Home Institution, Major, Class Standing: University of Illinois at Urbana-Champaign, Bioengineering, Junior

Tablet use has become increasingly popular and has been linked to neck pain. It is thought that this is due to the head moving forward, increasing forces on the spine. This study aimed to determine the shear and compressive loads on the disc between the 6^{th} and 7^{th} vertebrae in the neck. It was hypothesized that a neutral, upright neck posture would have the lowest compressive and shear force compared to common postures while using tablets. A previous study in our lab used x-ray and photographic data to develop musculoskeletal models of the head and neck while subjects used tablets in four different conditions. In the current study, muscle force and orientation data for all extensor muscles crossing the C6/7 joint were extracted. MATLAB was then used to solve force equilibrium equations and transform these values to the C6/7 disc orientation. Compression forces on the C6/7 disc were lowest when the subject was in a neutral posture (64.8± 10.6 N) and increased significantly (1.5 to 1.9 times higher) when the subject used a tablet. Shear forces were lowest for the neutral posture (27.0 ± 11.4 N). They increased to a range of 35.6N to 38.6N while using a tablet, but overall, these were not significantly different from neutral. These findings were consistent with the hypothesis that neutral postures create the lowest compressive forces on the C6/7 disc, although statistical methods do not support the hypothesis for shear forces. Higher forces on the vertebral discs may be the connection between tablet use and neck pain. The causes of neck pain must be further studied in order to find ways to prevent it. More than 40% of US homes now own a tablet, which means that the effects of use must be well understood to prevent harm.

Poster # 45

Comparing Data from Different Sensor Modalities

Presented by: Lucy Mujugira

Program: Multidisciplinary Undergraduate Research Training in Wearable Computing

Co-authors: Alinia Parastoo

Home Institution, Major, Class Standing: Bellevue College, Bioinformatics, Sophomore

There are multiple public datasets that collect data from different sensor modalities. However, there is little research on how the data from each sensor modality differ from each other. The purpose of this project was to investigate how the data from different sensors vary based on different activities. A public dataset was used to analyze the raw data from each sensor. The dataset recorded data from 9 subjects, performing 12 activities, each wearing 3 Inertial Measurement Units (IMUs) and a heart rate monitor. An IMU sensor was placed on the subject's dominant hand, dominant side ankle, and chest. The subjects performed each activity for approximately 1-3 minutes. During each activity, the sensors recorded acceleration, gyroscope and magnetometer data. The data provided was grouped according to the location of each sensor. Based on each activity the data from one sensor location was compared with data from the other locations. From the data, the minimum, maximum and standard deviation values were extracted. The values were used to compute the difference between the values of the other sensor across each activity. If the difference between the values is high the greater the difference in the data.

Poster # 46

Highly Conserved Region on MACET4 Protein Promotes Microtubule Nucleation

Presented by: Breanne Searing

Program: Plant Cell Biology and Biochemistry

Co-authors: Sharol Schmidt, Alyssa Parish, Joshua Storey, Tara Goble, Andrei Smertenko

Home Institution, Major, Class Standing: Washington State University, Microbiology, Senior

Microtubules are filamentous structures 25 nm in diameter present in the cytoplasm of all eukaryotic cells. One of the most important properties of microtubules is dynamicity: ability to grow and shrink. New microtubules are formed in a process known as nucleation from heterodimeric protein alpha-beta tubulin. During microtubule nucleation and growth the tubulin dimers attach upon one another to form protofilaments, which then interact laterally to form the microtubule lattice. A transition from growth to shrinkage is called catastrophe and transition from shrinkage to growth is called rescue. Dynamicity allows rapid changes of microtubule organization in cells. Microtubules are essential for many processes including intracellular trafficking, daughter chromatid segregation during mitosis, and separation of daughter cells during cytokinesis. During cytokinesis in plants, microtubule form specialized structure known as the phragmoplast that facilitates assembly of the partition between daughter cells. My project addresses regulation of microtubule dynamics during cytokinesis. Previous experiments demonstrated that the microtubule-binding protein MACET4 accumulates in microtubule nucleation regions of the phragmoplast and nucleates microtubules *in vitro*. MACET4 contains three highly conserved domains: I, II, and III. We hypothesize that one of these domains promotes microtubule nucleation. To test this hypothesis, we conducted two types of experiments. First, conserved domains of MCET4 were expresses as fusions to Green Fluorescent Protein in tobacco cells and microtubule dynamics in these cells was recorded using Laser Scanning Confocal Microscopy. Imaging data provided the numerical values for rate growth, shrinkage, catastrophe and rescue. Our analyses demonstrated that domains II and III are both essential for microtubule nucleation. Furthermore, these domains have greater equilibrium dissociation constant (Kd) relatively to the full-length MACET4. My future work will measure Kd for domains II or III individually. In conclusion, our data demonstrates and conserved domains II and III function together in promoting microtubule nucleation.

Poster # 47

Cloning, Mutagenesis, and Expression Optimization of Tropomodulin

Presented by: Karla Bonic

Program: Engineering Tools for Disease Diagnostics and Treatment

Co-authors: Garry E. Smith, Dmitri Tolkatchev, Alla Kostyukova

Home Institution, Major, Class Standing: University of Oklahoma, Biomedical Engineering, Senior

Actin filaments are essential for whole-cell locomotion and muscle contraction. Actin-binding protein tropomodulin (Tmod) is known to control the length of the filaments in skeletal and cardiac striated muscles. Optimal length of actin-thin filaments in sarcomeres, which are the smallest contractile units in striated muscles, is critical for healthy muscle operation. The first actin-binding site (ABS1) of the cardiac Tmod isoform (Tmod1) has an important function in the thin filament length regulation, but it is not completely mapped nor is its interaction with actin completely understood. The goal of this research project was to clone Tmod1 ABS1 and introduce mutations that will shed light on its mode of interaction with actin. To accomplish this, we first amplified a mouse Tmod1 ABS1 segment through PCR, using primers containing restriction sites native to target plasmid MFH-TMX2, which is an in-house vector for protein expression in Escherichia coli. We performed an endonuclease reaction on both the Tmod1ABS1 segments and the plasmid, then pasted them together using a ligase reaction. We transformed DH5α E.coli cells with the plasmid and used PCR-screening to find positive colonies. Four colonies were chosen for Sanger sequencing. As a result, we found one colony with the correct DNA sequence and performed a PCR-based mutagenesis to introduce mutations of interest into the expression vector.

Poster # 48

Determination of Effective Number of Pasteurization Units for Bottled Hard Cider

Presented by: Sarah Harkins

Program: Sustainable High-value Horticulture & Processing Systems in Washington State

Co-authors: Brianna Ewing

Home Institution, Major, Class Standing: Washington State University, Food Science, Senior

Post-fermentation pasteurization is important to ensuring shelf life of hard cider. Although cider can be stored at low temperatures to prevent the action of yeasts and common spoilage microorganisms such as *Zygosaccharomyces bailii*, pasteurization increases shelf life, and if done effectively, allows the product to be stored without significant quality changes or risks of refermentation. Currently, there is not an official recommendation for the amount of Pasteurization Units (PU) that should be applied. Therefore, the objective of this study is to find a generally acceptable range of PUs for cider. To determine this, a basic cider was bottled and inoculated with live cultures of *Saccharomyces cerevisiae* to create a known level of culture per 355 mL bottle. The inoculated bottles were capped and pasteurized in a water bath for a range of PUs. Samples were spread plated at full strength and at dilutions up to 10^{-3} to determine the effectiveness of the pasteurization treatment. Plates were then incubated at 30 ˚C and the colonies were counted after 48 and 72 hours. Preliminary findings show a substantial reduction in microbial growth after 5 PU of pasteurization. These results could indicate that the application of a small amount of PUs to cider is feasible for sufficient microbial control.

Poster # 49

Investigation of the α-Fe2O3 (0001) Surface via DFT Implemented using an Atom-Centered Basis

Presented by: Samantha Bennett

Program: Electrocatalysis

Co-authors: Kyle Groden, Jean-Sabin McEwen

Home Institution, Major, Class Standing: Washington State University, Chemical Engineering, Senior

Iron surfaces maintain the capability to exist in many different oxidation states enabling their participation in a variety of reactions and allowing for utilization in profitable processes, often acting as a support for catalytic applications. Hematite (α-Fe_2O_3) is the most common naturally occurring form of an iron oxide and its (0001) surface has been shown to be most favorable under natural conditions[1,2]. The reduction of this surface can be altered by the presence of precious metal dopants due to their effect on the energetic and electronic properties of the surface. Understanding the reduction process of the α-Fe_2O_3 (0001) surface is necessary for its optimization within practical applications, but theoretical studies are often hindered by large atomic relaxations, unusual hybridization of wavefunctions and difficulty in handling localized electrons[3].

Prior density functional theory (DFT) studies utilized plane wave calculations for quantum chemistry calculations due to their superior computational efficiency[4]. This work employs DFT implemented using an atom-centered basis within the Crystal17 software package to study the surface chemistry of α-Fe_2O_3 (0001) and benchmark differences between said calculations and the results from Hensley et al. [5] where electrons were treated as plane waves. It is hypothesized that the use of this more chemically intuitive basis will provide superior correlation with experimental results in comparison to calculations performed using the more commonly used plane wave basis. Different levels of theory were utilized to investigate various α-Fe_2O_3 (0001) surface terminations, oxygen vacancies and the effect of dopants on oxygen vacancy formation to allow for comparison to plane wave calculation techniques.

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Poster # 50

Assessment of the Impact of Rising Global Temperatures on the Microbiomes of Poplar Trees

Presented by: Steven Zhang

Program: Northwest Advanced Renewables Alliance (NARA)

Co-authors: Courtney Gardner

Home Institution, Major, Class Standing: University of California, Irvine, Biomedical Engineering, Junior

Poplar trees are an important emerging feedstock for biofuel production in the United States. The diverse microbiomes associated with the rhizosphere of poplar trees are known to contain beneficial microbes that support poplar health and biofuel production. However, these microbes rely on stable environmental conditions to grow and contribute to biofuel production. With rising global temperatures, the ability of these microbes to continue offering these benefits could potentially be challenged. To investigate the impacts of heat stress on the health and survival of these rhizobacteria, *Bacillus subtilis* and *Pseudomonas putida* were used as model beneficial microbes and were subjected to acute and chronic heat stress to simulate increasingly intense heat events. Bacteria were cultured in 10% LB media at 25C (control), 32C and 39C for 24 hours (i.e. acute heat stress conditions) or 72 hours (i.e. chronic heat stress conditions). All experiments were conducted in triplicate. Under these different heat stress conditions, growth curves were plotted and the bacteria were plated on LB media to assess the growth and viability of the bacteria. To understand whether rhizobacteria could continue to aid poplar health while under heat stress, both *Bacillus subtilis* and *Pseudomonas putida* had some of their genes for degrading organic contaminants monitored. Using PCR, *Bacillus subtilis* and *Pseudomonas putida* had their genes coding for phenol monooxygenase (PMO), their genes coding for catechol 2,3 dioxygenase (23 CAT), and their genes for naphthalene dioxygenase (NapDio) amplified. These amplified genes were then placed into agarose gels and underwent gel electrophoresis to visualize how abundant they were. Once these gels are analyzed, they will bring new insight as to whether or not rhizobacteria are less effective at supporting poplar health if they are subjected to heat stress.

Poster # 51

Non-enzymatic Diabetes Sensors: Analyzing Glucose Sensitivity, Detection Range, and Interference of Metallic Nanoparticles

Presented by: Sahithee Batchu

Program: Engineering Tools for Disease Diagnostics and Treatment

Co-authors: Wei Jyun Wang, Dr. Su Ha

Home Institution, Major, Class Standing: The Ohio State University, Biomedical Engineering, Senior

The incidence of diabetes has been steadily increasing in recent decades, with an estimated projection of 10.4% of the world's population being diabetic by year 2040. To improve the survival and prevent chronic complications of diabetic patients, blood sugar monitors are commonly used. Current sensors utilize detection technology involving enzymatic methods, with glucose oxidase or glucose dehydrogenase, due to their high selectivity towards glucose molecules; however, one challenge associated with these enzymes is their instability within changing environmental conditions, such as pH, temperature, and humidity. Therefore, in alignment with current research efforts, this project focuses on developing and analyzing non-enzymatic glucose monitoring methods as non-biological materials can overcome the environmental, intrinsic limitations posed by biosensors. Rapid advances in nanotechnology were used to produce non-enzymatic electrodes with metallic nanoparticles to emulate glucose monitors. Specifically, glucose analyte molecules are directly oxidized at the active sites of transition metal electrodes, thus generating increased electrical currents proportional to glucose concentrations. Platinum, gold, palladium, and other electrode samples were produced and run through Cyclic Voltammetry tests to analyze electrochemical properties of each metal in respect to the glucose oxidation mechanism. Then, Glucose Sensing tests was carried out with each electrode sample in buffers of gradually increasing glucose concentrations to produce step-wise increments in current. Sensing tests were also performed with the addition of interfering molecules, such as ascorbic acid, to determine their effect on glucose level detection. The linear portion of Current vs. Glucose Concentration plots outputted by sensing tests will provide information on the sensitivity and detection range of each metal to glucose oxidation. In this way, the ability of various metals to sensitively and accurately detect blood sugar levels will be studied and compared in this project, allowing more stable, robust glucose monitors to be produced in the future.

Poster # 52

Clustering the Varieties of Dried Peas based on their Composition and Functional Characteristics

Presented by: Natalie DeLand

Program: Sustainable High-value Horticulture & Processing Systems in Washington State

Co-authors: Girish Ganjyal

Home Institution, Major, Class Standing: Washington State University, Food Science, Senior

Dry pea varieties have been historically marketed based on their size and color. This was acceptable as the end uses included using these peas as whole seeds. With recent trends in the utilization of the peas for numerous sophisticated value-added foods in the US markets, there is increasing usage of the peas in the form of the flours. Thus, the need to have consistent quality of the flours. An effort was made in this research to understand the functionalities of different varieties of dry peas to understand the differences among the varieties. Twenty-four green pea varieties and thirty-nine yellow pea varieties from the 2018 harvest season were being evaluated to determine their composition and functional characteristics. Following American Association of Cereal Chemists approved methods, the dried pea samples were all milled into a fine whole seed flour before analysis. Initial results on moisture analysis showed significant differences within yellow pea (5.95-11.88 % w.b.) and green pea (6.03-9.49 % w.b.) varieties. Analysis of the fiber, starch, fat, and ash is in progress. Pasting and thermal properties will be analyzed using an MVAG and a Differential Scanning Calorimeter, respectively. All the collected data will be subjected to cluster analysis and group the pea varieties into clusters based on the composition and functional properties. The data analysis will be used to predict the best end use food applications for each cluster. The outcome of this research will assist the dry pea industry by enhancing the supply chain with appropriate information useful to connect the growers and processors.

Poster # 53

Predicting Uptake of the Digital Memory Notebook Based on Competency

Presented by: Parveer Kaur, Fiona Keogh

Program: Gerontechnology-focused Summer Undergraduate Research Experience (GSUR)

Co-authors: Parveer Kaur, Katelyn Brown, Maureen Schmitter-Edgecombe

Home Institution, Major, Class Standing: Kaur: Dartmouth College, Biomedical Engineering, Senior; Keogh: Pullman High School, N/A, N/A

Paper and pencil notebooks can support everyday memory by serving as an external aid, where past activities can be recorded to aid retrospective memory and future events scheduled to aid prospective memory. However, these traditional formats can be difficult to learn and navigate. Advances in technology allow for more effective design of compensatory strategy tools to help individuals with memory loss preserve functional independence. The Digital Memory Notebook (DMN) is an iOS application, iteratively developed as an "all-in-one" memory aid and organization tool to aid cognitively impaired older individuals. It has a user friendly interface with large font and consists of calendar functions, to do lists, notes, and journaling features. Currently, there is an ongoing clinical pilot trial examining the efficacy of the DMN for improving everyday functioning in individuals with mild cognitive impairment (MCI), a transition phase between normal aging and dementia. Real time collection of DMN data-metrics (e.g., total distinct uses) will be used to identify patterns in participant learning that may be predictive of low and high mastery of the DMN intervention. Mastery will be determined by clinician ratings (1-7 Likert scales) completed after each participant training session. It is hypothesized that participants with low mastery ratings (average <4) will demonstrate lower frequency and diversity of use of the DMN and its functions compared to individuals with high mastery ratings (average ≥ 4). Examining statistical relationships between cognitive abilities (e.g., memory, executive function) and DMN data-metrics will allow us to examine for possible associations between cognition and DMN usage. Future work includes investigating different parameters ratings to determine the best set of predictors instead of using an average rating. Understanding which aspects of competency are most efficient at predicting mastery of the DMN will give insight into how cognition impacts DMN usage.

Poster # 54

High Performance Bio-Based Plastics

Presented by: Anna Schraufnagel

Program: Bioplastics & Biocomposites

Co-authors: Ting-Han Lee, Eric Cochran, George Kraus

Home Institution, Major, Class Standing: North Carolina State University, Sustainable Materials and Technology, Senior

Polyethylene terephthalate (PET) is one of the most widely produced plastics in the world, commonly used in bottles and packaging. The shortcomings of this material are its poor thermal and barrier properties and the petrochemicals traditionally required to produce it. Polyethylene naphthalate (2,7-PEN) is a biobased polymer closely compared to PET, due to its similar but improved thermal, barrier, and mechanical properties. This study explores the creation of a copolymer using 2,7-PEN and PET using varying ratios of PEN to PET in order to determine the mixture that yields the best properties. Cost was also considered when determining the ratios to try; PEN is more expensive than PET. Intrinsic viscosity, thermal properties, crystallinity, and mechanical properties of PEN, PET, and the copolymers were tested. Based on these tests, the bio-based copolymer has been shown to have better properties than PET alone. Future tasks include optimization of the ratio of PET to PEN and barrier property analysis.

Poster # 55

The Effects of Rhizobia Strain Identity on the Flowering Time of Wild Clover

Presented by: Beatriz Jimenez

Program: Ecology and Evolution of Plant-Microbe Symbioses

Co-authors: Maren L. Friesen, Brett Younginger

Home Institution, Major, Class Standing: Heritage University, Biological Sciences, Senior

Rhizobia-bacteria that live in soil- are able to convert atmospheric nitrogen (N_2) into a plant-usable form of ammonium (NH_4^+), while living in a mutualistic interaction within the roots of leguminous plants. This process is known as biological nitrogen fixation. Biological nitrogen fixation is vital to the production of terrestrial ecosystem globally, with an estimated biological total of 175 (10^6 metric ton) per year. However, the identity of different strains of rhizobia may have important effects on the fitness of the host plants beyond providing nitrogen.

Here, we investigate how strain identity plays a role in the flowing time of a clover host plant, as flowering time may have a large effect on a plant fitness in natural population.

Seventy-eight different microbial strains were collected from a field site in Bodega Bay, CA to determine their effects in host plant phenotype and the benefits provided to the host's flower production and flowering time. We predicted that that clover host plant would have a much faster process in flowering time and flowering production having rhizobia as the inoculant compared to buffer or nitrogen. The results showed that indeed having rhizobia as the inoculant, it increased the wild clover flower production. Furthermore, data collected from this experiment will help us explore the genomes of these strains and determine if there are genetic associations with the benefits provided to the host.

Poster # 56

Organic Fertilizers and Cattle Grazing Density: Effects on Soil Fertility and Sustainability of Pastures

Presented by: Jordan Hummel

Program: Sustainable High-value Horticulture & Processing Systems in Washington State

Co-authors: Adel Almesmari, Lynne Carpenter-Boggs

Home Institution, Major, Class Standing: Washington State University, Agricultural Education, Junior

This project was designed to analyze the effect of different organic fertilizers and grazing types on soil health and pasture productivity. Soil is vital to agricultural production and organic agriculture is becoming prominent within the industry. Three different organic additives were selected to apply to cattle grazing pasture in order to determine which was ideal for soil health and composition. In a piece of land approximately 8 acres, 4 replicates of 8 treatments (factorial design of two grazing densities and four fertility treatments) were applied for a total of 32 plots. Strip sections were grazed by cattle in either a high density group or low density group. The fertility treatments included a non-treated control and three organic applications: gypsum plus bonemeal (to supply phosphorus and sulfur), extra manure, and compost tea. Plant biomass was sampled and weighed prior to grazing. Ninety-six soil samples were taken in total, 3 being from each plot, at depths of 0-6 inches, 6-12 inches, and 12-18 inches. Tests on soil samples included moisture content, pH and electrical conductivity, nutrient levels, and soil microbial biomass. The results from this experiment will show which fertilizer treatment, coupled with either high- or low-density grazing, is best for soil and pasture productivity.

Poster # 57

Mechanochemical-assisted Deconstruction of Lignocellulosic Biomass on a Pilot Scale to Improve Enzymatic Digestibility and Cellulosic Sugar Yield

Presented by: Rachel Hannah

Program: Northwest Advanced Renewables Alliance (NARA)

Co-authors: Tuhua Zhong, Michael P. Wolcott

Home Institution, Major, Class Standing: University of Arkansas at Pine Bluff, Chemistry, Sophomore

Lignocellulosic biomass can be converted to bio-ethanol by enzymatic hydrolysis of cellulose in lignocellulosic biomass followed by the fermentation of the resulting sugars. The recalcitrance of cellulose due to its crystalline structure and the surrounding lignin and hemicellulose prevent the enzymes accessing to celluloses, thus resulting in lower enzymatic digestibility, low sugar yield, and the high cost of the hydrolysis process. Mechanical milling usually demands high-energy inputs, which is a major barrier to its commercialized application. The objective of this study here is to investigate the effects of catalyst sodium hydroxide (NaOH) used in the pilot-scale milling on physicochemical properties of amorphized particles and sugar yield, to assess the mechanochemical- assisted pretreatment energy efficiency associated with the sugar recovery. The catalyst NaOH was expected to speed up the deconstruction of the lignin-carbohydrate complexes and crystalline structure in lignocellulosic biomass when in combination with the mechanical pulverization/amorphization forces generated by a Spring Suspended Vibratory Tube Mill (SSVTM). We conducted particle size, bulk density, and crystallinity analysis to measure the difference the catalyst NaOH made in the physicochemical of the resulting amorphized wood particles. So far, the results indicated that at the same milling time, the particle size of wood particles milled with the catalyst is slightly smaller than that of those milled without the catalyst. We also found that particles milled for 20 minutes without catalyst are slightly denser than those milled with the catalyst. On the other hand, particles milled for 45 mins with the catalyst are denser than particles milled without the catalyst. Finally, we carried out enzymatic hydrolysis and carbohydrate composition determination and enzymatic hydrolysis sugar yield analysis. We use enzymes Cellic CTec2 and HTec2 (Novozymes) during enzymatic hydrolysis as a pretreatment to further digest the lignocellulose structure. This should make it easier to collect a more considerable amount of undamaged cellulose sugar that can be used in the bioethanol production for bio-jet fuels.

Poster # 58

3D Printing of a Structural Scaffold with Controllable Mechanical Properties for Articular Cartilage Tissue Engineering

Presented by: Michele Counts

Program: Engineering Tools for Disease Diagnostics and Treatment
Co-authors: Mahmoud Amr, India Dykes, Joshua Kernan, Alia Mallah, Haneen Abusharkh, Olivia Reynolds, Bernard Van Wie, Nehal Abu-Lail, Juana Mendenhall, Arda Gozen
Home Institution, Major, Class Standing: University of Rochester, Biomedical Engineering, Senior

Osteoarthritis, characterized by the degradation of articular cartilage (AC) in the articulating joints, is a common disease affecting millions of people annually. Current treatments include pain killers, cortisone or lubrication injections, and eventually total knee replacement; yet, there are no effective, long-term solutions. Tissue engineering provides an alternative approach, were cells, scaffolds, growth-factors, and a bioreactor are used to create a functional tissue. In this work, we aim toward 3D printing an engineered AC structural scaffolds using hydrogel inks, consisting of Gum Arabic, Sodium Alginate, and Gelatin, to replicate the tri-layered AC complex structure. Our main hypothesis is that the 3D printed porous scaffolds with precisely controlled pore size and material properties will exhibit mechanical properties similar to that of the native tissue, which in turn will facilitate cell growth. To test this hypothesis, we printed scaffolds with thicknesses ranging from 2 to 5 mm and characterized their mechanical properties through compressive testing. Due to numerous controllable variables, designing a protocol with the capacity to provide consistency between prints is the initial challenge of this project. By controlling the printhead and print bed temperatures we are able to produce controlled replicates of our scaffold designs with varying pore size, layer height and thus mechanical properties. Compressive moduli of these scaffolds were characterized and compared to the various layers of the native articular cartilage. Our scaffold is unique, as it allows us to achieve structural integrity and strength through physical and chemical crosslinking. Future studies will focus on culturing chondrocytes and mesenchymal stem cells in a cell-laden hydrogel integrated with the structural scaffolds created herein, in a centrifugal bioreactor that provides mechanical stimuli and enhanced mass transfer of media and growth factors to mimic the native AC environment.

Poster # 59

The Effect of Rhizobia on Flowering Time and Fitness in Trifolium Barbigerum

Presented by: DeMarcus Turner

Program: Research Opportunities for Native Undergraduate Students

Co-authors: Maren Friesen, Chandra Jack, Brett Younginger, Beatriz Jimenez, Gabe Santana, Natalie Sanchez

Home Institution, Major, Class Standing: Norfolk State University, Biology, Senior

Atmospheric nitrogen is inaccessible to most species of plants, so they rely on microbes known as rhizobia to provide usable nitrogen through nitrogen fixation. However, the presence of these microbes may also have a profound effect on other key plant traits, such as flowering time. A plant's flowering time can have significant effects on fitness, health, and lifespan. Here, we test the effect of rhizobia on flowering time of *T. barbigerum* plants. and determine how this affects fitness. In a greenhouse experiment, a single genotype of *T. barbigerum* was inoculated with 80 different strains of rhizobia to see which strains provide the greatest fitness benefit. The flowering time and number of flowers on each plant were recorded during the first 8 weeks of growth. The plants were grown for 10 weeks before being harvested and the number of seeds produced was recorded. Since the same plant genotype is used, any variation is likely due to genetic variation within the rhizobia. This data will show which strain of rhizobia provides the greatest influence on the *T. barbigerum* plants' flowering and the largest impact on fitness. If certain strains of microbes improve plant flowering and fitness, it will provide significant research on microbially mediated plant functional traits.

Poster # 60

Ecological Momentary Assessment Mobile App for Real-time Behavioral Measures

Presented by: Karla Bustamante

Program: Multidisciplinary Undergraduate Research Training in Wearable Computing

Co-authors: Porismita Borah

Home Institution, Major, Class Standing: Highline College, Computer Science, Junior

Ecological Momentary Assessment, or EMA for short, is able to collect data from mobile app users in real time. Being on a mobile app, the EMA helps collect repeated and real time data on the users' behaviors and experiences in their natural environments. Users will also be able to jot down their thoughts through daily diary reports.

Although my job for this research experience is not to collect information and data from users to see their behavioral experiences. I will be creating and beginning the code for this application in mind. At its core the application will be able to send repeated messages throughout the day depending on which survey a user is doing, keep diary logs of their progress, show and ask questionnaires about certain habits, and as well creating an account to be able to access everything else.

Using an apple laptop, xCode, swift and an apple laptop I'll be able to create the front end portion of this application, meaning the layout and user interaction, showing the basics of what the application is meant to do, practically a mock up.

Poster # 61

Multiple Language Usage in Open Source Github Repositories: How Computer Languages are Being Utilized in Real-World Applications

Presented by: Austin Marino

Program: Undergraduate Research in Smart Environments

Co-authors: Haipeng Cai

Home Institution, Major, Class Standing: Washington State University, Software Engineering, Senior

There are hundreds of programming languages available for software development today. Each one was created to offer some unique functionalities that hadn't existed prior to its creation. With the massive amounts of computer languages now in existence, it can be hard to know when and how to use an individual or combination of programming languages for any given project. Understanding this has become the focus of this research project.

With a plethora of publicly hosted software applications available on Github, we were able to obtain thousands of individual repositories to help answer this question and the underlying aspects that drive it. Through simple numerical analysis, we can see how often each programming language is being used and what other languages it's being used with, how many bytes are being written in a language and the average amount of languages being used across all repositories. The more pressing issue, however, posed a stronger challenge in solving. In order to uncover what the purpose of a language and or language combination within a repository meant, we had to use more advanced data mining techniques. We applied natural language processing methods to the repositories descriptions in order to pinpoint the most important words contained within it. We then used unsupervised machine learning techniques to form clusters of related terms and assigned a category name to each unique cluster. Through this technique, we were able to assign every repository its best-fitted category and using supervised ML techniques we discovered relationships between programming languages and a given software development topic.

While there are still questions to be answered, we have highlighted how programming languages are being used in current software applications and the factors driving our results.

Poster # 62

Bidirectional Isotachophoresis for the Detection of Disease Biomarkers in Exosomes

Presented by: Martin Niemiec

Program: Engineering Tools for Disease Diagnostics and Treatment

Co-authors: Cornelius Ivory, Daniel Molina

Home Institution, Major, Class Standing: University of Arizona, Biomedical Engineering, Senior

Cancer is a complex, multifactorial disease that hijacks the normal functions of the body in improper ways. If a tumor eventually metastasizes or becomes resistant to therapy, it does so partly by exploiting normal modes of intercellular communication like membrane vesicle trafficking, wherein signaling molecules are transported to other cells via lipid vesicles. There are two main types of these vesicles: exosomes, which form inside intracellular compartments, and microvesicles, which bud directly from the plasma membrane. Exosomes have been implicated in cancer metastasis and treatment resistance: studies have shown that hypoxic tumor cells have increased secretion of exosomes with angiogenic and metastatic capabilities, and that exosomes promote cancer cells' characteristic stem-ness as well as desmoplasmic reaction. As such, exosomes have become a promising diagnostic target for early detection of cancer, but existing methods of isolating and detecting exosomes are still lacking.

Electrophoretic methods such as isotachophoresis (ITP) have shown promise in not only separating exosomes, but concentrating them simultaneously, increasing their usefulness early on when concentrations of disease biomarkers are low. ITP can also be used to move oppositely charged analytes in opposite directions (bidirectional ITP). This study aims to utilize bidirectional ITP to transport fluorescently labeled antibodies through a zone of biomarker-containing exosomes, creating a new "band" of antibody-exosome complexes that can be quantified via fluorescence microscopy. If a high concentration of antibody-exosome complexes is achieved, ITP will proceed in "plateau mode", which will allow the amount of biomarker to be calculated by measuring the width of the band. A system of buffers consisting of MES-titrated potassium hydroxide and tris-base-titrated hydrochloric acid will be used to conduct bidirectional ITP in a PMMA (poly(methyl methacrylate)) microchip. This system has potential to provide early diagnosis of cancer via detection of cancerous biomarkers in exosomes, saving lives by allowing for earlier treatment.

Poster # 63

3D Printed Biocompatible Glycerol Vitrimer

Presented by: Amanda Bye

Program: Northwest Advanced Renewables Alliance (NARA)

Co-authors: Cheng Hao

Home Institution, Major, Class Standing: Washington State University, Material Science and Engineering, Senior

Vitrimer materials have previously relied heavily on catalysts for crosslink formation, rendering them toxic and with poor biocompatibility. The curing process for vitrimer materials can be time-consuming and has limited shaping ability. In this study, a bulk reaction using glycerol and Glycidyl methacrylate (GMA) in the presence of significantly reduced Dimethyl sulfoxide (DMSO) was able to limit the toxic catalyst and wash. This formula could be cured under UV lights in 2 minutes and was 3D printed to meet shape criteria and with increased water absorption and flexibility properties generally seen in vitrimers. The 3D printed vitrimer provided a hydrogel that demonstrated self-healing properties under relaxation and testing. This study was able to demonstrate the biocompatible formation of a 3D printed vitrimer gel and further it with increased absorption and self-healing abilities.

Poster # 64

Identification of Microtubule-associated Protein Dynamics in MACET4

Presented by: Tara Goble

Program: Plant Cell Biology and Biochemistry

Co-authors: Alyssa Parish, Andrei Smertenko, Breanne Searing, Joshua Storey, Sharol Schmidt, Tetyana Smertenko, Zoe Ferguson

Home Institution, Major, Class Standing: Washington State University, Forestry, Junior

Plant cells divide by a unique mechanism that utilizes a structure known as the phragmoplast. The backbone of the phragmoplast is made of microtubules, 25nm-thick nano-tubes composed of α and β tubulin heterodimers. Tubulin molecules assemble to lengthen the microtubule or disassociate to shorten the microtubule. In the phragmoplast, microtubules operate jointly with microtubule-associated proteins (MAP), which regulate elongation, shortening and nucleation of new microtubules. A previously identified MAP, MACET4, was reported to promote nucleation while restricting microtubule elongation in the phragmoplast. The aims of my work was to understand how MACET4 regulates microtubules. It has been shown that MACET4 contains three conserved domains: I, II, and III. We used *in vitro* and *in vivo* analyses to determine how these domains contribute to MACET4 functions. In our *in vitro* experiments fluorescently-labeled tubulin was polymerized in the presence of two fragments: delta 4 included domains II and III, and delta 7 included only domain II. Images of microtubules were recorded with Total Internal Reflection microscopy. The results of this experiment showed that on average, as the concentration of the MAP increased, the delta 4 proteins caused greater abundance of shorter microtubules than delta 7. We also counted asters and cores (tubulin aggregates), and discovered greater incidence of both types of structures at higher concentrations of delta 4. These outcomes indicate that domains II and III promote microtubule nucleation. Although we may have discovered what region delta 4 may be doing, it is still unknown what the other regions of our protein are contributing to.

Poster # 65

The Influence of Ascorbic Acid on Chondrocytes Encapsulated in Agarose Hydrogels

Presented by: Terreill Robertson

Program: Engineering Tools for Disease Diagnostics and Treatment
Co-authors: O. Guobadia, H. Abusharkh, O. Reynolds, J. Mendenhall, B.J. Van Wie
Home Institution, Major, Class Standing: Morehouse College, Chemistry, Senior

Osteoarthritis is a degenerative disease that affects approximately 30 million Americans. This common disease is a result of the deterioration of cartilage which leads to the reduction of natural shock absorption properties of the tissue causing interaction between the bones that it supports. Unfortunately, inflamed cartilage tissue is unable to regenerate because the tissue is avascular and aneural. Current treatments such as microfracture, knee replacement, and autologous bone marrow transplant are available to individuals; however, these solutions cannot restore cartilage's native structure and function. Cartilage tissue engineering is an emerging field of research that explores designing 3D constructs with mechanical and chemical properties similar to native cartilage tissue. Tissue scaffolds are made from polymers that are biocompatible and biodegradable. In this study, agarose hydrogels were used as scaffolds because the material can sustain chondrocyte cell cultures. Ascorbic acid was added to cultures because its antioxidant properties are known to reduce inflammation of cartilage. One set of scaffolds was prepared with 1.5% agarose in PBS and varying ascorbic acid concentrations while the other set lacked ascorbic acid. bovine articular chondrocytes were seeded inside each hydrogel. Five groups were tested for each culture environment: a positive control with healthy chondrocytes, negative control with inflamed chondrocytes, and inflamed chondrocytes with 500 μM, 100 μM or 10 μM ascorbic acid concentrations. Chondrocytes cultured in scaffolds without ascorbic acid were exposed to the nutraceutical via culture medium. After 10 days of culturing, samples were tested for nitric oxide concentration to measure inflammatory markers, glycosaminoglycan, collagen, and DNA quantity and cell viability. In the experiment, we expect to see an increase in chondrogenic markers and cell proliferation in scaffolds without ascorbic acid inside the hydrogel because ascorbic acid was refreshed during medium renewal.

Poster # 66

RepeatAnalyzer Interactive Website

Presented by: Zachary Cutler

Program: Undergraduate Research in Smart Environments

Co-authors: Assefaw Gebremedhin, Helen Catanese

Home Institution, Major, Class Standing: University of Utah, Computer Science, Senior

Repeat Analyzer is a tool used for tracking, managing and analyzing Short Sequence Repeats (SSRs). It is a popular tool that many biologists use. We built upon the previous Repeat Analyzer and developed an interactive website that allows for further analysis of SSRs. This method results in a number of improvements over the prior python application. First, a website significantly reduces potential problems with installation. Previously, a number of libraries needed to be installed properly, and a functioning version of the now outdated python 2.7 was required. Second, the website greatly increases ease of use of the application. The former program was a command line based tool. For biologists, some of whom have little to no programming experience, this could be unintuitive. Switching to a graphical user interface allows for a faster learning curve with the tool. Additionally, extensive improvements to the mapping portion of the application were made, primarily focused on interactivity. Finally, by creating a central database that keeps track of SSRs instead of every individual user having their own makeshift database, we can better control when SSRs are added to the database and make it easier for researchers to know when other SSRs have been found.

Poster # 67

Application of Paper-Based Isotachophoresis (ITP) Technology for Isolation and Detection of Exosomes

Presented by: Rhea Sablani

Program: Engineering Tools for Disease Diagnostics and Treatment

Co-authors: Alex Pettit-Estell, Dr. Wenji Dong

Home Institution, Major, Class Standing: Whitman College, Biochemistry/Biophysics/Molecular Biology (BBMB), Junior

Exosomes are extracellular vesicles that play important roles in intercellular communication. Since cancer derived exosomes contain proteins, DNA, and RNA that reflect the origin of the parent cells, exosomes and their cargo proteins can be used as biomarkers for early diagnosis of cancer. Early detection of diseases is a vital aspect of point-of-care testing as it facilitates improved patient care management and better disease diagnosis. However, current isolation and assay methods are either laborious, expensive to produce, or lack the sensitivity and reliability needed for early diagnosis.

Paper-based analytical devices are advantageous in point-of-care testing because they enable the fabrication of affordable and portable diagnostic tools. Furthermore, isotachophoretic techniques have shown potential in rapidly concentrating and isolating charged biomolecules at low physiological concentrations.

This study seeks to use paper-based anionic isotachophoresis (ITP) to detect malignant cell derived exosomes from healthy cell exosomes. The paper-based ITP device consists of a 3D printed cartridge device in the presence of a nitrocellulose membrane and a discontinuous buffer system for ITP operation. Our results showed that under 175V, ITP can effectively stack fluorescently labeled exosomes into a bright fluorescent band on a membrane strip. Fluorescence intensity of the enriched bands was analyzed by a fluorescence microscope and enrichment factor was calculated.

This research paves the way for exosome assay in point-of-care testing and demonstrates how paper-based ITP is a viable method for detecting multiple analytes for diseases that require higher sensitivity.

Poster # 68

Nano Cellulose Reinforcing Regenerated Fibers From Cotton Waste

Presented by: Joshua Blair

Program: Northwest Advanced Renewables Alliance (NARA)

Co-authors: Hang Liu, Tuhua Zhong, Dana Van Fossen

Home Institution, Major, Class Standing: Daytona State College, Undecided, Freshman

Cellulose is a naturally-produced and most abundant biopolymer that is readily found in cotton and cotton-based products. Being able to reuse the cellulose found in thrown away clothing items cuts down the waste of cotton tremendously. The objective of this research was to first extract the nanocellulose using cotton and denim products as raw starting materials. Subsequently, we created regenerated fibers using post-customer T-shirts, and reinforced them with cellulose nanofibers (CNF), finally went onto further testing to find out if this mixture was good for reusing the fibers. To extract nanocellulose by top-down breaking down the fibers, the materials went through a process called sulfuric acid hydrolysis with the 2,2,6,6-tetramethylpiperidine 1-oxyl (TEMPO)-mediated oxidation method. The material properties of the resulting nanocellulose were characterized by transmission electron microscopy (TEM), X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), and thermogravimetric analysis (TGA). Once the shredded cotton material has gone through the acid hydrolysis, it goes through a dissolving process to turn the solid material into a liquid solution by mixing with alkaline solution (LiOH/Urea/Water) at -12 degrees Celsius. The solution is mixed with a percentage of cotton, mechanically stirred for 40 minutes, and is refrigerated overnight. To create solid fibers, the material undergoes wet spinning. This process includes the material being pushed through a spinneret with 5 micro sized holes by nitrogen gas. The liquid material turns into a solid immediately when it touches the coagulation bath. Once the fibers are pulled through the coagulation bath, they are spun onto testing tubes to dry for further testing. Once dry, the material properties of the resulting regenerated fibers with/without CNF is characterized by tensile strength test, thermal stability analysis, microstructures, and crystallinity measurement techniques. This recycling process will cut down the post-customer cotton-based textile waste in the environment, while providing new cellulose-based products like cellulose nanocrystals, cellulose nanofibers, and regenerated fibers.

Poster # 69

Genetic and Phenotypic Characterization of the Silent Knight 1 (silk1) Mutant

Presented by: Evelyn Bohnee

Program: Research Opportunities for Native Undergraduate Students

Co-authors: Matthew Marcec, Kiwamu Tanaka

Home Institution, Major, Class Standing: University of Idaho, Environmental Science, Junior

Like all living things, it is essential for plants to respond to their environment around them in order to survive against possible threats. Plants sense these threats, such as diseases, via receptors on the exterior of their cells. Triggering these receptors provokes the cell to release calcium (Ca^{2+}),reactive oxygen species (ROS) and other signal molecules which turn on downstream responses. For example, bacteria flagella sensed by plant receptors will trigger a rise $Ca^{2+}$and ROS concentrations thus activating immune responses such as cell wall build up or defense hormone synthesis. Interestingly,for each different environmental threat,the plant produces unique $Ca^{2+}$and ROS signals. Here,we examine the relationship of Ca^{2+}signaling to plant immunity. To do so we use a unique, yet unidentified, Arabidopsis mutant, *silent knight 1* (*silk1*), that produces no Ca^{2+} signature to any response tested. The mutant can potentially be a usefultool to study the characteristics of plant immunity. This study attempts to identify the causal gene of the *silk1* mutation through traditional mapping techniques. This study also explores the physiological consequences of plants lacking Ca^{2+} signatures through examining *silk1* in various light conditions and to pathogen challenges. This research will aid us in gaining a better understanding of plant immunity to help crop breeding and plant protection for future generations.

Poster # 70

Increasing Biolistic Transformation Efficiency Through Amine Structure

Presented by: JiaMin Wu

Program: Bioplastics & Biocomposites

Co-authors: Kyle Miller, Alan Eggenberger, Fei Liu, Shan Jiang

Home Institution, Major, Class Standing: Boise State University, Materials Science and Engineering, Sophomore

Genetic transformation in plant cells is a fundamental challenge due to the presence of the cell wall. Various methods can be applied to animal cells, but do not work with plants. The few techniques that can work for plant cells, such as Agrobacterium, only work well for a few plant species. As such, there is a great need for more efficient gene delivery techniques. The technology can potentially help crops become more resistant to disease and insects, as well as enable plants to become more efficient at growing and absorbing nutrients. Biolistics, directly shooting genetic information into a cell, provides an alternative to cross the cell wall and is applicable to most plant species. Our lab is looking at improving the efficiency of biolistic transformations by testing a library of different delivery agents that have been successfully used for animal cells. To ensure consistency, the transformation efficiency is tested using a double barrel biolistic system on an onion model. Additionally, modifications of these agents provide a platform to systematically study the effect of molecular structure on the delivery efficiency. The wealth of knowledge developed through researching genetic engineering for animal cells will be applied to improve plant transformation and vice versa.

Poster # 71

USDA Dry Bean Nutritional Evaluation

Presented by: Bryce Morgan

Program: Sustainable High-value Horticulture & Processing Systems in Washington State

Co-authors: Theodore Kisha

Home Institution, Major, Class Standing: California State University, Chico, Nutrition and Food Science, Junior

Beans (Phaseolus spp.) are a nutritious crop that contain high amounts of protein, fiber, vitamins, minerals, and polyphenols. Polyphenols are a category of naturally occurring compounds in food that can act as antioxidants to neutralize free radicals and promote health benefits that are associated with the risk reduction of diabetes, cardiovascular disease, and cancer. An examination of a group of heirloom beans of various colors and pattern revealed a large variance of phenolics, even within a group of black beans. Subsequent analysis of Black and Red beans showed 5 and 3-fold differences, respectively within these market classes. Yellow beans were assessed to identify the levels of extractable and non-extractable polyphenols among accessions. One hundred and seventeen accessions of yellow beans were finely ground, weighed into samples and tested for phenolics through spectrophotometric analysis. The results showed high variability among the different accessions, with some beans having up to triple the level of extractable polyphenol content as other yellow beans. Yellow beans will be analyzed for non- extractable polyphenol and protein levels to further research the nutrient density in yellow beans.

Poster # 72

Integrating Action Response in RAS

Presented by: Glenn Duncan, Asim Fauzi

Program: Undergraduate Research in Smart Environments

Co-authors: Glenn Duncan, Chris Pereyda, Dr. Larry Holder, Dr. Aaron Crandall

Home Institution, Major, Class Standing: Duncan: Washington State University, Computer Science, Senior; Fauzi: Miami University, Computer Science, Junior

Robot assisted living could be crucial for the future of healthcare as humans are living longer than before and an inflated elderly population has induced an increased demand in eldercare labor. However, robot assisted living is not yet prevalent in the modern day healthcare industry. Robot Activity Support, or RAS, is a prototyped assisted living robot whose main purpose is to aid Alzheimer's patients and other cognitively impaired individuals. RAS' software is built using Google's Cloud Speech-to-Text API as well as one of Tensorflow's object detection models to find a person in a smart environment. The current objective is to implement a response system for RAS where a patient may call out to request help and receive a proper response such as approaching the human and prompting assistance. The outcomes of this experiment will be measured by the robot's ability to understand a command, and its ability to find and navigate to the person calling it. To find these measures, an experiment will be conducted in smart environments, the on-campus smart apartment and CASAS lab. It will have the participants perform a scripted multi-step activity to have RAS intervene in an activity. Once RAS has been led through the task by the participants, they will give survey feedback of the outcomes that are listed above.

Poster # 73

Mutualistic Bacteria and Seed Counts in Trifolium barbigerum

Presented by: Gabreil Santana

Program: Plant Genomics and Biotechnology

Co-authors: Maren Friesen, Richard Allen White III

Home Institution, Major, Class Standing: Western Washington University, Biology, Senior

Interactions between plants, and mutualistic bacteria associated with the rhizosphere (rhizobia), play a critical role in plant survival and diversity via influences on phenotype. Whether it be leaf traits to root traits, and everything in between, rhizobia often have a part to play via the creation and/or modification of pathways for the synthesis of biochemicals. The question this project aims to answer revolves around the effect of rhizobia on the fitness of *Trifolium* barbigerum plants, specifically: how does the strain of rhizobia influence seed count? To answer this question, ~1200 *T.* barbigerum plants were inoculated with 1 of ~80 strains of rhizobia, and harvested, some before and some after maturation to collect as much data as possible. Biomass of roots and shoots, as well as flowering time, flower count, seed count, and height for all plants was collected. A comparison of all seed counts by rhizobium will be performed, the results of which will be used to elucidate the importance of rhizobia strains in plant fitness.

Poster # 74

Measuring Resiliency in Power Grids Using Graph Metrics

Presented by: Lauren Smith

Program: Undergraduate Research in Smart Environments

Co-authors: Anurag Srivastava, Sajan Sadanandan, Venkatesh Venkataramanan

Home Institution, Major, Class Standing: St. Mary's College of Maryland, Computer Science and Mathematics, Senior

Power grids are connected networks that deliver electricity to various locations. The performance of these networks depends on resiliency of the system. Power grids are susceptible to various types of interference such as natural disasters and cyberattacks. In order to measure how such a system is able to recover from these events, it is useful to measure the resiliency by looking at vulnerabilities. As part of a larger effort to quantify resiliency and how it impacts power grids, we utilized various graph metrics such as centrality and redundancy. Based on these metrics, we will be able to observe how disruptions in a power grid affect the functioning of the grid. To further investigate the resilience of a power grid, we will see how creating disruptions in the network impacts the overall grid strength.

Poster # 75

Back to the Future: Methods to Recover Historic Rhizobial Strains from Herbarium Specimens

Presented by: Amanda Antoch

Program: Ecology and Evolution of Plant-Microbe Symbioses

Co-authors: Renee H. Petipas, Maren L. Friesen

Home Institution, Major, Class Standing: Washington State University, Biochemistry/Molecular Biology, Senior

Preserved plant specimens can provide a better understanding of coevolutionary patterns by acting as a snapshot of plant/microbe interactions throughout time, which may indicate the trajectory of coevolution in the Anthropocene. The revival of herbarium specimens could allow for manipulative experiments to study historic patterns, however it is unclear if these historic samples can be revived. This experiment examined whether the manipulation of components in bacterial growth media could result in the revival of historic rhizobia from herbaria. We selected nodules from *Medicago lupulina* specimens collected from five counties in Washington State from 1950-2015. We performed a culturing experiment using seven different types of media: Luria broth (LB), tryptone yeast (TY), yeast mannitol (YM), dilute YM, YM plus extra calcium, YM plus extra salt, and YM plus pyruvate. We were able to recover historic bacteria from three specimens, which were collected in 2015, 2004, and 1950. Bacteria from fresh nodules grew equally well on all media except Luria broth (χ^2=22.56, P=0.001). Bacteria from historic, preserved nodules grew significantly better on tryptone yeast (χ^2=6.85, P=0.03). We determined that historic strains of bacteria can be recovered from herbarium specimens but the time frame may be limited to the recent past, and the most effective media for recovering bacteria from historic nodules was tryptone yeast extract (TY) media. Future steps include confirming identity of isolated cultures with Sanger sequencing. The successful recovery of historic bacteria from herbaria indicated that preserved herbaria samples can be effective resources of material for experiments to better understand plant-microbe relationships and their coevolution.

Poster # 76

Understanding the Role of the Anthocyanin Synthesis Pathway in the Tolerance Exhibited Towards Fsp in Purple-seeded Pea Lines

Presented by: Leonardo Orozco

Program: Molecular Interaction Between Peas and Root-Rot Disease

Co-authors: Bruce A. Williamson-Benavidez, Richard M. Sharpe, Amit Dhingra

Home Institution, Major, Class Standing: Washington State University, Biochemistry, Junior

Pisum sativum, commonly referred to as the pea, is a very valuable cover and break crop. Pea is an excellent nutritional and economical crop for growers due to its short life cycle, low water usage, rich protein profile, and its ability to fix nitrogen. The fungus, *Fusarium solani* f. sp. *pisi* (*Fsp*), causes root rot and poses a threat to the production of peas. However, the purple seeded pea genotypes appear to be completely tolerant to *Fsp* root rot. These pigmented genotypes are undesirable for human consumption due to a bitter aftertaste produced by the purple pigmentation. The purple pigmentation is produced by anthocyanins present in the seed coats within these tolerant genotypes. Preliminary research completed in Dr. Amit Dhingra's laboratory at Washington State University gave rise to an alternative hypothesis which states tolerance within pea plant genotypes is not determined by the pigmentation of the pea line and additional genes are involved in providing total or partial tolerance to *Fsp* root rot. The aim of our investigation is to assess whether or not the anthocyanin synthesis pathway is involved in the tolerance some pea lines exhibit towards *Fsp*. We will evaluate the role of this pathway in the tolerance to *Fsp* through RNA silencing and the overexpression of the Flavanone-3-hydroxylase (F3H) gene involved in the anthocyanin pathway. The F3H gene has been silenced as well as overexpressed in the purple-seeded lines PI125673, PI175226 and Melrose. After agrobacterium transformation and two months under kanamycin selection, the initial signs of regenerative, transgenic plantlets have been observed. Putative transgenic plantlets will be confirmed via extraction of DNA, amplification and sequencing of involved transgenes.